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Out of sight, out of mind: Divestments and the global reallocation of pollutive assets[☆]

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ABSTRACT

We document a global reallocation of pollutive assets as a response to investor pressure: large firms facing increased investor pressure divest foreign-located pollutive assets to firms that are less in the limelight. There is no evidence of increased engagement in any other emission reduction activities. We estimate that 369 million metric tons (mt) of CO2e are reallocated via divestments in the post-Paris Agreement period. Our results indicate that investor pressure to decarbonize reshapes the global conglomerate structure of large firms.

1. Introduction

We analyze *global* firm-level carbon emission reduction strategies over the 2011–2021 period, covering 1354 listed firms in 45 countries, which are responsible for almost 4 billion metric tons (mt) of carbon emissions per annum. In particular, we ask the following questions: How much did firms reduce carbon emissions? Did those firms that were under increased pressure from investors, stakeholders, and the public reduce carbon emissions more? If yes, which strategies did these firms use to reduce emissions?

We make use of a comprehensive global data set on publicly listed firms' carbon emissions for the 2011–2021 period (the Carbon Disclosure Project data set, henceforth CDP). For each firm, we break down year-on-year changes in combined Scope 1 and 2 emissions into four distinct categories: [1] boundary of the firm (divestment or acquisition), [2] changes in output, [3] changes in methodology, and [4] a residual (i.e., a change in carbon intensity on a like-for-like basis). For [1], we hand-collect a global data set on buyer and seller locations of divested assets. To the best of our knowledge, our paper is the first to assess carbon reduction strategies by companies worldwide, and the

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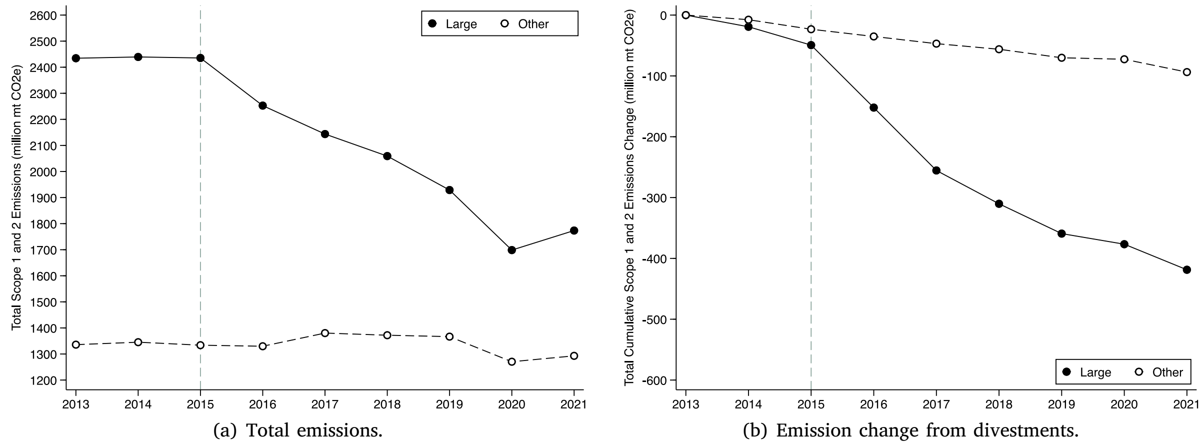


Fig. 1. Emissions and divestments around the 2015 Paris Agreement.
Panel (a) of this figure shows the total combined gross Scope 1 and 2 emissions for a balanced sample of 613 firms around the 2015 Paris Agreement (million mt CO2e), split by large emitters (N = 73) and other emitters (N = 540). Panel (b) of this figure shows the combined *cumulative* gross Scope 1 and 2 emissions (million mt CO2e) that firms divested since 2013 (base year) for the same sample of firms.

first to document the global nature of asset reallocation after the Paris Agreement.

We split our data set into two samples and two periods. *Large emitters* are firms targeted by Climate Action 100+, an investor-led scheme signed by more than 500 asset managers worldwide that aims to put pressure on the largest firms across the globe to reduce emissions, and *other emitters*, which comprises all other publicly listed firms. Large emitters are plausibly subject to increased pressure from investors, stakeholders, and the public to reduce their carbon footprint after the Paris Agreement. We compare the behavior of large emitters to other emitters in the same industry and region, both in the period before the Paris Agreement (2011–2015) and in the period thereafter (2016–2021). For example, we compare a publicly listed chemicals company that is a Climate Action 100+ focus firm (such as Bayer AG, Germany) with a publicly listed chemicals company that is not a Climate Action 100+ focus firm (such as Evonik Industries AG, Germany). While our control group firms are smaller, they do have a similar business model and similar emission intensities. Further, we address differences between treatment and control firms by explicitly matching firms on industry, country, and emission intensity. We report matched-sample results alongside the unmatched baseline results throughout the paper, and the results are consistent across specifications.

We document four key results: First, in the aggregate, large emitters reduced their combined Scope 1 and 2 emissions by 19% after the Paris Agreement relative to the period before the agreement, while other publicly listed firms did not reduce carbon emissions at all (see Panel A Fig. 1). Within-firm estimates confirm this trend, with large emitters reducing their emissions relative to other emitters by 13%–16% after the Paris Agreement, on average.

Second, changes to the firm boundary, driven by divestments, are the single largest contributor to emission reductions by large emitters compared to other emitters after the Paris Agreement (see Panel B of Fig. 1). Large emitters are 9 percentage points more likely to divest pollutive assets in the post-agreement period, an increase of over 75%. We do not find any significant difference between large emitters and other emitters after the Paris Agreement for any of the other categories (output, methodology, change in carbon emissions on a like-for-like basis).

Third, we analyze *why* large emitters divest pollutive assets after the Paris Agreement. We do so by analyzing firms' CDP responses about preceived climate risks [including physical, regulatory, and other risks (such as investor pressure)] and by analyzing the risk-factor section of large emitters' annual reports over time. We find that both large and other emitters report increased exposures to regulatory and physical risks after the Paris Agreement; however, we do not find any significant differences between the two groups. In contrast, we do find strong evidence that large emitters report more investor-related risks relative to other emitters after the Paris Agreement. We find consistent evidence when analyzing annual reports of large emitters. In 2013, the beginning of our sample period, only 3% of large emitters mentioned investor-related environmental risks. By 2021, the end of our sample period, this share increased to close to 50%, i.e., investor-related concerns rose markedly. We also show that the divestment effect is stronger for large emitters that actually report increased investor pressure. This suggests that investor pressure is an important channel for understanding increased divestment activity in the post-Paris Agreement period.

These key results are robust to a wide array of econometric specifications and data checks. The results hold when controlling for firm fixed effects, industry x time fixed effects, country x time fixed effects, or match-cohort x time fixed effects (in the matched-sample analyses). They also hold when excluding closures (firms sometimes, but rarely, report closures under the divestment category). Thus, the result cannot be explained by large emitters clustering in certain industries or regions, by different unobservable (time-invariant) firm characteristics, by differences in exit and entry rates, by large emitters closing down polluting plants, or by large emitters having higher emission intensities and therefore more scope to reduce emissions. We also explicitly distinguish the effects of investor pressure from the effects of regulatory pressure. Following Ben-David et al. (2021) we use the World Economic Forum (WEF) stringency of environmental regulation (SER) score to measure regulatory pressure. Our results are unaffected by controlling for the SER score as well as controlling for the SER score interacted with a Post-dummy. This is intuitive, as the SER score various across countries, while our treatment measure varies within countries, and we include country x year fixed effects throughout our specifications. We also analyze a worlwide sample of divestments using SDC data and find that there is no general differential divestment dynamic between large and small firms after 2015: post-2015 differences in divestments between large and small firms are only observed in industries with high carbon emissions. Furthermore, differences in divestment rates between large and small emitters only emerge after the 2015 Paris Agreement, suggesting we do not pick up a mechanical relation between large and small emitters that would hold in any period.

Fourth, using a matched sample of SDC Platinum and CDP as well as a hand-collected sample of divestments, we analyze the characteristics of divested assets and the buyers of these assets. Divested assets are typically assets that cannot be physically moved (production sites, distribution networks, or resource extraction sites) so that ownership changes without a physical relocation of assets. A typical example is the sale of Chinese plants by the Swiss cement manufacturer LafargeHolcim in 2018. We document that (i) investor overlap between buyers and sellers is limited, that is, assets are indeed sold to firms with different owners, (ii) emission-reducing divestments by large emitters are more likely to involve international assets and international buyers post-2015 (relative to divestments by control group firms), in particular from countries with lower environmental pressure, (iii) buyers of emission-reducing divestments by large emitters are more likely to be non-public firms post-2015 (again, relative to divestments by control group firms), (iv) overall, the divestment activity leads to a net reallocation of ownership from European firms to firms in the rest of the world, with European firms primarily divesting assets outside their home region (i.e., non-domestic assets), (v) divestments are associated with positive announcement returns in the post-Paris-agreement period, suggesting that divestments are beneficial to the shareholders of the divesting firms. We find no evidence that sellers retain (partial) control by selling assets to *connected firms*, i.e., joint ventures or strategic alliance partners. Taken together, our evidence is consistent with the narrative that dirty assets tend to be acquired by firms that are less in the limelight.[1]

The CDP data relies on self-reported information. A difference in divestment activities between large and small emitters could, in theory, arise if large firms overreport divestment activity or small firms underreport divestment activity after the Paris Agreement. Note that incentives, if any, should lead large firms to underreport divestments. To ensure our results are not driven by post-Paris differences in reporting, we manually verify divestment activities for large emitters as well as for other emitters using a hand-collected data set from annual reports and company filings. We do not find any evidence that differences in reporting rates drive our results. Further, we obtain similar results if we only use firm-years for which reporting was certified by a third party, and we document a similar pattern using SDC divestment data.

Our analysis comes with one key caveat: we are not able to track carbon emissions after dirty assets have been divested. Tracking carbon emissions post-divestment is only feasible when dirty assets are sold to firms that are subject to reporting requirements themselves. The nature of the reallocation we document—a global reallocation of dirty assets to firms that do not report emissions—is precisely what makes tracking post-divestment emissions impossible, but at the same time makes documenting these patterns most relevant.

Related literature. We make three key contributions to the literature: First, we contribute to the literature that documents how firms modify their operations and asset base to look green under pressure. Ben-David et al. (2021) document that firms headquartered in countries with strict environmental regulation perform their polluting activities abroad in countries with relatively weaker policies, while Bartram et al. (2022) provides evidence that firms reallocate their emissions away from California to other states after the implementation of the cap-and-trade program. Both papers document effects of regulatory policies *within* a firm's boundaries; in contrast, we show that firms facing increased investor pressure divest foreign-located pollutive assets. This is consistent with regulation working at the asset location level, while investor pressure works at the group level, so that shifting emissions *within* the firm does not help to evade investor pressure. Duchin et al. (2025) focus on U.S. firms' domestic divestment activities and find that U.S. firms respond to environmental pressures (from investors or regulators) by divesting pollutive plants.[2] Buyers are firms facing weaker environmental pressures that have supply chain relationships or joint ventures with the sellers. Relatedly, both Li and Zhou (2017) and Dai et al. (2024) document outsourcing of emissions to suppliers. These papers document reallocation efforts that remain within the firm's perimeter and are thus captured by broader firm-level measures such as group-level Scope-3 emissions. In contrast, we are the first to document that investor pressure leads to a global reallocation of pollutive assets to unconnected buyers fully outside the seller's control. Affected firms divest foreign-located assets, thereby reshaping the global conglomerate structure of large firms. The global reallocation we document is large in scale, with 369 million mt CO2e of carbon emissions being reallocated via divestments in the post-Paris-agreement period, approximately the size of France's total annual carbon emissions.

Second, we provide a method to decompose changes in carbon emission for the near-universe of public firms worldwide into four categories: [1] boundary of the firm, [2] changes in output, [3] changes in methodology, [4] changes in carbon emissions on a like-for-like basis. Any researcher who is interested in the effects of a policy X on firm-level carbon emissions can use this decomposition to better understand the environmental impact of policy X. Applications include: (i) sustainable finance instruments (e.g., Flammer, 2021; Kim et al., 2025) (ii) impact investing and pressure by activist investors (e.g., Akey and Appel, 2019; Azar et al., 2021; Choi et al., 2021; Hong et al., 2023; Ilhan et al., 2023; Krueger et al., 2020; Shive and Forster, 2020), (iii) the role of banks in inducing firms to become greener (e.g., Ivanov et al., 2024; Kacperczyk and Peydró, 2021), (iv) the role of disclosure requirements (e.g., Bonetti et al., 2023; Downar et al., 2021; Jouvenot and Krueger, 2019; Sautner et al., 2023; Tomar, 2023), (v) environmental regulation (e.g., Colmer et al., 2024; Dechezleprêtre et al., 2023; He et al., 2020; Hsu et al., 2023), or (vi) self-commitments (e.g., Bolton and Kacperczyk, 2026; Brandon et al., 2022; Comello et al., 2021; Dahlmann et al., 2019; Freiberg et al., 2021; Ioannou et al., 2016). Our decomposition can be used to go beyond analyzing firm-level carbon emissions, but instead to understand where changes in carbon emissions stem from. This is important, because the fundamental conclusion of this literature hinges on whether reductions in carbon emissions are "true" reductions stemming from efficiency gains or are simply driven by changes in the method used to calculate carbon emissions or changes to a firm's boundary without any effect on global carbon emissions.

Third, we relate to the work on corporate governance and ESG investing in a global context. Bisetti et al. (2026) show that firms restructure their global supply chains to avoid suppliers associated with environmental and social incidents. Brandon et al. (2022) find that institutional investors who sign the Principles for Responsible Investment (PRI) have better portfolio ESG scores than non-PRI signatories. This, however, is only the case for investors outside of the U.S. That is, U.S. investors who claim to follow responsible investment principles appear not to do so in practice (see also Matos, 2020). Pastor et al. (2025) examine financial institutions' ESG-related portfolio tilts and document that portfolios of European institutions are greener than those of U.S. institutions. Our results complement this work by documenting that large emitters located in Europe, in particular, report increased investor pressure and reduced emissions after the Paris Agreement.

Taken together, our paper highlights the *global* nature of asset reallocation after the Paris Agreement. It suggests that divestments of foreign-located brown assets, with a full change in control, are a key response of firms to investor pressure. Researchers analyzing firm-level carbon emissions should therefore carefully distinguish between reductions due to genuine operational improvements and reductions due to changes in firm boundaries. We provide clear guidance for such a decomposition using generally accessible data bases.

[1] Note that "less in the limelight" only refers to environmental topics here. Buyers of dirty assets might be subject to similar scrutiny on their financial performance or other topics.

[2] Zhou (2022) find that publicly listed energy firms divest pollutive assets (at the time of writing, only an abstract of this paper is available). Gözlügöl and Ringe (2023) provides case studies on the divestment of carbon-intensive assets from publicly listed firms to private firms. Ecker and Keeve (2025) provide evidence that mandatory disclosure requirements in the UK led firms to sell assets either to firms that have the same ultimate influential owner, or to firms within the supplier–customer relationship.

2. Data and descriptive statistics

Emission data. We obtain firm-level emission data from the Carbon Disclosure Project (CDP) Climate Change dataset. CDP is the most comprehensive source of information on carbon emissions of public firms across the globe and provides estimates of firms' CO2 emissions on an annual basis. Emissions are categorized into three "scopes" following the Greenhouse Gas (GHG) Protocol Corporate Standard: Scope 1 emissions are direct GHG emissions from controlled or owned sources. Scope 2 emissions are indirect GHG emissions from the purchase of electricity, steam, heat, or cooling. Scope 3 emissions are indirect emissions not produced by the company itself, and not contained in Scope 2 emissions. This category comprises indirect emissions that occur in the firm's value chain (upstream or downstream). We focus on Scope 1 and 2 emissions, i.e., emissions that are directly under the reporting firms' control.

We obtain further information on various aspects of firms' GHG emissions from the CDP database. This information, available from 2011 onwards, includes the reasons firms give for why their combined gross global Scope 1 and 2 emissions increased or decreased relative to the previous year. Firms are required to break-down year-on-year emission changes (in percent of previous year emissions) into 11 reasons, which we group into 4 categories[3]:

(1) *boundary of the firm* (divestment, acquisition, merger),
(2) *changes in output* (change in output[4]),
(3) *changes in methodology* (change in methodology,[5] change in boundary[6]), and
(4) a *residual*; that is, a change in carbon intensity on a like-for-like basis. The residual includes any emission reduction activities beyond divestment strategies, changes in output, or changes in the methodology. The two most important emission reduction categories in the residual category are "changes in renewable energy consumption" and "other emission reduction activities".[7]

Firms indicate in which direction the respective reason affected emissions (increase or decrease) and by how much. Note that the direction is category-specific, i.e., firms can report that certain reasons increased emissions while other reasons decreased emissions in the same year. That is, individual reasons might increase (decrease) emissions even though the net emission change in the year is negative (positive).

Fig. 2 exemplarily shows the response by the Spanish natural gas and electrical energy utilities company Naturgy Energy Group SA to the 2022 CDP survey question C7.9a about *"the reasons for any change in [the firm's] gross global emissions (Scope 1 and 2 combined) [...]"*. Naturgy's response provides information on how the firm's total emission change from 2020 to 2021 can be broken down into different categories.[8] Divestments decreased emissions by 6.08%, changes in output increased emissions by 3.37%, there was no change in the methodology, and the carbon emissions on a like-for-like basis decreased by 10.26% (2.99% + 7.39%–0.12%), yielding a net emission change of −6.08% + 3.37% + 0%-10.26% = −12.97%. This exactly corresponds to Naturgy's total reported Scope 1 and 2 emissions change from 2020 to 2021.[9] Firms are further asked to provide a text description how emissions are allocated to the different categories (see footnotes to Fig. 2).

Sample selection. The raw sample comprises 19,857 firm-years for public non-financial firms (non-missing ISIN) over the 2011 (the first year with available CDP information on emission reduction categories) to 2021 period that can be linked to S&P's Compustat Global database or S&P's Compustat North America database. We apply the following additional filters: (i) we require that firms are in the database for at least 3 years and that firms report information for at least one year in both the pre- and post-Paris Agreement period (−6,317 firm-years; −20% of total baseline sample Scope 1 and 2 emissions), (ii) we remove firms with large outliers, i.e., firms that have reporting years in which the absolute combined Scope 1 and 2 emission growth rate exceeds 500% (−608 firm-years; −6.6% of total baseline sample Scope 1 and 2 emissions),[10] and (iii) firms with very small average emission levels (combined Scope 1 and 2 emissions <1000 mt CO2e) in the pre-Paris Agreement period (−579 firm-years; −0.04% of total baseline sample Scope 1 and 2 emissions). The final sample comprises 12,353 firm-years and 1354 public firms that are incorporated in 45 different countries. We define the panel based on "reporting years", i.e., the year in which the respective reporting period ends.[11] We supplement the dataset with balance sheet information on firms from S&P's Compustat Global and Compustat North America as well as with stock price information from Refinitiv Datastream.

[3] Note that most but not all reasons are available for all survey waves. The reasons "change in renewable energy consumption" and "change in physical operating conditions" were only added in the most recent survey waves.

[4] According to CDP, *change in output* "refers to changes that occur as a result of changes (increases or decreases) in your business output (i.e. a product or service)". The output category does not include abatement activities nor changes in renewable energy consumption (both are separate categories in CDP) but focusses on changes in production output (examples given by CDP include organic growth, e.g., the launch of a new product, or changes in production due to demand variation).

[5] *Change in methodology* is defined by CDP as "changes that occur due to modifications in the way that the inventory is calculated, for example, changes in emissions factors used or changes in methodology protocol followed". CDP further clarifies that this category should also include changes that result from modifications in accounting practices. Thus, this category includes both changes in measurement methods as well as changes in accounting practices. Overall, the category reflects any changes to emissions that solely result from the way emissions are reported but not from actual changes in physical emissions.

[6] The CDP reporting guidance describes *change in boundary* as "Changes in the boundary used for your inventory calculation, i.e., changing from financial control to operational control". Thus, this reason most adequately fits into the *changes in methodology* category.

[7] CDP indicates that firms should "report the change in your organization's emissions because of the consumption of self-generated or purchased renewable energy" in the *change in renewable energy* consumption category. According to CDP, the *other emission reduction activities category* "refers to changes in emissions that have occurred because of proactive emissions reduction initiatives or activities [...] other than those caused by a change in renewable energy consumption".

[8] The data from Fig. 2 is available via Link to Naturgy Energy 2022 CDP Survey by scrolling down to C7.9a (access is free of charge, but users need to be registered with CDP). Data for other firms is also freely accessible via Link CDP Seach. Note that each CDP survey wave contains information about the firms' activities in the previous year. That is, the 2022 survey wave asks about information on emission activity for the year 2021.

[9] In this example the firm's total emission change can be perfectly decomposed into different categories. This, however, is not always the case, i.e., reporting is noisy and the sum across all categories might not exactly correspond to the firm's reported change in total Scope 1 and 2 emissions over the respective period. Figure A-1 in the Internet Appendix shows the histogram for the "pure emission growth residual", i.e., the difference between the total Scope 1 and 2 emission growth rate for firm i from year $t-1$ to t (in percentage points) and the total emission growth rate implied by the 11 emission change categories described in Fig. 2. As noted above, we include this "pure residual" in the *residual* category (4) such that the sum across categories (1) to (4) always corresponds exactly to the firm's observed Scope 1 and 2 growth rate. While reporting is clearly noisy, the residuum is centered around zero and small for most of the sample.

[10] Extremely large emissions growth rates are generally the result of reporting errors. We remove firms with spotty reporting as growth rates cannot be reliably adjusted with the available information.

[11] For most firms in the reporting years coincide with calendar years, i.e., firms generally report information for the January to December period.

Reason	Direction of change	Emissions value (percentage)	Please explain calculation
Change in renewable energy consumption	Decreased	2.99	*1)
Other emission reduction activities	Decreased	7.39	*2)
Divestment	Decreased	6.08	*3)
Acquisitions			
Mergers			
Change in output	Increased	3.37	*4)
Change in methodology			
Change in boundary			
Change in physical operating conditions			
Unidentified			
Other	Increased	0.12	*5)

***1)** "In Electricity Generation, a) the increase in renewable capacity of 73MW in wind capacity in Spain in 2021 resulted in 45,755 tCO2e avoided [...] b) the increase in renewable capacity of 206MW in wind capacity and 101MW in solar PV capacity in Chile in 2021 resulted in 177,501 tCO2e avoided [...] c) the increase in renewable capacity of 181MW in wind capacity in Australia in 2021 resulted in 238,968 tCO2e avoided [...] In total, the emissions reduction activities described above avoided the emission of 462,224 tCO2e. The emissions (scope 1 and 2) in 2020 were 15,455,482 tCO2e. Therefore, the percentage of emission decrease can be calculated as 462,224 tCO2e / 15,455,482 tCO2e = 2.99%. [...]"

***2)** "Regarding Scope 1, a) in Electricity Generation the shut-down of all coal power plants ins Spain implies a reduction of 1,067,936 tCO2e; b) in Electricity Generation as a result of the Energy Efficiency Operational Plan (E.E.O.P), resulting in a reduction in specific fuel consumptions, [...] which implies the reduction of 73,788 tCO2e; Regarding Scope 2, c) in Electricity Distribution, the decrease in electricity losses in transport and distribution in Spain implies a reduction of 5 tCO2e. [...] the percentage of emission decrease can be calculated as 1,141,729 tCO2e / 15,455,482 tCO2e = 7.39%."

***3)** "The divestment in electricity networks in Chile implies a reduction of 939,057 tCO2e (scopes 1 and 2). [...] the percentage of emission decrease can be calculated as 939,057 tCO2e / 15,455,482 tCO2e = 6.08%."

***4)** "a) The increase in LNG activities implies an increase of 359,712 tCO2e; b) the increase in natural gas distribution activities imply an increase of 119,597 tCO2e; c) the increase in electricity distribution activities implies an increase of 41,943 tCO2e; [...] the percentage of emission decrease can be calculated as 521,252 tCO2e / 15,455,482 tCO2e = 3.37%."

***5)** "Increase in emissions due to different small factors. The sum of all of them accounts for an increase in emissions of 18,583 tCO2e (0.12% of total emissions in 2020)."

Fig. 2. CDP Information on changes in gross global Scope 1 and 2 emissions.
This figure shows the response by Naturgy Energy Group SA to question C7.9a (*"Identify the reasons for any change in your gross global emissions (Scope 1 and 2 combined), and for each of them specify how your emissions compare to the previous year".*) for the 2022 CDP survey wave (which asks about information on emission activity for the year 2021). According to the 2022 survey response, Naturgy's total Scope 1 and 2 emissions for the year 2021 were 13,452,307 tCO2e. In the previous year, Naturgy reported 15,455,482 tCO2e, i.e., Scope 1 and 2 emissions declined by 12.97% from 2020 to 2021. Naturgy's response to question C7.9a indicates how this change can be broken down into different categories. Changes in energy consumption, other emission reduction activities, and divestments decreased emissions by 16.46% (2.99 + 7.39 + 6.08), while output changes and other miscellaneous factors increased emissions by 3.49% (3.37 + 0.12), yielding a net emission change of 3.49–16.46 = −12.97%.

Large emitters. We classify all Climate Action 100+ focus companies as "large emitters". Climate Action 100+ is an investor-led scheme signed by more than 500 asset managers worldwide that aims at putting pressure on 166 of the largest firms across the globe to reduce emissions. We use this list of firms as it avoids having to rely on ad-hoc emission level cut-off rules and because it comprises the most visible large emitters that have been increasingly under public pressure, particularly since the 2015 Paris Agreement.[12] However, we obtain similar result if we use alternative treatment definitions (see Section 5). We can identify 111 of the 166 Climate Action 100+ focus companies in our final sample. While these large emitters make up for only about 8% of all firms in our final sample, they, on average, account for about 60% of total emissions.

Divested assets. We hand-collect detailed information on divested assets of large emitters from company filings, press releases, and other available resources. This includes information on buyers and assets (type, location). In addition, we collect divestment information from SDC Platinum. We discuss both samples and their differences in detail in Section 4.2.

Climate risks and investor pressure. In later sections, we further supplement the dataset with information on firms' exposure to regulatory and physical climate risks as well as information on firms' exposure to investor pressure. The CDP questionnaire explicitly asks firms about their perceived climate risks, categorized into physical, regulatory, and other risks. We extract information on exposure to investor pressure from text descriptions in the "other category". We provide details in Section 4.

Descriptive statistics. Table 1 reports descriptive statistics on our final sample. The firms in our sample are large with median total assets of 9 billion USD. The Scope 1 (Scope 2) emission distribution is highly skewed with a median of 146 (185) thousand mt CO2e and a mean of 3.5 (0.7) million mt CO2e. Emissions grow by 1.82 p.p. per year on average.[13] Note that the 1.82 p.p. growth rate is equally weighted, the weighted emissions growth rate is negative (see Fig. 1 in the introduction) as large firms decrease emissions (in particular via divestments), while smaller firms increase emissions (partially from acquiring assets divested by larger firms). The total sample is split relatively evenly

[12] Note that Climate Action 100+ was formally launched only in December 2017 while we use the 2015 Paris Agreement as a shock to investor awareness. Note, however, that several initiatives predate the formal launch: in December 2015, the "2015 Global Investor Statement on Climate Change" was developed by 409 investors representing USD 24 trillion in assets and in September 2016 the initial meeting that led to the Climate Action 100+ initiative took place. This evidence suggests that investor pressure on large emitters predates the formal 2017 launch of Climate Action 100+, which then merely consolidated engagements under a coordinated umbrella. Our results are robust to excluding the years 2015/2016 and using only 2011–2014 as pre-period and 2017–2021 as post-period.

[13] Note that the number of observations for the scope 1 + 2 growth rate is somewhat lower than for the emission level because calculating growth rates requires information on previous year emissions (that is, growth rates are not defined for the first year that a firm is observed in the database). Similarly, the *residual* category in Panel C of Table 1 requires information on the total emission growth rate, as the category includes any unexplained emission changes relative to the observed growth rate, see footnote 9. Excluding all firm-years with missing emission growth rates from the analyses yields very similar results.

Table 1
Descriptive statistics.

	Mean	Median	Std. Dev	Obs.
A. Firm characteristics				
Large emitter (0/1)	0.09	0.00	0.29	12,353
Total assets ('000 million USD)	24.44	9.02	43.01	12,353
Total revenue ('000 million USD)	15.85	6.48	25.96	12,353
Europe (0/1)	0.37	0.00	0.48	12,353
North America (0/1)	0.28	0.00	0.45	12,353
Rest of the world (0/1)	0.35	0.00	0.48	12,353
B. Emission data				
Scope 1 ('000 metric tonnes CO2e)	3497.82	146.03	10,641.61	12,340
Scope 2 ('000 metric tonnes CO2e)	693.76	185.43	1428.05	11,868
Scope 1+2 Growth Rate (%)	1.82	−1.01	25.29	10,785
C. Emission breakdown				
Firm boundary				
Firm boundary net (%)	0.46	0.00	5.24	12,331
Divestment (0/1)	0.12	0.00	0.32	12,353
M&A (0/1)	0.14	0.00	0.35	12,353
Output				
Output net (%)	1.38	0.00	7.32	12,331
Decreased output (0/1)	0.17	0.00	0.37	12,353
Increased output (0/1)	0.32	0.00	0.47	12,353
Method				
Method net (%)	0.63	0.00	5.67	12,331
Decreased method (0/1)	0.11	0.00	0.32	12,353
Increased method (0/1)	0.15	0.00	0.36	12,353
Residual				
Residual net (%)	−1.39	−1.77	21.45	10,785
Residual < −1% (0/1)	0.55	1.00	0.50	10,785
Residual < −5% (0/1)	0.32	0.00	0.47	10,785
Residual > 1% (0/1)	0.27	0.00	0.44	10,785
Residual > 5% (0/1)	0.16	0.00	0.37	10,785

This table reports descriptive statistics at the firm- (reporting) year level. The sample period is 2011 to 2021.

across geographic regions: Europe (37%), North America (28%), Rest of the World (35%).

We report net annual emission changes (in percent of previous year total emissions) for the four aggregate categories j = {Firm boundary, Output, Method, Residual}. On average, emissions increase by 0.46 p.p. per year because of changes in firm boundary, by 1.38 p.p. per year because of output changes, and by 0.63 p.p. per year because of changes in the methodology. The net residual; that is, a change in carbon intensity on a like-for-like basis, decreases emissions by −1.39 p.p. per year, on average. Overall, emissions decrease because of a decrease in emissions on a like-for-like basis, but increase because of increases in output. Changes to the boundary of the firm increase emissions on average; however, we will document a dramatic difference between large and small emitters in our empirical analysis below.

We further report information on indicator variables equal to one if firm i indicates that their combined global Scope 1 and 2 emissions changed in year t because of one of the four categories j, separately for emission increases and decreases. In 12% of firm-years companies indicate that emissions were reduced because of divestments, while in 14% of firm-years emissions increase because of M&A. Output changes decrease emissions in 17% of cases and increase emissions in 32% of cases (in the remaining 51% of cases firms do not report significant output changes that affected their carbon emissions). Changes in the method decrease reported emissions in 11% of cases, and increase emissions in 15% of cases.

Table 2 reports descriptive statistics for the 111 "large emitters" (treatment firms). Unsurprisingly, treatment firms are large, both in terms of total asset (mean: 92 billion USD) and emissions (mean Scope 1 emissions: 23.5 million mt CO2e). Panel B reports details on the geographical distribution. The majority of treatment firms are located in North America (N = 41) or Europe (N = 46). Individual countries with the most treatment firms are the US (N = 35), Germany (N = 10), France (N = 9), the UK (N = 9), and Japan (N = 8). Panel C reports details on the distribution across industries. Most treatment firms are in oil and gas, transportation, or chemicals sectors.

3. Results

3.1. Baseline effect on firm emissions

3.1.1. The Paris Agreement

We start by analyzing the behavior of large emitters around the 2015 Paris Agreement ("the Agreement"). The Agreement, signed by 194 parties in December 2015, formulated the goal to keep the rise in mean global temperature to well below 2°C above pre-industrial levels. The Agreement increased both the awareness of risks tied to GHG emissions and the prospect of tighter regulatory frameworks to limit emissions.

This event has been used in a variety of recent studies (e.g., Bolton and Kacperczyk, 2021; Ginglinger and Moreau, 2023; Ilhan et al., 2021; Mueller and Sfrappini, 2025; Ramadorai and Zeni, 2024; Reghezza et al., 2022; Seltzer et al., 2022) and constitutes a shock to firms' environmental policies. Even though the meeting was planned for a long time, the outcome was uncertain even weeks before the conference (see, e.g., the references provided in Seltzer et al., 2022). Further, the scope, both in terms of the ambition of the goals that were set and the number of participants that agreed to the terms, was surprising to many observers.

The event implied that in particular high GHG emitting firms would face an increase in climate regulatory risk. For instance, Ramadorai and Zeni (2024) provide evidence that firms upwardly revised their beliefs about future climate regulation intensity. Engle et al. (2020) find a significant increase in their climate change news index, indicating a significant shift in public awareness. Seltzer et al. (2022) provide evidence that investor concerns about climate and other regulatory risks increased after the Agreement, affecting firm's bond spreads.

3.1.2. Empirical strategy

We examine the effect of increased pressure on large emitters after the Paris Agreement using a difference-in-differences (DiD) framework. We run the following standard DiD specification:

$$\ln(\mathrm{Y})_{i,t} = \beta \text{ Large Em}_i \times \mathrm{Post}_t + \alpha_{i,t}^{ind,yr} + \alpha_{i,t}^{cntry,yr} + Z_i' \times \mathrm{Post}_t + \epsilon_{i,t}, \quad (1)$$

where $Y_{i,t}$ is a measure of firm i's GHG emissions in mt CO2e (Scope 1 or Scope 2) in reporting year t. $Large\ Em_i$ is an indicator variable equal to one if firm i is a large emitter, as defined in Section 2, and zero otherwise. $Post$ is an indicator variable equal to one for reporting years after 2015, and zero otherwise. $\alpha_{i,t}^{ind,yr}$ are industry (2-digit SIC code) × year fixed effects. $\alpha_{i,t}^{cntry,yr}$ are country × year fixed effects. Z is a set of firm-level controls (pre-event average leverage and profitability). Standard errors are clustered at the firm level.

A potential concern is that control group firms might have lower emission intensities and thus less room to reduce emissions. As a result, our treatment-control comparison may capture differential dynamics between high- and low-emission-intensity firms that are unrelated to investor pressure, but might be driven by, e.g., differential exposure to technological advancements. We therefore construct a matched control group by matching on industry (exact match), country (exact match), and emission intensity (nearest-neighbor matching, retaining the three closest control firms).[14] Potential matches are further restricted to firms

[14] We drop matches with ΔIntensity ≥ 3 to ensure that control firms indeed have similar emission intensities. We typically find matches with very similar emission intensities for all our treatment firms and this condition only drops two treatment firms.

Table 2
Descriptive statistics – Large emitters.

Panel A. Firm characteristics (averages over 2011 to 2015 period)	Mean	Median	Std. Dev	Obs.
Total assets ('000 million USD)	92.33	66.45	74.47	111
Total revenue ('000 million USD)	59.62	46.35	47.80	111
Scope 1 ('000 metric tonnes CO2e)	23,460.00	12,429.31	25,201.66	111
Scope 2 ('000 metric tonnes CO2e)	2719.39	1594.59	2789.60	108

Panel B. Geographical distribution	#	Panel C. Industries (2-digit SIC)	#
North America (N = 41)		Electric and Gas services (49)	26
USA	35	Petroleum refining (29)	15
Canada	6	Transportation equipment (37)	15
		Chemicals (28)	9
Europe (N = 46)		Oil and Gas extraction (13)	6
Austria	1	Metal mining (10)	5
Denmark	1	Food and Kindred products (20)	5
Finland	1	Stone, Clay, Glass, and Concrete (32)	5
France	9	Primary metal (33)	5
Germany	10	Transportation by air (45)	4
Ireland	1	Public sector (Other) (99)	4
Italy	3	Other	13
Luxembourg	1		
Netherlands	3		
Norway	1		
Spain	3		
Switzerland	3		
United Kingdom	9		
Other Countries (N = 24)			
Australia	5		
Brazil	3		
Colombia	1		
Japan	8		
Mexico	1		
Russia	1		
South Africa	1		
South Korea	2		
Taiwan	1		
Thailand	1		

This table reports descriptive statistics for the sample of 111 large CO2 emitters (see main text for details).

with below-median Scope 1 emissions within the country–industry cluster. The matching reduces the treatment sample slightly (by about 20%) while effectively eliminating differences in emission intensity between treatment and control firms (see Internet Appendix A.3). The matched-sample analysis mirror model (1) but replace country × year and industry × year fixed effects with match-cohort × year fixed effects.[15] Since country and industry are embedded in the matching procedure, any country- or industry-level trends are absorbed by the cohort × year fixed effects.

3.1.3. Emissions around the Paris Agreement

We start by estimating a dynamic version of Eq. (1) by including separate year dummies instead of the *Post* 2015 indicator. Fig. 3, Panel A, illustrates that there are no significantly different pre-trends in combined Scope 1 and 2 emissions of Large Emitters ("treatment firms") versus other public firms with positive emission levels ("control firms") before the Paris Agreement in 2015 in the baseline panel estimation. Following the Agreement, emissions start to decrease visibly for treatment relative to control firms, and the effect is statistically significant. In other words, even if there was a decrease in emissions already before the Paris Agreement, this trend was not different for treatment compared to control firms. The economic magnitude of the treatment effect is large: Scope 1 and 2 emissions decrease by up 15% for treatment versus control firms until 2021 relative to the 2015 emission levels. Results for the emission-intensity–matched sample (Panel B) are similar but somewhat noisier, reflecting that the control group consists of smaller firms with lower absolute emission levels, which naturally leads to greater variability in emission changes.

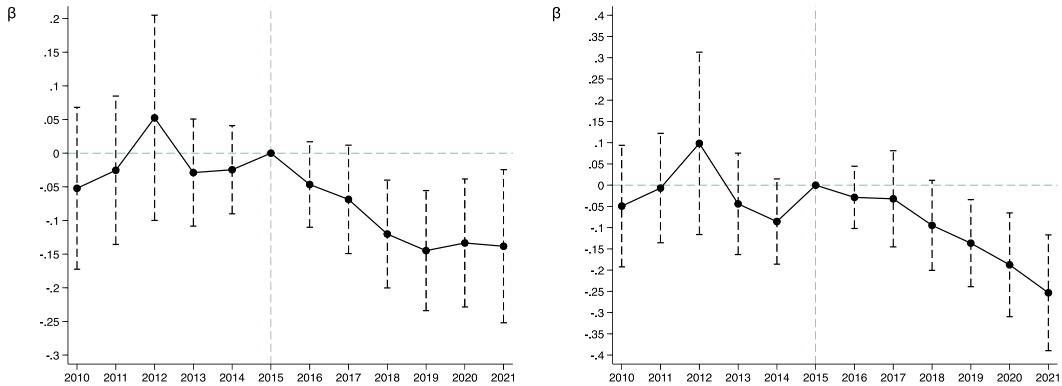
Table 3 confirms this result using a standard DiD design, i.e., the model described in Eq. (1). Column 1 documents that Scope 1 emissions decrease, on average, by 16% for treatment relative to control firms post 2015, and the effect is highly statistically significant. Column 2 includes 2-digit SIC code dummies interacted with (reporting-) year indicators as well as country dummies interacted with (reporting-) year indicators to account for differences in emission reduction activities across industries and across countries over time. The economic magnitude of the treatment effect is only marginally reduced. Column 3 examines effects on Scope 2 emissions, documenting that there is no measurable effect on Scope 2 emissions. Overall, the baseline effects on firm emissions show that *Large Emitters* significantly decreased their Scope 1 (but not Scope 2) emissions after the Paris Agreement relative to other emitters. Column 4 shows that there is not only a decline in emission levels but also emission intensity decreases for treatment firms relative to control firms after the Paris Agreement. Column 5 restricts the sample to firms in high-emission industries (above median pre-Paris emission intensity), with consistent results. Columns 6 to 8 report results for the emission-intensity–matched sample. Despite the significant reduction in sample size, results are very similar.

3.2. Reasons for changes in firm emissions

3.2.1. Baseline results

CDP asks firms to indicate why their combined Scope 1 and 2 emissions changed relative to the previous year. As discussed in Section 2, we classify reasons into four broad categories: (i) firm boundary, (ii)

[15] Indicators for each cluster of treated firms and their matched control firms interacted with year dummies.



(a) Baseline. (b) Intensity-matched.

Fig. 3. Dynamic effect on firm emissions.
This figure examines the combined Scope 1 and 2 emissions of large emitters around the 2015 Paris Agreement. Results are reported for two samples: (i) the full baseline panel and (ii) emission-intensity matching. See the main text for details on the matching procedures. Estimated coefficients are from the following regression specification:
$\ln(\text{Scope } 1{+}2_{i,t}) = \sum_{k=2010}^{2021} \beta_k \left(\text{Large Emitter } (0/1)_i \times \text{Year k } (0/1)_t\right) + \alpha_{i,t}^{ind,yr} + \alpha_{i,t}^{cntry,yr} + Z_i' \times \text{Post}_t + \delta_i + \epsilon_{i,t}$,
where *Large Emitter*$_i$ equals one if firm i is a larger CO2 emitter (defined in more detail in the main text), and zero otherwise. *Year k*$_t$ equals one in (reporting) year k, and zero otherwise (2015 is the omitted category). *Scope 1 + 2*$_{it}$ is the gross global combined Scope 1 and 2 emission (in metric tones CO2e) of firm i in reporting year t. δ_i denotes firm fixed effects. $\alpha_{i,t}^{ind,yr}$ are industry (2-digit SIC code) × year fixed effects. $\alpha_{i,t}^{cntry,yr}$ are country × year fixed effects. Z is a set of firm-level controls (pre-event average leverage and profitability). The dashed lines represent 90% confidence intervals, adjusted for firm-level clustering. Note that the matched sample regressions include match-cohort × year fixed effects instead of industry × year and country × year fixed effects.

Table 3
Changes in firm emissions.

Sample:	Base					Intensity-matched		
Restriction:					High Em industries			
Variable:	ln(Scope 1) (1)	ln(Scope 1) (2)	ln(Scope 2) (3)	Δ Intensity (4)	ln(Scope 1) (5)	ln(Scope 1) (6)	ln(Scope 2) (7)	Δ Intensity (8)
Large Em$_i$ × Post$_t$	−0.162*** (0.005)	−0.127** (0.038)	−0.016 (0.844)	−0.040*** (0.001)	−0.139** (0.028)	−0.121* (0.095)	0.056 (0.636)	−0.054*** (0.002)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	–	–	–	–	–	–	–
Firm controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry × Year	–	Yes	Yes	Yes	Yes	–	–	–
Country × Year	–	Yes	Yes	Yes	Yes	–	–	–
Cohort × Year	–	–	–	–	–	Yes	Yes	Yes
Observations	12,331	12,172	11,660	11,700	6250	2707	2589	2416
Adj R^2	0.96	0.96	0.93	0.11	0.96	0.98	0.86	−0.09

This table examines the emission activity of large emitters around the 2015 Paris Agreement. The unit of observation is the firm-year level i,t. The sample period is 2011 to 2021. *Large Em* equals one if firm i is a large CO2 emitter (defined in more detail in the main text), and zero otherwise. *Post* is an indicator variable that is equal to one for firm reporting years after 2015, and zero otherwise. *Scope* is the gross global emission (in metric tonnes CO2e) of firm i in reporting year t. Columns 1–2 and 5–6 report results for Scope 1 emissions; columns 3 and 7 report results for Scope 2 emissions. In column 5 the sample is restricted to industries with an above median (pre-Paris) emission intensity. *Δ Intensity* is the change in Scope 1 emission intensity of firm i from reporting year $t-1$ to t. Emission intensity is defined as gross global Scope 1 emission ('000 metric tonnes CO2e) scaled by firm revenue (million USD). Results are reported for two samples: (i) the full baseline panel and (ii) emission-intensity matching. In the emission-intensity–matched sample, treated firms are matched to control firms with similar emission intensity within the same country and industry. See the main text for details. The regressions include firm fixed effects, year fixed effects, year × industry (2-digit SIC code) fixed effects, year × country fixed effects, and match-cohort × year fixed effects, when indicated. Further controls include firm-level characteristics (pre-event average leverage and profitability interacted with *Post*). p-values based on robust standard errors, clustered at the firm level, are reported in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

output, (iii) method, (iv) residual. We start by defining indicator variables that are equal to one if firm i indicates that the respective category is responsible for an emission change in year t, and zero otherwise. We further distinguish between emission increases and decreases (for the firm boundary category this is equivalent to distinguishing between divestments and M&A). Given that the residual category is non-zero for most firm years (albeit often small), we define indicator variables equal to one if the residual is above/below 5%/−5%.[16] We estimate linear probability models similar to the setup described in Eq. (1), and report the results in Table 4.

Panel A reports results for the likelihood that firm i indicates that the respective activity reduced emissions in year t. We find a highly statistically and economically significant effect for divestments for both samples. Treatment firms are 9–11 p.p. more likely to report that divestment activities decreased emissions relative to control group firms and relative to the period before the Paris Agreement. This effect is large: relative to the unconditional mean of 12%, a 9 p.p. increase (unmatched estimate from column 1) translates into more than a 75% higher likelihood that *Large Emitters* attribute emission reductions to divestment activities in the post-Paris period.

[16] Internet Appendix Table A-1 reports results using a +1%/−1% cutoff for robustness.

Table 4
Reasons for changes in firm emissions.

Panel A. Activities that **decrease** emissions

Sample:	Base	Matched	Base	Matched	Base	Matched	Base	Matched
Variable:	Divestments (0/1)		Output (0/1)		Method (0/1)		Residual < − 5% (0/1)	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Large $\text{Em}_i \times \text{Post}_t$	0.089***	0.106***	0.037	0.003	−0.030	−0.080**	−0.080**	−0.017
	(0.005)	(0.005)	(0.216)	(0.944)	(0.241)	(0.011)	(0.027)	(0.713)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry × Year	Yes	–	Yes	–	Yes	–	Yes	–
Country × Year	Yes	–	Yes	–	Yes	–	Yes	–
Cohort × Year	–	Yes	–	Yes	–	Yes	–	Yes
Observations	12,193	2711	12,193	2711	12,193	2711	10,599	2377
Adj R^2	0.25	0.30	0.17	0.08	0.14	0.10	0.08	−0.03
Mean of dep var:	0.12	0.16	0.17	0.21	0.11	0.13	0.32	0.29

Panel B. Activities that **increase** emissions

Sample:	Base	Matched	Base	Matched	Base	Matched	Base	Matched
Variable:	M&A (0/1)		Output (0/1)		Method (0/1)		Residual > 5% (0/1)	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Large $\text{Em}_i \times \text{Post}_t$	0.016	0.004	−0.038	−0.062	−0.051*	−0.061*	−0.014	−0.025
	(0.519)	(0.894)	(0.313)	(0.181)	(0.069)	(0.068)	(0.576)	(0.453)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry × Year	Yes	–	Yes	–	Yes	–	Yes	–
Country × Year	Yes	–	Yes	–	Yes	–	Yes	–
Cohort × Year	–	Yes	–	Yes	–	Yes	–	Yes
Observations	12,193	2711	12,193	2711	12,193	2711	10,599	2377
Adj R^2	0.19	0.13	0.22	0.09	0.13	0.12	0.05	−0.02
Mean of dep var:	0.14	0.13	0.32	0.38	0.15	0.15	0.16	0.14

This table examines the channels through which emission activities of large emitters change around the 2015 Paris Agreement. The unit of observation is the firm-year level i, t. The sample period is 2011–2021. *Large Em* equals one if firm i is a large CO_2 emitter (defined in more detail in the main text), and zero otherwise. *Post* is an indicator variable equal to one for firm reporting years after 2015, and zero otherwise. The dependent variables are indicator variables equal to one if firm i reports that its combined global Scope 1 and 2 emissions changed in year t due to: (i) divestments, (ii) output changes, (iii) changes in emissions measurement (*Method*), (iv) merger activity, or (v) other reasons, including efficiency improvements and emission-reduction activities (*Residual*). Panel A (B) examines activities that reduced (increased) emissions. Results are reported for two samples: (i) the full baseline panel and (ii) emission-intensity matching. In the emission-intensity–matched sample, treated firms are matched to control firms with similar emission intensity within the same country and industry. See the main text for details. The regressions include firm fixed effects, year × industry (2-digit SIC code) fixed effects, year × country fixed effects, and match-cohort × year fixed effects, when indicated. Further controls include firm-level characteristics (pre-event average leverage and profitability interacted with *Post*). p-values based on robust standard errors, clustered at the firm level, are reported in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

There is limited evidence for increased engagements in other emission reduction activities. If anything, we are *less* likely to observe a decrease in emissions on a like-for-like basis in the post-Paris period for treatment firms (see columns 7 to 8). This effect is, however, only statistically significant in the unmatched sample and the economic magnitude of this effect is moderate relative to the unconditional mean (0.080/0.32 = 25%). Methodological changes are also, if anything, *less* likely to explain the relative emission reduction (Panel A, columns 5 to 6).

Similarly, we find no differential effects for activities that increase emissions for treatment relative to control firms (see Panel B). The only exception is that treatment firms appear to be somewhat less likely to report that "methodological changes" increased emissions in the period after the Paris Agreement (Panel B, columns 5 to 6). Overall, the results indicate that the main reason for emission decreases of *Large Emitters* relative to other firms in the post treatment period is divestments.

Next, we examine the dynamic effect on firm divestment activities around the 2015 Paris Agreement. That is, we estimate a dynamic version of the linear probability models reported in Table 4, Panel A, columns 1 to 2, by including separate year dummies instead of the *Post* 2015 indicator. Fig. 4 illustrates that there are no significantly different pre-trends in both samples. Post 2015 the likelihood that a firm indicates that emissions are reduced because of divestment activities increases significantly.

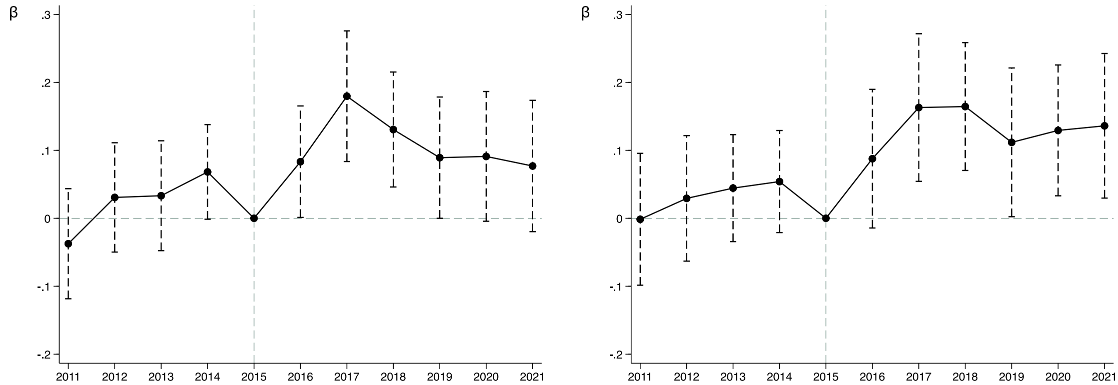
3.2.2. Intensive margin

The results reported in Table 4 focus on the extensive margin, i.e., the likelihood that a firm cites a particular category as the reason for changes in emissions in a given year. This might mask important information. For instance, even if there is no change in the *likelihood* that firms report output reductions, they might report *stronger* reduction activities after the Paris Agreement.

We address this concern by examining intensive margin effects. Specifically, we estimate models similar to Table 4 but instead of indicator variables use the annual net percentage changes by category (see Section 2). We omit firm-years in which the firm did not report any change in emissions as result of the respective category, that is, any estimated effect comes from changes in the importance of the category for a firm over time, conditional on reporting an activity. Results are shown in Panel A of Table 5.

We do not find any effects at the intensive margin in the unmatched sample, including on firm boundaries (M&A minus divestment activities). In the intensity-matched sample, the firm boundary effect is large and significant indicating that, if at all, there is a tendency for large firms to divest more on the intensive margin. However, we interpret this evidence with caution as sample sizes become very small for the matched sample. It is unsurprising that we find limited results at the intensive margin as divestments are relatively rare events (firms report divestment activities in 12% of all firm-years) that can have large effects on firms' total emissions. That is, most of the divestment effect is plausibly at the extensive margin, as documented in Table 4.[17]

[17] There is some indication that output changes if anything increase emissions in the intensity-matched sample, cf. column 4.



(a) Baseline.   (b) Intensity-matched.

Fig. 4. Dynamic effect on firm divestment activities.
This figure examines the divestment activity of large emitters around the 2015 Paris Agreement. Results are reported for two samples: (i) the full baseline panel and (ii) emission-intensity matching. See the main text for details on the matching procedures. Estimated coefficients are from the following regression specification:
$\text{Divestments } (0/1)_{i,t} = \sum_{k=2010}^{2021} \beta_k \left(\text{Large Emitter } (0/1)_i \times \text{Year k } (0/1)_t\right) + \alpha_{i,t}^{ind,yr} + \alpha_{i,t}^{cntry,yr} + Z_i' \times \text{Post}_t + \delta_i + \epsilon_{i,t}$,
where the dependent variable is an indicator variable that is equal to one if firm i indicates that their combined global Scope 1 and 2 emissions changed in year t because of divestments, and zero otherwise. All other variables are defined in Fig. 3. The dashed lines represent 90% confidence intervals, adjusted for firm-level clustering. Note that the matched sample regressions include match-cohort × year fixed effects instead of industry × year and country × year fixed effects.

Table 5
Reasons for changes in firm emissions – Ex- and intensive margin.

Panel A. Intensive margin

Sample:	Base	Matched	Base	Matched	Base	Matched	Base	Matched
	Boundary net %		Output net %		Method net %		Residual net %	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Large $\text{Em}_i \times \text{Post}_t$	−0.89	−10.97*	1.01	2.45*	−1.88	8.16	−0.59	−1.64
	(0.756)	(0.056)	(0.325)	(0.085)	(0.625)	(0.434)	(0.623)	(0.240)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry × Year	Yes	–	Yes	–	Yes	–	Yes	–
Country × Year	Yes	–	Yes	–	Yes	–	Yes	–
Cohort × Year	–	Yes	–	Yes	–	Yes	–	Yes
Observations	2127	213	5570	1257	2514	240	10,560	2347
Adj R^2	0.10	−0.24	0.18	−0.03	0.11	−0.61	0.02	−0.09
Mean dep var:	2.90	1.00	3.55	2.57	3.70	−0.27	−1.39	−1.40

Panel B. Ex- and intensive margin

Sample:	Base	Matched	Base	Matched	Base	Matched	Base	Matched
	Boundary net %		Output net %		Method net %		Residual net %	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Large $\text{Em}_i \times \text{Post}_t$	−2.33**	−4.44***	0.16	0.98	0.06	2.71**	−0.06	−7.08***
	(0.029)	(0.005)	(0.825)	(0.363)	(0.914)	(0.013)	(0.978)	(0.008)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry × Year	Yes	–	Yes	–	Yes	–	Yes	–
Country × Year	Yes	–	Yes	–	Yes	–	Yes	–
Cohort × Year	–	Yes	–	Yes	–	Yes	–	Yes
Observations	10,799	2408	10,799	2408	10,799	2408	10,599	2377
Adj R^2	0.28	0.58	0.41	0.25	0.12	−0.01	0.41	0.21
Mean dep var:	0.48	0.06	1.48	1.46	0.63	−0.11	−1.39	−1.38

This table explores through what means emission activities of large emitters change around the 2015 Paris Agreement. The unit of observation is the firm-year level *it*. The sample period is 2011 to 2021. *Large Em* equals one if firm i is a large CO2 emitter (defined in more detail in the main text), and zero otherwise. *Post* is an indicator variable that is equal to one for firm reporting years after 2015, and zero otherwise. The dependent variable is the Scope 1 and 2 emission change in year t (in percent of total $t-1$ emissions) that results from category k, where $k \in$ {Firm Boundary, Output, Method, Residual}. Positive (negative) values indicate that emissions increased (decreased) as result of the respective category. Note that *net* changes by category are calculated, e.g., *Firm Boundary* is the difference between divestment and M&A activity and can take on both positive or negative values. Panel A of this table focuses on the intensive margin, i.e., firm-years in which there was no emission change as result of the respective category are excluded. Panel B of this table includes firm-years in which there was no emission change as result of the respective category and weights regressions by the firms' (lagged) Scope 1 and 2 emissions. Results are reported for two samples: (i) the full baseline panel and (ii) emission-intensity matching. Treated firms are matched to control firms with similar emission intensity within the same country and industry. See the main text for details. The regressions include firm fixed effects, year × industry (2-digit SIC code) fixed effects, year × country fixed effects, and match-cohort × year fixed effects, when indicated. Further controls include firm-level characteristics (pre-event average leverage and profitability interacted with *Post*). *p*-values based on robust standard errors, clustered at the firm level, are reported in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

3.2.3. Aggregate emissions reallocated via divestments

How large are the aggregate emissions that are reallocated via divestments in the post-Paris Agreement period? To answer this questions, we combine the intensive and the extensive margin and weight regressions using firms' (lagged) Scope 1 and 2 emissions. Combining intensive and extensive margin and weighting by firms' (lagged) Scope 1 and 2 emissions ensures that results are informative about aggregate emission changes.

Panel B of Table 5 provides the results. The results document again that changes to firm boundary (divestments and M&A) are the largest contributor to emission reductions by large emitters in the post-Paris period.[18] The coefficient of –2.3 p.p. per year in column 1 implies a reduction of 13 p.p. $[1 - (1 - 0.023)^6]$ over the 2016–2021 horizon. Evaluated against the average total emission level of large emitters over the pre-Paris period in the unbalanced sample (3142 million mt CO2 per year), this implies that 409 million mt of CO2 were reallocated via divestments in the post-Paris Agreement period.

The firm boundary effects are similar and highly significant also in the matched sample. There is also some indication that methodological changes, if anything, increase emissions (Panel B, column 6), while changes to the residual category appear to decrease emissions (Panel B, column 8). These effects, however, are not stable across samples and should be interpreted with caution.

Fig. 5 provides a descriptive angle. It decomposes total firm emission changes in million mt CO2e by category, using the balanced sample of firms used in the motivating Fig. 1, and plotting results separately for large firms and other firms. Fig. 5 also reports M&A and divestments ("firm boundary") separately to highlight the role of divestments in emission reductions of large emitters.

The figure again documents that large emitters significantly increase divestment activities after the Paris Agreement. The effect is both immediate and largest in the two years after the Agreement. This is consistent with divestments being among the fastest methods that can be employed to reduce emissions. The divestment effect is sizable: over the total 2016 to 2021 period large emitters divest on average 61 million mt CO2e *per year* (>100 million mt in both 2016 and 2017). The cumulative emission reduction as result of divestments over this period is 369 million mt CO2e, very similar to the results obtained from the regression approach in Panel B of Table 5, and approximately the size of France's total annual carbon emissions.

Overall, the results document that divestment activities are the single largest contributor to emissions reductions of large emitters vis-a-vis other emitters after the Paris Agreement. Changes to the firm boundary explain essentially the entire large-versus-other emitter difference after the Paris agreement. Magnitudes are economically large: we estimate that around 400 million mt CO2e were reallocated via divestments in the post-Paris Agreement, approximately the size of France's total annual carbon emissions. These results question whether the observed large emission reductions following increased public pressure on large emitters result in overall lower emission levels for the planet as a whole.

4. Buyer and seller characteristics

4.1. Why do firms divest: Higher risk exposure or more investor pressure?

So far, we have documented *that* divestment activities are the single largest contributor to emissions reductions of large emitters vis-a-vis other emitters after the Paris Agreement. We now turn to the question *why* large emitters behave differently to small emitters. Two explanations come to mind: First, large emitters might be exposed to higher transition risks.[19] Second, large emitters might face pressure from investors and therefore divest polluting assets to stay out of the limelight. We start by providing firm-level evidence (Section 4.1.1), before analyzing the role of country-level environmental regulation (Section 4.1.2).

4.1.1. Firm-level evidence from CDP

The CDP questionnaire explicitly asks firms about their perceived climate risks, categorized into physical risks, regulatory risks, and other risks and to provide a short description of the key risks firms are facing. Firms both report whether they have *"identified any inherent climate change risks that have the potential to generate a substantive change in your [i.e., the firm's] business operations, revenue or expenditure"* (yes/no) as well as the expected magnitude of the impact (low, medium-low, medium, medium-high, high). We aggregate the answers into a score, which is equal to 1 if firms answer "no" to a particular category and else ranges from 2 (low impact) to 6 (high impact). We use the natural logarithm of the score in the regression model to analyze relative changes in the score over time. The categories are (a) physical risk, (b) regulatory risks, (c) investor-related risk, and (d) other risks. Both (c) and (d) are formally part of the "other risks" category in the CDP, and we identify investor-related risks by the keywords "investor", "shareholder", and "capital market" in the textual description of the "other risks" category.[20] If large emitters are quicker in realizing the risks to their business models after the Paris Agreement than small emitters, we would expect them to report regulatory or other risks earlier than smaller firms.

One concern is that firms can freely choose how many risk factors to report within each category. This might make across-firm comparisons difficult as some firms might be more diligent in their reporting compared to others. Similarly, as with most surveys, firms might interpret differently what constitutes a *low* or *high* risk exposure. To address this issue, we focus on *within* firm changes, i.e., absorb any general differences across firms in their reporting. Specifically, we collapse data into a pre- and post-period to deal with reporting noise inherent in this data and report results of a difference-in-difference regression in Table 6.

There is clear evidence that larger emitters face higher investor-related risks post-Paris: the coefficients in columns 5 and 6 are highly statistically significant and equal to more than half the unconditional mean (reported at the bottom of the table). In other words, large firms' mentioning of investor-related risks increases by more than 50% post-Paris relative to smaller firms. There is no evidence for larger emitters facing higher physical, regulatory, or other risks in the post-Paris period relative to the pre-period and relative to small emitters

[18] When we separate firm boundary into divestment and M&A, the effect is large (coefficient of –1.4 p.p.) and highly significant for divestment, and insignificant for M&A, suggesting the boundary effect is largely driven by divestments. See Internet Appendix Table A-2.

[19] Note that we include industry x time fixed effects in all our regressions. We are therefore comparing, for example, transition risks of large versus small cement producers. It is therefore not clear why large emitters should face higher risk exposure than small emitters. Note also that this channel includes two subchannels: large emitters might be exposed to higher risks, or they might simply be more sophisticated and therefore quicker in understanding the looming transition risks.

[20] We verify that firms indeed mention investor concerns as risk factors when related keywords are mentioned in the "other risk" category by manually reading relevant text passages. An example includes the following note by BASF: *"BASF has a significant corporate carbon footprint (e.g., it is listed amongst the 167 focus companies [...] by Climate Action 100+) [...] BASF is in the focus of investor-led initiatives aiming to engage with the world's largest corporate GHG emitters [...] If major investors would perceive BASF business activities to be misaligned with the growing global momentum to act against climate change this would pose a reputational risk to the company. About 16% of BASF shares [...] are held by shareholders who describe socially responsible investment (SRI) being at the core of their investment strategy. In case of a major reputational loss this group may divest a significant number of shares which will reduce BASF's market value. Moreover, there is potential risk of exclusion from thematic (climate) funds"*.

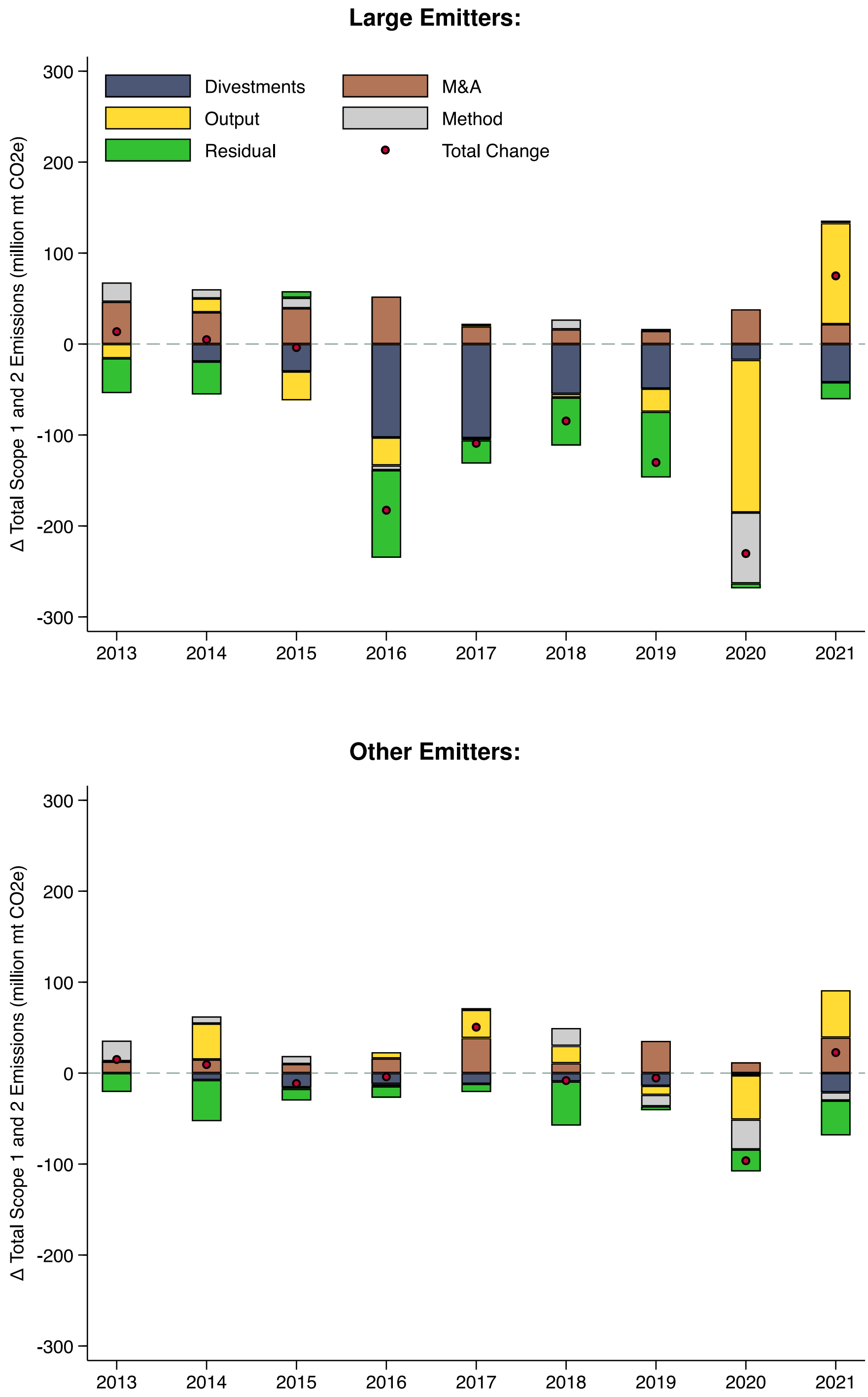


Fig. 5. Annual changes in firm emissions by category.
This figure shows the annual change in total combined gross Scope 1 and 2 emissions (million mt CO2e) by category for a balanced sample of large emitters (N = 73) and other emitters (N = 540).

in the unmatched sample. For the intensity-matched sample, there is some indication that treatment firms are *less* likely to report exposure to physical risks in the post-Paris period (column 2), though the effect is borderline significant and economically small ($-0.12/1.31 = 9.1\%$). Further, treatment firms are *less* likely to report "other risks" in the intensity-matched sample (Panel A, column 8), which appears to reflect that intensity-matched control firms are smaller and tend to report more idiosyncratic risks.

Panel B of Table 6 provides alternative measures instead of the score: We simply classify all observations with a "yes" to the respective questions as "1", irrespective of the perceived magnitude of the risk. Results in Panel B confirm the prior results.

Fig. 6, Panels (a) to (b), provides a dynamic version of Table 6, Panel B.[21] Across specifications, firms become more likely to report investor-related risks after the event, with no evidence of differential pre-trends. The dynamic estimates, however, are noisy with also most of the

[21] Figure A-2 in the Internet Appendix presents the corresponding plots for the alternative outcome ln(Risk Score), which display very similar dynamics.

Table 6
Risk factors.

Panel A. Dependent variable: ln(Risk score [1–6])

Sample:	Base	Matched	Base	Matched	Base	Matched	Base	Matched
Variable:	Physical		Regulatory		Investor		Other	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Large $\text{Em}_i \times \text{Post}_t$	−0.06	−0.12*	0.05	0.03	0.16**	0.15*	−0.09	−0.21***
	(0.250)	(0.069)	(0.232)	(0.601)	(0.040)	(0.056)	(0.104)	(0.003)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls × Post FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry × Post FE	Yes	–	Yes	–	Yes	–	Yes	–
Country × Post FE	Yes	–	Yes	–	Yes	–	Yes	–
Cohort × Post FE	–	Yes	–	Yes	–	Yes	–	Yes
Observations	2654	584	2654	584	2654	584	2654	584
Adj R^2	0.49	0.27	0.55	0.45	0.54	0.21	0.41	0.10
Mean of dep. var.:	1.32	1.31	1.37	1.39	0.30	0.29	1.20	1.23

Panel B. Dependent variable: Any risk (0/1)

Sample:	Base	Matched	Base	Matched	Base	Matched	Base	Matched
Variable:	Physical		Regulatory		Investor		Other	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Large $\text{Em}_i \times \text{Post}_t$	−0.03	−0.07*	0.03	−0.03	0.12**	0.13**	−0.07	−0.19***
	(0.206)	(0.053)	(0.230)	(0.244)	(0.023)	(0.018)	(0.137)	(0.000)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls × Post FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry × Post FE	Yes	–	Yes	–	Yes	–	Yes	–
Country × Post FE	Yes	–	Yes	–	Yes	–	Yes	–
Cohort × Post FE	–	Yes	–	Yes	–	Yes	–	Yes
Observations	2654	584	2654	584	2654	584	2654	584
Adj R^2	0.39	0.09	0.40	0.03	0.53	0.32	0.32	−0.00
Mean of dep. var.:	0.90	0.91	0.93	0.95	0.22	0.22	0.77	0.82

This table explores risk factors that large emitters report around the 2015 Paris Agreement. The unit of observation is the firm-period-level *it*, i.e., the sample period is split into a pre-Paris period (2011 to 2015) and a post-Paris period (2016 to 2021). The dependent variables measure whether firms are exposed to (i) physical risks, (ii) regulatory risks, (iii) investor related risks, or (iv) other risks (categories are defined in more detail in the main text). Panel A uses *ln(Risk Score)* as dependent variable, where risk scores range from 1 (no risk) to 6 (high risk). Scores are defined as maximum scores by period and category. Panel B uses indicator variables that are equal to one if the firm reports *any* risk exposure in the respective category and period, and zero otherwise. All other variables are defined in Table 3. Results are reported for two samples: (i) the full baseline panel and (ii) the emission-intensity–matched sample. Treated firms are matched to control firms with similar emission intensity within the same country and industry. See the main text for details. The regressions include firm fixed effects, *Post* × industry (2-digit SIC code) fixed effects, *Post* × country fixed effects, and match-cohort × *Post* fixed effects, when indicated. Further controls include firm-level characteristics (pre-event average leverage and profitability interacted with *Post*). *p*-values based on robust standard errors, clustered at the firm level, are reported in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively. *p*-values based on robust standard errors, clustered at the firm level, are in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.

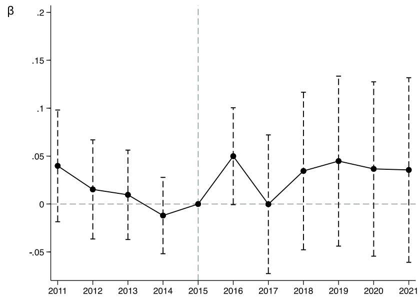
post-event coefficients being statistically insignificant. We investigate the source of this noise in detail. As discussed above, investor-related risks—unlike regulatory or physical risks—are not a separate category but have to be identified from free-text disclosures in the "other risks" category. We implement a simple and transparent approach by searching for keywords in the other risks category. While we manually verified that results are reasonable, i.e., indeed about shareholders concerns regarding climate issues, the classification is conservative and reporting varies within firms over time. In some years firms provide generic or inadequate descriptions of certain risks. As a result, firms may switch from reporting to not reporting investor-related risks with our classification. Inspection of firm-level time series indicates that often it is unlikely that going from reporting to not reporting investor risks reflects true changes in exposure.[22]

We address this issue by introducing a new outcome variable, *Any Risk (Cumulative)*, which equals one from the first year in which a firm reports investor-related risk onward, overwriting subsequent non-reporting years. This approach smooths the time series and allows the dynamic estimates to be interpreted as firms *beginning* to report investor-related risks. Note that we apply this adjustment for treatment and control group firms alike and estimate the same dynamic difference-in-differences model, i.e., we are not picking up a mechanical increase in the incidence of investor risk reporting over time with this definition. The corresponding dynamic plots—shown in Fig. 6 panels (c) to (d)—are substantially cleaner. We observe a clear increase in treatment firms starting to report investor-related risks in the post-event period, while all pre-event coefficients remain close to zero and statistically insignificant across the baseline and matched sample.

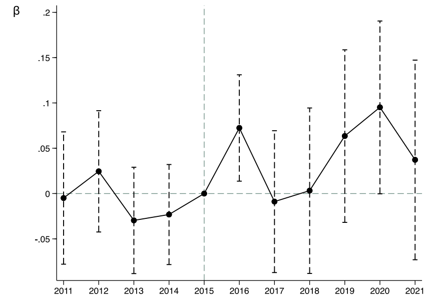
Table A-3 in the Internet Appendix further identifies firms that report *"investor-related opportunities"*. We find no effect in this placebo-test, indicating that large emitters are not generally more likely to report investor-related information post-Paris.

One might be concerned that larger emitters—for strategic reasons—do not report a perceived increase in risks post Paris-Agreement. Note, however, that we do observe a significant increase in our risk score for regulatory risks post Paris-Agreement.[23]

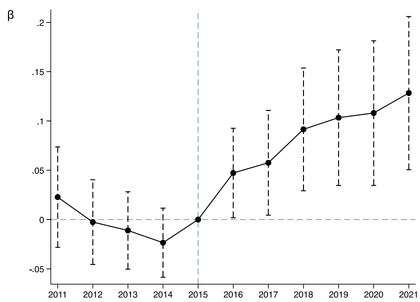
[22] Example, Devon Energy Corporation writes in 2019 that *"[...] certain financial institutions, funds and other sources of capital have begun restricting or eliminating their investment in oil and natural gas activities due to their concern regarding climate change. [...] Because these reputational risks apply to Devon-specific assets, we do receive questions from stakeholders [... and t]hese topics help guide our conversations with shareholders, including BlackRock and Climate Action 100+"*. In 2020 they slightly adjusted the wording to *"[...] funds and other sources of capital have begun restricting their investment in oil and natural gas activities due to their concern regarding climate change. Such restrictions in capital could decrease the value of our business and make it more difficult to fund our operations"*. In this example, Devon no longer uses any of our keywords from 2020 onwards, while the sentiment of their risk description is unchanged. While it is possible to adjust our list of keywords, we prefer our conservative approach as words like "funds" or "capital" often appear in the text descriptions in unrelated context.



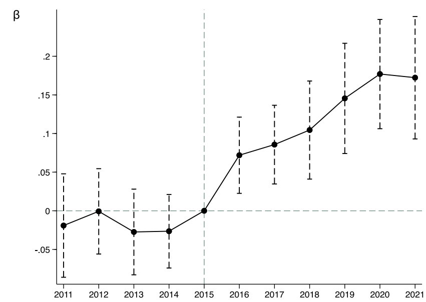
(a) *Any risk* – Baseline.



(b) *Any risk* – Intensity-matched.



(c) *Any risk cumulative* –Baseline.



(d) *Any risk cumulative* – Intensity-matched.

Fig. 6. Dynamic effect: investor-related risks.
This figure examines investor-related risks of large emitters around the 2015 Paris Agreement. The regression specification mirrors Figs. 3 and 4 but uses an indicator variable that equals one if the firm reports any investor-related risks in the respective year (*Any risk*), and zero otherwise, as dependent variable in Panels (a)–(b). In Panels (c)–(d), the dependent variable is *Any risk (cumulative)*, an indicator variable that equals one for all years after a firm reports any investor-related risks for the first time, and zero otherwise. The dashed lines represent 90% confidence intervals, adjusted for firm-level clustering.

This makes intuitive sense: both small and large emitters recognize that regulatory risks have increased post 2015. But, there is no significant differential effect for large vs. small firms. If large firms strategically underreport risks in order to be able to sell polluting assets, they would need to strategically report an increase in regulatory risks which is exactly in line with the increase in regulatory risk reported by small firms—without having access to small-firm estimates at the time when they submit their data to CDP.

To explore further whether the investor-related risks mentioned by large emitters primarily reflect environmental pressures from investors, financial performance concerns, or transition cost pressures, we further conduct a manual analysis of financial statements of large emitters. Specifically, we review the "risk factor" sections in the annual reports, focusing on the first (2013) and last (2021) years of our sample period. Publicly available reports containing risk sections are available for 103 of the 111 treatment firms in our sample in both years. We manually review all 206 reports and identify any references to risks related to investor ESG preferences or risks related to environmental regulation.

First, our analysis confirms that concerns about investor-driven environmental risk have become substantially more salient over time. In 2013, only 3% of firms mentioned investor-related environmental risks. By 2021, this share increased to close to 50%. For comparison, environmental regulation is cited as a risk by about 90% of firms in both years, indicating that concerns about regulatory pressure remained stable,[24] while investor-related concerns rose markedly (see Fig. 7).

Second, to distinguish between different investor-related risk mechanisms, we classify the 46 reports from 2021 that mention such risks. Of these 46 reports, 12 include generic references to sustainability-focused investors without specifying the type of risk.[25] Two dominant themes emerge[26]:

- **Reputational Risk** (23 reports): These statements suggest that poor environmental performance could damage the firm's image among investors. For example, the cement producer Holcim notes: *"[...] a perception of the sector as a high emitter could impact our reputation, thus reducing our attractiveness to investors [...]"*
- **Access to Capital** (22 reports): Firms frequently highlight the risk that failure to meet ESG expectations could restrict financing. For example, Suncor Energy notes: *"Failure to achieve the company's net-zero and GHG emissions reduction targets, or a perception among financial institutions and investors that such targets are insufficient, could adversely affect the company's reputation and ability to attract capital".*

These statements suggest the perceived risks extend beyond a narrow focus on profitability and reflect broader concerns related to investor expectations around environmental performance.[27]

[23] This cannot be seen in Table 6 because the included fixed effects absorb the baseline Post-2015 indicator. Table A-4 in the Internet Appendix reports results without country x time and industry x time fixed effects. We find a highly significantly positive "post-Paris effect". That is, all firms report a significant increase in regulatory pressure post Paris. The effect, however, is not different for treatment versus control firms.

[24] Using CDP data, we find that both large and small emitters report increased regulatory risk exposure in the post-Paris period (see footnote 23). However, this reflects a rise in the *magnitude* of perceived risk among firms already reporting such exposure, rather than an increase in the *number* of firms identifying regulatory risk at all.

[25] For example, *"There is increased focus, including by investors, on these and other sustainability matters"*. The remaining reports provide more concrete risk characterizations.

[26] Reports can be classified as containing risks related to access of capital and reputation, i.e., the categories are not mutually exclusive.

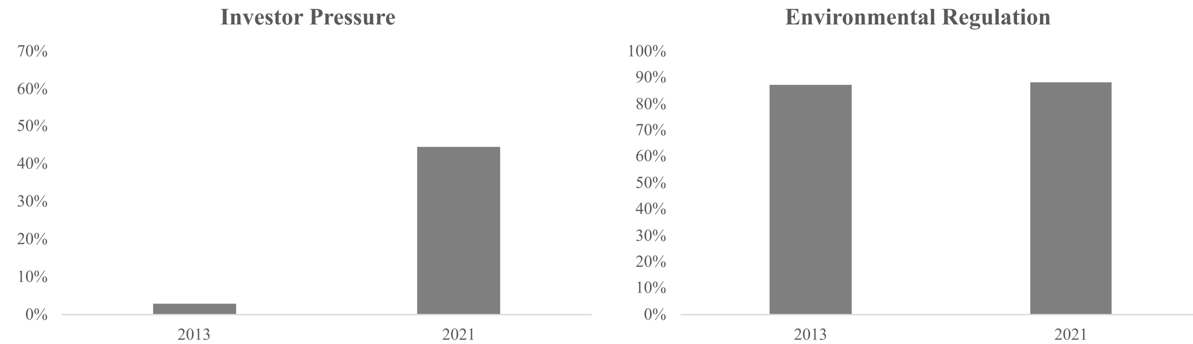


Fig. 7. Investor and environmental regulation risks in annual reports.
This figure shows the fraction of large emitters that mention risks related to investor ESG preferences (left) or risks related to environmental regulation (right) in their 2013 or 2021 annual report.

Table 7
Emissions and divestment activity – Investor risk.

	Panel A. ln(Scope 1)				***Panel B.*** Divestments (0/1)			
Sample:	Base		Intensity-matched		Base		Intensity-matched	
Investor risk:	Any	High	Any	High	Any	High	Any	High
Large $\text{Em}_i \times \text{Post}_t \times (D = 1)_i$	−0.164*	−0.238**	−0.166	−0.325***	0.142***	0.175***	0.221***	0.229***
	(0.092)	(0.038)	(0.202)	(0.005)	(0.007)	(0.002)	(0.000)	(0.001)
Large $\text{Em}_i \times \text{Post}_t \times (D = 0)_i$	−0.102	−0.081	−0.094	−0.036	0.055	0.054	0.037	0.054
	(0.147)	(0.230)	(0.270)	(0.686)	(0.138)	(0.145)	(0.402)	(0.214)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry × Year FE	Yes	Yes	–	–	Yes	Yes	–	–
Country × Year FE	Yes	Yes	–	–	Yes	Yes	–	–
Cohort × Year FE	–	–	Yes	Yes	–	–	Yes	Yes
Observations	12,172	12,172	2707	2707	12,193	12,193	2711	2711
Adj R^2	0.96	0.96	0.98	0.98	0.25	0.25	0.30	0.30
Coeff. equal? (p-val)	0.59	0.22	0.64	0.05**	0.15	0.06*	0.02**	0.03**

This table examines the emission and divestment activity of large emitters around the 2015 Paris Agreement. The unit of observation is the firm-year level *it*. The sample period is 2011 to 2021. In columns indicated with *Any*, $D = 1$ ($D = 0$) is an indicator variable that is equal to one if the firm reports *any* (*no*) investor-related risk exposure, and zero otherwise. In columns indicated with *High*, $D = 1$ ($D = 0$) is an indicator variable that is equal to one if the firm reports investor-related risk exposure with a score of *medium-high* [4–6] (*low* to *medium* [1–3]), and zero otherwise. See Table 6 for details. All other variables are defined in Tables 3 and 4. Panel A (B) examines emission (divestment) activity. Results are reported for two samples: (i) the full baseline panel and (ii) emission-intensity matching. See Table 3 and the main text for details on the matching procedures. The regressions include firm fixed effects, year × industry (2-digit SIC code) fixed effects, year × country fixed effects, and match-cohort × year fixed effects, when indicated. Further controls include firm-level characteristics (pre-event average leverage and profitability interacted with *Post*). *p*-values based on robust standard errors, clustered at the firm level, are reported in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

The results so far indicate that large emitters are more likely to report investor pressure after the Paris Agreement. We next examine whether, among large emitters, firms reporting greater investor-related risk exposure post-Paris are more likely to reduce emissions through divestments. Specifically, we split the treatment sample into firms reporting investor-related risk exposure in CDP of *medium-high or above* versus *below medium-high* post-Paris. Using the alternative definition from Table 6, Panel B (a simple "any risk" indicator), yields similar results. Findings are reported in Table 7.

Panel A presents results for emission changes. Within the treatment group, firms reporting higher investor pressure post-Paris tend to reduce emissions by more, although estimates are noisy and differences are statistically significant only in the intensity-matched sample (column 4). This reflects limited *within*-treatment variation in reported investor pressure. Panel B reports results for divestment activity. Consistent with the emissions results, firms reporting higher investor pressure tend to increase divestment activity more, though estimates remain imprecise and coefficients differ significantly only in columns 6 to 8.

Overall, the evidence suggests that increased investor pressure seems to be an important factor in understanding the relative emissions reductions and increased divestment activity by large emitters after the 2015 Paris Agreement.

4.1.2. Cross-country evidence using the Stringency of Environmental Regulation (SER) score

As documented in the previous section, while treatment firms report a significant increase in investor-related risks after the Paris Agreement relative to control firms, they do not report an increase in regulatory risks relative to control firms. Thus, our setup plausibly captures investor pressure orthogonal to changes in regulatory pressure. Our investor-engagement treatment—firms targeted by the Climate Action 100+ Initiative—is at the firm level, whereas regulation applies at the country or supranational (e.g., EU) level. In our empirical tests, we compare treatment firms with control firms that also emit CO2 in the same country and industry; hence, any country-level dynamics are accounted for in the research design.

[27] Clearly, these risks are not orthogonal to firm performance—several firms explicitly note that, for example, reduced access to capital due to ESG-related investor concerns may negatively affect financial outcomes. However, the nature of these concerns reflects a shift toward acknowledging investor preferences that extend beyond immediate financial metrics of the firm. In the environmental regulation category, in contrast, firms typically cite the monetary costs of complying with requirements as the key concern.

Table 8
Stringency of environmental regulation.

Panel A. Emission activity – Dependent variable: ln(Scope 1)

Sample:	Baseline			Intensity-matched		
	(1)	(2)	(3)	(4)	(5)	(6)
Large $\mathrm{Em}_i \times \mathrm{Post}_t$	−0.127**	−0.144**	−0.133**	−0.121*	−0.125*	−0.129*
	(0.038)	(0.022)	(0.034)	(0.095)	(0.099)	(0.076)
SER $\mathrm{Score}_i \times \mathrm{Post}_t$		−0.085**	−0.063		0.084	0.002
		(0.025)	(0.109)		(0.347)	(0.981)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm controls	Yes	Yes	Yes	Yes	Yes	Yes
Industry × Year FE	Yes	Yes	Yes	–	Yes	Yes
Country × Year FE	Yes	–	–	–	–	–
Region × Year FE	–	–	Yes	–	–	Yes
Cohort × Year FE	–	–	–	Yes	–	–
Observations	12,172	12,244	12,244	2707	2783	2783
Adj R^2	0.96	0.96	0.96	0.98	0.98	0.98

Panel B. Divestment activity – Dependent variable: Divestment (0/1)

Sample:	Baseline			Intensity-matched		
	(1)	(2)	(3)	(4)	(5)	(6)
Large $\mathrm{Em}_i \times \mathrm{Post}_t$	0.089***	0.087***	0.089***	0.106***	0.109***	0.107***
	(0.005)	(0.008)	(0.007)	(0.005)	(0.002)	(0.003)
SER $\mathrm{Score}_i \times \mathrm{Post}_t$		0.014	0.012		0.016	0.018
		(0.191)	(0.317)		(0.729)	(0.706)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm controls	Yes	Yes	Yes	Yes	Yes	Yes
Industry × Year FE	Yes	Yes	Yes	–	Yes	Yes
Country × Year FE	Yes	–	–	–	–	–
Region × Year FE	–	–	Yes	–	–	Yes
Cohort × Year FE	–	–	–	Yes	–	–
Observations	12,193	12,266	12,266	2711	2786	2786
Adj R^2	0.25	0.25	0.25	0.30	0.34	0.35

This table examines the emission (Panel A) and divestment (Panel B) activity of large emitters around the 2015 Paris Agreement. The unit of observation is the firm-year level *it*. The sample period is 2011 to 2021. *Scope 1* is the global Scope 1 emissions (in mt CO2e) of firm i in reporting year t. *Divestments* is an indicator equal to one if firm i indicates that their emissions changed in year t because of divestments. *Large Em* equals one if firm i is a large CO2 emitter (defined in more detail in the main text), and zero otherwise. *Post* is an indicator variable that is equal to one for firm reporting years after 2015, and zero otherwise. *SER Score* is the stringency of environmental regulation (SER) in the firm's headquarter country. Results are reported for two samples: (i) the full baseline panel and (ii) the emission-intensity–matched sample. Treated firms are matched to control firms with similar emission intensity within the same country and industry. See the main text for details. The regressions include firm fixed effects, year × industry (2-digit SIC code) fixed effects, year × country fixed effects, year × region fixed effects, and match-cohort × year fixed effects, when indicated. Further controls include firm-level characteristics (pre-event average leverage and profitability interacted with *Post*). p-values based on robust standard errors, clustered at the firm level, are reported in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

In this section, we more explicitly explore the role of environmental regulation by using proxies for regulatory stringency across countries instead of absorbing country-level trends via country × year fixed effects. In particular, we follow Ben-David et al. (2021) and collect the World Economic Forum (WEF) Stringency of Environmental Regulation (SER) score, a country-level index ranging from 1 (= very lax) to 7 (= among the world's most stringent).

Table 8 shows our main results—the "Large Emitter x Post" effect for emission activity and divestment activity—with additional controls for the host country SER score as of 2017 interacted with the Post indicator.[28] This absorbs any pre- versus post differences that can be explained by a differential behavior of firms in countries with different levels for environmental regulation. Note that in our empirical tests so far, we have always included *Country x Year* fixed effects, that is, we compare treatment firms with control groups firms in the same country and year. The SER score only varies across countries, so we now report specifications without *Country x Year* fixed effects (in which can we can use the full variation of the SER score across countries) and with *Region x Year* fixed effects (in which case we are only exploring SER-variation within regions).

Our main effect of interest remains unaffected by the inclusion of environmental regulation controls, both for the emission activity (Panel A) as well as for the divestment activity (Panel B).

4.2. Which assets are divested and who buys them?

Next, we examine the nature of divested assets and buyer characteristics in more detail. We compare the characteristics of emission-reducing divestments of large emitters to the overall divestment behavior of the control group in a difference-in-difference analysis. CDP does not include detailed data on divested assets and their buyers. We therefore collect divestments from SDC Platinum for our 2011–2021 sample period and match this data to our CDP sample. We describe the SDC sample selection in more detail in Internet Appendix A.4.

We define emission-reducing divestments as all divestments that occur in years where firms report emission-reducing divestments in CDP. Assume, for example, that a firm reports an emission-reducing divestment in CDP in 2018 and SDC Platinum reports three divestments for that firm in 2018. In this case, all the three divestments from 2018 are defined as emission-reducing divestments. The resulting sample is on the transaction level. For the 1354 firms in our CDP sample (see

[28] 2017 is the first SER score available after the 2015 Paris Agreement. In principle the SER score is time-varying, however, it is not updated every year. Given the low frequency of the index and given that the relative ranking of countries by their SER score did not change much over our sample period, we fix the score in 2017 and capture a potential differential firm behavior in low vs. high regulation countries over time by interacting the score with the post treatment indicator.

Section 2), we find 6020 divestments for 836 firms in SDC Platinum, an average of 0.65 divestments per firm-year.[29]

The difference-in-difference regression uses the same design (FE, controls, clustering of standard errors)[30] as our prior tables (Tables 3–7), with one exception: we cannot include firm fixed effects, because our sample size is smaller (firms only report emission-reducing divestments in 12% of firm-years, with even lower incidences pre-2015, see Section 2). We analyze four buyer and asset characteristics as dependent variables: (i) Country of the buyer: Is the divestment national or international? We define a divestment to be international when the (ultimate parent of the) buyer is headquartered in a different country than the (ultimate parent of the) seller, (ii) Country of the asset: Is the divested asset located in the seller's headquarter country or not?, (iii) Public/private status of the buyer: Is the buyer a publicly listed non-financial firm or not?, (iv) Stringency of environmental pressure in buyer country: What is the difference in the environmental pressure between seller and buyer country. We measure environmental pressure on the country level using either (iv-1) the Stringency of Environmental Regulation (SER) score (see above), (iv-2) the CL100+ ratio, defined as the fraction of assets under management in a country that is managed by Climate Action 100+ signatories, (iv-3) the combined SER-CL100+ ratio, where we impute missing values for the CL100+ ratio—which is available for fewer countries than the SER score—using predicted values from the countries' SER score. Both measures are highly correlated and are described in more detail in Internet Appendix A.5.

Results are reported in Table 9. The unmatched results reported in Panel A, columns 1 to 3, suggest that emission-reducing divestments by large emitters are more likely to be international in the post-Paris period relative to control-group divestments. The same holds true for international assets (not surprisingly, as international divestments (0/1) and international asset (0/1) are highly correlated). There is a reduction in emission-reducing divestments by large emitters to public firms, suggesting that large emitters increasingly sell to non-public firms in the post-Paris period relative to control group divestments. The unmatched results reported in Panel B, columns 1 to 3, show that large emitters increasingly divest to countries with lower SER score and lower CL100+ ratios relative to control group divestments, suggesting that polluting assets are divested to buyers located in countries with weaker environmental pressure.

The sample size is substantially reduced under intensity matching. Results are reported in Table 9, Panels A and B, columns 4 to 6. Despite the drop in sample size, the main results are unchanged: we to find that, post-Paris, deals by treatment firms are more likely to be international and to involve buyers located in countries with weaker regulatory and investor pressure. Effect sizes and statistical significance are similar to the unmatched sample.

Differences arise in Panel A, columns 5 and 6: while the signs of the public-buyer and the inter-national-asset effect remain the same, these effects are no longer statistically significant. This is largely driven by the inclusion of country x year fixed effects, which are restrictive in the matched samples.[31] Using only country and year fixed effects, or alternatively region x year fixed effects, mostly restores statistical significance for the international-asset effect (coefficients of 0.096 and 0.101 with p-values of 10% and 11%, respectively; untabulated). The public-buyer effect, however, remains noisy in the intensity-matched sample.

One drawback of the SDC data is that we cannot identify emission-reducing divestments on the deal level. Instead, we label all divestment as emission-reducing when they occur in years where firms report emission-reducing divestments in CDP. In the next step, we carefully hand-collect data on buyer and asset characteristics using all information available (e.g., CDP, SDC, annual reports, press releases, news articles). CDP provides a textual description of the divestment, which typically allows us to find the respective divestments in other sources. This hand-collected sample therefore provides more precise information, for example on the asset type and asset location.

For this hand-collected sample, we restrict the sample to treatment firms (large emitters) and firm-years in which divestment activities reduced firms' total emissions by at least 1%. This leaves us with 187 observations. We can find detailed divestment information for 139/187 (74%) of the firm-years (note: there can be more than one deal in each firm-year, i.e., the number of deals used in the analyses is larger than 139).[32] Results from a simple pre-versus-post difference analysis using this hand-collected sample are presented in Table 10. The results from Table 9 are largely confirmed when using the smaller hand-collected sample. The key difference is that the hand-collected sample provide somewhat weaker evidence that large emitters sell assets more frequently to non-public firms (possibly because information on such divestments is harder to find in the public domain). Note that, as no control group is used, matched-sample results cannot be reported for this test.

Finally, Table A-5 in the Internet Appendix explores whether treatment firms are more likely to sell divested assets to *connected firms*—defined as joint venture or strategic alliance partners—after the Paris Agreement compared to control group firms. We do not find that this is the case.[33]

4.3. Geographic shift in emissions around the world

In the prior subsection, we documented that large emitters increasingly sell international assets to international buyers located in countries with lower environmental pressure. We now provide descriptive evidence on the geographical implications of this global reallocation of pollutive assets. In particular, we document the absolute reallocation of emissions (in terms of million mt CO2e) via divestments across different regions.

Table 11 provides information on seller and buyer location, Table A-6 in the Internet Appendix further provides information on asset types as well as detailed locational information. We report information

[29] Note that we compare emission-reducing divestments of larger emitters to all divestments by control group firms. We can as well compare the emission-reducing divestments by large firms to the emission-reducing divestments by control group firms. This significantly reduces sample size by almost 4000 divestments (because control group firms report very few emission-reducing divestments) and reduces statistical significance; however, our results remain robust—both economically and statistically—to this alternative specification.

[30] Country fixed effects refer to the seller location.

[31] Unlike the firm-year panel analyses in the rest of the paper, the deal-level analysis only observes firms in years in which they divest assets. Including country x year fixed effects therefore requires not only that treatment and matched control firms are observed in the same country in both the pre- and post-event periods, but also that they have divestment activity in the exact same years. For example, if in a given country control firms divest in 2013 (pre) and 2017 (post), while treatment firms divest in 2014 (pre) and 2016 (post), these observations do not contribute to identification because all variation is absorbed by country x year fixed effects.

[32] The remaining observations are mainly firm-years during which a firm engages in multiple transactions that are individually small (and hence transaction details are hard to come by/not disclosed). We verify that divestments are indeed asset sales and not closures of plants and facilities (cf. Section 3.2). We find mentioning of plant closures in 8 firm-years, however, even then the firm engaged in a combination of assets sales and closures. We find no firm-year in which the divestment activity can plausibly be mainly attributed to closures of facilities.

[33] Another form of firm interlinkages could arise through supply chains. However, in our setting it is very unlikely that assets are sold to suppliers, as our sample is dominated by commodity-producing assets (see Table A-6 in the Internet Appendix). For example, it is unlikely that a cement producer divests a *foreign-located* plant to another producer and then sources cement from that competitor.

Table 9
Deal-level analysis.

Panel A. Deal location and buyer public status

Sample:	Base			Intensity-matched		
Variable:	Int Deal (1)	Int Asset (2)	Public (3)	Int Deal (4)	Int Asset (5)	Public (6)
Large $Em_i \times Post_t$	0.095***	0.128***	−0.079**	0.106**	0.034	−0.020
	(0.007)	(0.003)	(0.014)	(0.048)	(0.575)	(0.685)
Firm controls	Yes	Yes	Yes	Yes	Yes	Yes
Industry × Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Country × Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	6025	6025	6025	884	884	884
Adj R^2	0.19	0.15	0.09	0.27	0.19	0.15

Panel B. Regulatory stringency and investor pressure

Sample:	Base			Intensity-matched		
Variable:	Lower SER (1)	Lower CL100 (2)	Lower SER-CL100 (3)	Lower SER (4)	Lower CL100 (5)	Lower SER-CL100 (6)
Large $Em_i \times Post_t$	0.095***	0.055	0.078**	0.089**	0.027	0.096**
	(0.008)	(0.136)	(0.043)	(0.041)	(0.554)	(0.041)
Firm controls	Yes	Yes	Yes	Yes	Yes	Yes
Industry × Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Country × Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	5847	4600	5847	859	713	859
Adj R^2	0.19	0.34	0.28	0.28	0.41	0.31

This table examines the divestment activity of large emitters around the 2015 Paris Agreement. The unit of observation is at the deal level. The sample period spans 2011 to 2021. *Large Em* equals one if the seller is a large CO2 emitter (defined in more detail in the main text), and zero otherwise. *Post* is an indicator variable that is equal to one for deals completed after 2015, and zero otherwise. Divestment information is from SDC Platinum. For treatment firms, the sample is restricted to deals completed in years in which the firm reports divestments that reduced Scope 1 and 2 emissions. *Int Deal* is an indicator equal to one if the buyer is headquartered in a different country than the seller, and zero otherwise. *Int Asset* is an indicator equal to one if the divested asset is not located in the seller's headquarter country, and zero otherwise. *Public* is an indicator equal to one if the buyer is a publicly listed non-financial firm, and zero otherwise. *Lower SER* is an indicator equal to one if the stringency of environmental regulation (SER) score is lower in the buyer country versus the seller country. *Lower CL100* is an indicator equal to one if the CL100+ Ratio is lower in the buyer country versus the seller country. *Lower SER-CL100* is based on *Lower CL100* but missing values for the CL100+ Ratio in the buyer and seller country are predicted using the countries SER score (cf. Figure A-3, Panel A). Results are reported for two samples: (i) the full baseline panel and (ii) the emission-intensity–matched sample. Treated firms are matched to control firms with similar emission intensity within the same country and industry. See the main text for details. The regressions include year × industry (2-digit SIC code of the seller) fixed effects and year × (seller) country fixed effects, when indicated. Further controls include firm-level characteristics (pre-event average leverage and profitability interacted with *Post*). *p*-values based on robust standard errors, clustered at the firm level, are reported in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Table 10
Deal-level analysis – Hand-collected divestment data.

Variable:	Int Deal (1)	Int Asset (2)	Public (3)	Lower SER (4)	Lower CL100 (5)	Lower SER-CL100 (6)
Post 2015_t	0.109**	0.076	−0.011	0.051	0.081*	0.106**
	(0.032)	(0.443)	(0.912)	(0.546)	(0.069)	(0.032)
Country	Yes	Yes	Yes	Yes	Yes	Yes
Observations	234	234	242	233	170	233
Adj R^2	0.23	0.27	−0.02	0.25	0.53	0.42

This table examines the divestment activity of large emitters around the 2015 Paris Agreement. The unit of observation is at the deal level. The sample period spans 2011 to 2021. *Post* is an indicator variable that is equal to one for deals completed after 2015, and zero otherwise. This table uses hand-collected divestment information for large emitters as described in Table 11. All variables are defined in Table 9. The regressions include seller-country fixed effects, when indicated. *p*-values based on robust standard errors, clustered at the firm level, are in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.

separately for asset sales (Panel A) and spin-offs (Panel B).[34] Looking at the combined volume of asset sales and spin-offs, the total emission reduction due to divestments is 358 million mt CO2e in the post Paris period (267.1 from asset sales, 90.8 from spin-offs) and 138 million mt CO2e in the pre Paris period (112.1 from asset sales, 25.5 from spin-offs), i.e., divestment activity almost tripled in terms of volume. While spin-offs only account for 4% (6/141) of deals in the post Paris period, they account for 25% of the total divestment volume. This is unsurprising as spin-off transactions are typically large (the sample, e.g., includes the "E.ON-Uniper", "BHP Billiton-South32", and "Exelon-Constellation" deals). The aggregate increase in divestment activity is, however, not exclusively driven by a few large spin-off transactions. Also excluding spin-offs, the divestment volume increased by a factor of ∼2.5 in the post-Paris period (+155 million mt CO2e).

Panel A provides information on sellers and buyers of divested assets by geographic region (excluding spin-offs). We find that predominantly firms located in Europe increased their divestment activities from 81.2 to 176.3 million mt CO2e (+95.1 million mt CO2e or +117%). The divestment activities of North American firms also increased significantly, however, at a much lower level (+44.1 million mt CO2e). There is only limited divestment activity for firms located in other countries.

While European sellers account for a large share of the total divested emissions, European firms only account for a small share of buyers. Europe is a "net seller" of assets both in the pre-Paris period and in the post-Paris Period (pre: −46.5, post: −132.3 million mt CO2e). Most buyers are North American firms or firms located in other countries around the world (mainly Asia and Oceania). Both regions have *tripled* the purchase volume relative to the pre-Paris period, while the total volume purchased by European firms has (roughly) remained stable. Overall, the results indicate that European firms are net sellers of

[34] Spin-offs are large but rare transactions. Further, in spin-offs shares are offered to the shareholders of the parent firm. That is, there is no clearly defined "buyer" and the spun-off part of the business continues to operate as a stand-alone entity.

Table 11
Divestment activity by large emitters – Seller and buyer region.

Panel A. Asset sales										
Pre Paris Agreement:										
	Volume (mil mt CO2e)					# Deals				
	Total	EU	NA	RoW	Unk.	Total	EU	NA	RoW	Unk.
Sell	**112.1**	81.2	30.0	0.9	–	**101**	74.0	25.0	2.0	–
Buy	**112.1**	34.7	37.0	39.2	1.1	**101**	21.0	43.5	35.5	1.0
Net (B–S)	–	−46.5	7.0	38.3	1.1	–	−53.0	18.5	33.5	1.0
Post Paris Agreement:										
	Volume (mil mt CO2e)					# Deals				
	Total	EU	NA	RoW	Unk.	Total	EU	NA	RoW	Unk.
Sell	**267.1**	176.3	74.1	16.7	–	**141**	92.0	42.0	7.0	–
Buy	**267.1**	44.1	115.8	104.7	2.6	**141**	28.5	47.8	57.7	7.0
Net (B–S)	–	−132.3	41.6	88.0	2.6	–	−63.5	5.8	50.7	7.0
Post–Pre Paris Agreement:										
	Volume (mil mt CO2e)					# Deals				
	Total	EU	NA	RoW	Unk.	Total	EU	NA	RoW	Unk.
Net (Po–Pr)	**155**	−85.7	34.6	49.6	1.5	**40**	−10.5	−12.7	17.2	6.0
Panel B. Spin-offs										
	Volume (mil mt CO2e)					# Deals				
	Total	EU	NA	RoW	Unk.	Total	EU	NA	RoW	Unk.
Pre Paris	**25.5**	4.7	20.8	–	–	**7**	2.0	5.0	–	–
Post Paris	**90.8**	82.2	8.2	0.4	–	**6**	3.0	2.0	1.0	–
Post–Pre	**65.3**	77.5	−12.7	0.4	–	**−1**	1.0	−3.0	1.0	–

This table reports descriptive statistics on the divestment activities of large emitters. We collect information on divestment activities for all firm-years in which a large emitter reports that divestments reduced their total combined Scope 1 and 2 emissions by at least 1% (139 firm-years). We report separate statistics for the period before the Paris Agreement (2010–2015) and the period after the Paris Agreement (2016–2021). Panel A reports information on all sales of assets and subsidiaries. "Volume sold" is the total Scope 1 and 2 emission reduction in million mt CO2e that results from divestments by large emitters that are headquartered in region j = {Europe (EU), North America (NA), Rest of the World (RoW), Unknown (Unk.)}. "Volume bought" is the flipside of "volume sold" and identifies in which regions the divested emissions end up (based on the headquarter location of the buyer(s)). That is, for each period and across all regions, total volume sold == total volume bought. When identifying buyers, we take into account that sellers can engage in multiple divestments per year that involve different buyers (potentially located in different regions). As CDP information on emission reductions due to divestments is only available at the (selling-) firm-year level, we approximate emissions at the deal ×buyer level as follows: First, we split the total reported emission reduction due to divestments by seller i in year t equally across all deals of the seller that we can identify in the respective year. Second, in case a deal involves multiple buyers, we equally split emissions across all firms. The number of deals (# Deals) is defined in the same manner (e.g., for a deal with two buyers, each buyer is assigned a deal share of 0.5). Panel B reports information on spin-off transactions. For spin-offs we do not differentiate between buyer and seller region, as the spun-off entity remains a stand-alone company (whose shares are offered to the current shareholders of the seller).

divested assets, while firms in the "Rest of the World" and North America are net buyers.[35]

5. Robustness

Broader time trend of large firms shedding (foreign) assets: Our main findings—the post-2015 increase in divestment by large emitters—may simply reflect a broader time trend of (large) firms shedding (foreign) assets, for example due to trade policies, geopolitical risks, or trends in access to finance. Since small firms typically hold fewer assets, in particularly fewer foreign assets, this would naturally lead to a divergence in the propensity to divest (foreign) assets between large and small firms. We therefore analyze divestment behavior of small and large firms across different industries. We do this using both CDP (which only captures divestments that have significantly reduced emissions) and a more comprehensive sample from SDC Platinum (which covers divestments independent of their effect on emissions). We describe the SDC sample selection in more detail in Internet Appendix A.4. In particular, we construct a dependent variable equal to one if firm i engaged in any divestment in year t, and zero otherwise. We repeat the same analysis using foreign divestments (i.e., divestments where the divested asset is not located in the country in which the seller is headquartered). Results are reported in Table 12. We find a "Large Firm x Post2015" effect only in industries with high emission intensities, but not in other industries. This holds when looking at emission-reducing divestments (Panel A, based on CDP), when looking at all divestments (Panel B, based on SDC), as well as when focusing on divestments of foreign-located assets (Panel C, based on SDC). This suggest that there is no broader time trend of larger firms shedding (foreign) assets.

We also construct matched treatment and control groups based on industry (exact match), country (exact match), and firm size to ensure our results are not driven by differential dynamics between larger and smaller firms around the Paris Agreement that are unrelated to differences in emission levels. This matching comes with two caveats: First, the matching procedure reduces the treatment-firm sample significantly, as not all treated firms have suitable control firms within the same country and industry that are even approximately comparable in size. Second, it is challenging to separate large emitters from large asset size within the same industry, because most industries are either dominated by high- or low-emitting firms.[36] As

[35] In Internet Appendix A.6 we investigate if divestments are value enhancing for sellers. We find positive stock market reactions to divestment announcement, in particular after the Paris agreement.

[36] We match on 2-digit SIC codes. As an example, the 2-digit SIC code 49 (Electric, Gas, and Sanitary Services) includes utilities that generate electricities with nuclear power (low emissions) as well as utilities that generate

Table 12
Robustness: Divestment activity of large firms.

Panel A. Emission-reducing divestment activity

Emission intensity:	Low	Medium	High
Variable:	Divestments (0/1) (1)	Divestments (0/1) (2)	Divestments (0/1) (3)
Large $\text{Firm}_i \times \text{Post}_t$	−0.044	0.009	0.103***
	(0.119)	(0.824)	(0.005)
FEs and controls	Yes	Yes	Yes
Observations	4715	3885	3458
Adj R^2	0.18	0.22	0.33

Panel B. Overall divestment activity

Emission intensity:	Low	Medium	High	
Variable:	Any Divest (0/1) (1)	Any Divest (0/1) (2)	Non-Reduc Divest (0/1) (3)	Emission-Reduc Divest (0/1) (4)
Large $\text{Firm}_i \times \text{Post}_t$	−0.016	0.038	−0.051	0.094***
	(0.659)	(0.396)	(0.204)	(0.005)
FEs and controls	Yes	Yes	Yes	Yes
Observations	4715	3885	3458	3458
Adj R^2	0.31	0.33	0.24	0.33

Panel C. International divestment activity

Emission intensity:	Low	Medium	High	
Variable:	Any Divest (0/1) (1)	Any Divest (0/1) (2)	Non-Reduc Divest (0/1) (3)	Emission-Reduc Divest (0/1) (4)
Large $\text{Firm}_i \times \text{Post}_t$	0.016	0.047	−0.074**	0.067**
	(0.603)	(0.225)	(0.033)	(0.031)
FEs and controls	Yes	Yes	Yes	Yes
Observations	4715	3885	3458	3458
Adj R^2	0.28	0.35	0.26	0.38

This table examines the divestment activity of large firms around the 2015 Paris Agreement. The unit of observation is the firm–reporting year level (it). The sample period spans 2011–2021. *Large Firm* equals one if firm i belongs to the top 20% of firms in its industry, measured by pre-Paris average total assets, and zero otherwise. *Post* is an indicator equal to one for firm–reporting years after 2015, and zero otherwise. In Panel A, the dependent variable is an indicator equal to one if firm i reports (in CDP) that its combined global Scope 1 and 2 emissions changed in year t due to divestments, and zero otherwise. In Panel B, the dependent variable is an indicator equal to one if firm i completed *any* divestment deal or spin-off in year t (according to SDC data), and zero otherwise. Panel C mirrors Panel B but the sample is restricted to international divestment deals. Columns (3) and (4) of Panels B and C distinguish between firm–years in which the firm reports divestments that reduced Scope 1 and 2 emissions (based on CDP information) (column 4) and those in which divestments occurred without reported emission reductions (column 3). Finally, the sample is split into three groups—low, medium, and high emission intensity—based on each industry's pre-Paris Scope 1 emission intensity. The regressions include firm, year × industry (2-digit SIC code), and year × country fixed effects. Further included are firm-level controls (pre-event average leverage and profitability × *Post*). p-values based on robust standard errors, clustered at the firm level, are in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.

a result, the size-matched estimates are somewhat noisier; however, they remain economically and statistically significant, and the qualitative conclusions are unchanged. Details are reported in Internet AppendixA.7.

Alternative treatment definitions. We define all Climate Action 100+ focus companies as "large emitters" for our main analyses. We use this list of firms as it avoids having to rely on ad-hoc emission level cut-off rules and because it comprises the most visible large emitters that have been increasingly under public pressure, particularly since the 2015 Paris Agreement. Table A-7 in the Internet Appendix reports our baseline results using alternative treatment definitions, for robustness. We obtain similar result if we define the top 150 emitters or the top 10% emitters according to CDP data as large emitters (the overlap between all treatment definitions is naturally very high).

Verified or assured emissions. Emission data is self-reported by firms to CDP. One potential concern is that reporting might be inaccurate or firms might strategically mis-report emission activities. For robustness, we re-run our baseline analyses using only firm-years for which reporting to CDP was certified by a third party. Results are shown in Table A-8 in the Internet Appendix. Estimates are virtually unchanged.

Asset sales versus closures. One concern is that firms classify closures of plants or other facilities as divestments. If this were the case this would affect the interpretation of the results presented in this paper. If assets are divested, i.e., sold, the facility continues to operate, i.e., emit CO2, under a different owner. In contrast, if facilities are closed down, emissions are reduced overall. We address this issue by hand-collect information on all divestments by large emitters and manually verify that assets are sold (and who bought them). See Section 4.2 above for details.

For robustness, we also use text descriptions on emission changes by category directly contained in the CDP data (see Fig. 2) to distinguish between asset sales and closures. Specifically, we flag all entries that contain (versions of) the keywords "closed", "closure", or "shut down" in the comment field of the divestment category. We separately flag all entries that contain (versions of) the keywords "sale", "sold", or "spin-off". Note that this approach is conservative as firms in most cases generically speak of "divestments" without using keywords that explicitly refer to asset sales (see, e.g., the Naturgy example in Fig. 2).

Results are reported in Table A-9 in the Internet Appendix. The coefficient is virtually identical to the baseline divestment effect if we set the variable to zero for firm-years where the comment field contains any keywords that might be associated with closures of plants or other facilities.

The coefficient is close to zero and statistically insignificant if we define a "closure indicator", i.e., an indicator that is equal to one if firm i states that their combined global Scope 1 and 2 emissions changed in year t because of divestments *and* the comment field indicates that the firm *closed down* plants or other facilities. Overall, results confirm that treatment firms are more likely to divest and not more likely to close down facilities after the Paris Agreement.

Financial constraints. Another channel that has been proposed in the literature is that in particular firms that face tighter financial constraints are more likely to react to increased climate risks. For instance, Bartram et al. (2022) provide evidence that financially constrained firms reallocate their emissions away from California to other states after the implementation of the cap-and-trade program. However, financial constraints are unlikely to be a main explanation for our findings as our treatment firms are large publicly listed firms.

Table A-10 in the Internet Appendix splits the treatment sample into firms with above and below median total assets and leverage, respectively. Total assets and leverage are defined as averages over the pre Paris Agreement period. The results show that, if anything, it is the largest firms with the lowest leverage ratios that decrease their emissions. This evidence is inconsistent with the idea that binding financial constraints are a main explanation for why large emitters reduced their emissions after the Paris Agreement.[37]

Crossholdings. We identify crossholdings, i.e., investors that own shares of both sellers and buyers of pollutive assets, to analyze whether the sale of pollutive assets actually implies a change in ownership, or whether buyers and sellers have a large overlapping investor base. We

electricity with coal/oil/gas (high emissions). Our matching therefore picks up different business models within a 2-digit SIC code.

[37] There is some evidence that the divestment effect is stronger for firms with high versus low leverage, however, the difference is economically small and not statistically significant.

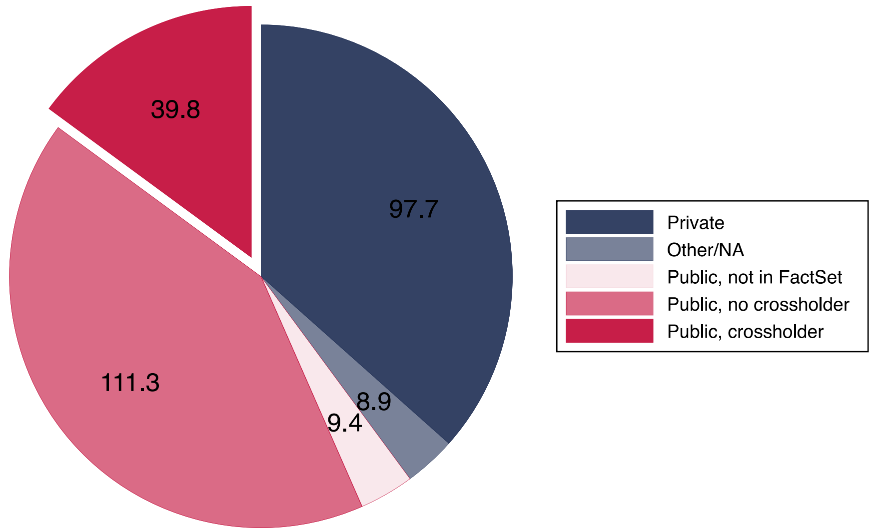


Fig. 8. Investors in buyers of divested assets: Crossholdings.
This figure provides information on the investor structure of buyers of divested assets after the Paris Agreement (see Table 11 in the main paper for details on the sample). "Crossholders" are investors that hold shares in both buyers and sellers of assets. The sample is restricted to the post Paris Agreement period and distinguishes between private and public (i.e., listed) buyers. The figure indicates the deal emission volume (mil mt CO2e) for each category.

collect information on shareholders of publicly listed buyer and seller firms worldwide from the FactSet/LionShares database.[38] For each deal, we split emissions (mt CO2e) into a part going to crossholders and non-crossholders based on investor ownership in the *buyer*.[39] For example, if crossholders own 50% in a buyer firm, 50% of the emission volume is classified as going to crossholders. We can only identify crossholders for publicly listed buyers. We report the deal volume going to private buyers separately. The investor overlap for the private-buyers-category is likely limited because crossholders in public firms are larger institutional investors that tend not to be investors in privately held firms. However, focusing on the sample of only public buyers yields qualitatively similar conclusions (see below).[40]

Fig. 8 shows that investor overlap is limited: only 39.8 mil mt CO2e go to crossholders, i.e., ~15% of divested emissions. The rest, i.e., 85% of emissions, shift to a new investor base. This is not due to missing data—only a small fraction of the deal volume (3.5%) involves public buyers outside FactSet. Even among public buyers, i.e., not considering the volume purchased by private firms, only about a quarter of investors overlap.

6. Conclusion

In this paper, we have analyzed firms' carbon reduction strategies worldwide. We document a *global* reallocation of pollutive assets in response to pressure by investors, stakeholders, and the public to reduce carbon emissions. The reallocation is economically large, with 369 million mt CO2e of carbon emissions being reallocated via divestments in the post-Paris-agreement period, approximately the size of France's total annual carbon emissions. Divestments are also accompanied by positive announcement returns, suggesting that reallocation is beneficial to the divesting firms' shareholders. Emission-reducing divestments by large emitters are more likely to involve international assets and international buyers post-2015 (relative to divestments by control group firms), in particular from countries with lower environmental pressure.

Overall, our results indicate that public pressure, and pressure from investors in particular, can lead to significant asset reallocation effects on a global scale, shifting emissions out of the limelight. Our results imply that anyone who wants to affect global carbon emission through an engagement with polluting firms needs to monitor firms' divestment strategies closely.

CRediT authorship contribution statement

Tobias Berg: Writing – review & editing, Writing – original draft, Supervision, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Conceptualization. **Lin Ma:** Writing – review & editing, Writing – original draft, Visualization, Validation, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Daniel Streitz:** Writing – review & editing, Writing – original draft, Supervision, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

[38] We adopt a conservative approach by allowing for investor overlap across transactions. Specifically, if investor A holds shares in a firm that divested a pollutive asset but not in the specific firm that acquired it, A is still classified as a crossholder if they hold shares in the acquiring firm in any other transaction.

[39] FactSet ownership stakes often sum to less than 100% because only large, reportable holdings are visible. The rest (about 30% on average) is "free float", held by retail investors, whom we treat as non-overlapping. Though some may be crossholders, they are individually negligible and have, individually, no influence on firm policy.

[40] Another potential concern is that assets are mainly bought by our control group, i.e., non-Climate Action 100+ firms that report to CDP. If this were the case the SUTVA (no spillover) assumption would be violated. We find that the majority of buyers of pollutive assets do not report to CDP and the fraction of CDP-reporting buyers of divested assets has not increased in the post-Paris period compared to the pre-Paris period.

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