Corporate Emissions and Profits

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Abstract

This study examines the fundamental link between corporate emissions and operating profits as well as how it interacts with carbon pricing. We match facility-level emissions data verified through the EU Emissions Trading System (ETS) with firm-level financial data to estimate this link, which is of fundamental interest and also central importance to carbon policies. Despite significant prior evidence to the contrary, we find over much the ETS history that increasing carbon emissions increases corporate profits for the average firm, controlling for scale. A one-ton increase in annual carbon emissions is associated with a €3.00 rise in same-year operating profits (or €8.00 in manufacturing), controlling for firm activity. This positive link exists contemporaneously but also over longer horizons, in that emission reductions in a given year are associated with lower future operating profits for at least five years. The estimated profit impact is remarkably stable across a series of research design choices debated in prior work. We exploit carbon allowance shortfalls due to ETS changes to address endogeneity in emission intensities and find that the link strengthens when firms are induced by shortfalls to reduce their carbon emissions. The profit link weakens predictably as the ETS carbon price increases, which intensifies the tradeoff between the (opportunity) costs of carbon allowances and abatement costs. This change in the fundamental link between emissions and profits with carbon pricing implies significant transition risks for firms with high emission intensities, which we find to be priced in firm value long before carbon costs materialize in profits.

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1. Introduction

What is the link between corporate emissions and profits? Understanding this link is of fundamental importance and central to assessing the need for and design of environmental policies, especially considering that carbon emissions are likely the largest corporate externality (e.g., Greenstone et al. 2023). Basic economics suggests that, if carbon emissions are free or unpriced, they should exhibit a positive relation with profits (Palmer et al. 1995; Jensen 2010). This reasoning implies abatement is costly and that the introduction of carbon pricing imposes transition risks on emitters; at the same time, pricing carbon should weaken the positive relation with profits. An influential counterargument — the Porter hypothesis — holds that well-designed environmental regulation uncovers inefficiencies and spurs innovation, which can offset compliance costs and raise profits and competitiveness (Porter and van der Linde 1995). This debate has spurred a large empirical literature on the link between environmental and financial performance, most of which finds a positive or at least non-negative link (see meta-studies by Friede et al. 2015; Atz et al. 2023).[1] Studies of the European Union's Emissions Trading System (EU ETS) point the same way, showing modest or little impact on profits from the introduction and during the early phases despite incentivizing reasonable emission reductions (Dechezleprêtre et al. 2023; Colmer et al. 2025). Taken together, the evidence appears to side with Porter.

However, interpreting the evidence in the above meta-studies with respect to the link between emissions and profits is challenging. First, in the underlying studies, environmental performance is measured heterogeneously and often broadly, including ESG ratings, rather than emissions or decarbonization. Such ratings diverge across providers and can conflate corporate impact with risk

[1] This also holds in the few studies that focus on emissions or decarbonization and the relation with corporate financial performance (Atz et al., 2023).

exposure (Berg et al. 2022). Second, even studies focusing on carbon emissions often face measurement challenges because until recently emissions were not widely available and vendor-estimated emissions are modeled as functions of firm sales and other fundamentals. Thus, regressions of profits on emissions could recover the underlying firm fundamentals (Aswani et al. 2024a; Zhang 2024). Third, voluntary sustainability activities such as decarbonization raise selection and reverse causality concerns, such as that firms select into abatement precisely when it is cheap or because it is profitable (Bénabou and Tirole 2010; Dechezleprêtre et al. 2019).

We estimate the emissions-profit link in a setting that overcomes these challenges: the EU ETS, the world's first and second largest cap-and-trade system for carbon emissions. The EU ETS provides actual, facility-level emissions for compliance purposes that are externally verified and not estimates. These data can be matched to corporate financial data for a large sample of more than 7,000 unique private and public firms. The system's design also permits a tighter identification strategy. Specifically, the total number of carbon allowances and the allocation mechanism (free vs. auctioned) vary sharply across and within the different EU ETS phases.[2] We exploit these regime changes to identify changes in emission intensity that are essentially induced by a carbon allowance shortfall that occurs when past emissions are no longer covered by free future allowances granted in the next phase. Furthermore, the EU ETS exhibits considerable variation in carbon prices over time (see Figure 1), which aids our analysis in several ways. First, the very low prices in the early phases are fortuitous, in that they make it unlikely that the allowances or their prices directly increase operating profits or materially influence the estimated link. Of course, expectations of higher future prices could still trigger abatement investments. In

[2] So far, there are four phases of the EU ETS: Phase I (2005-2007), Phase II (2008-2012), Phase III (2013-2020) and Phase IV (2021-2030).

fact, the latter are a likely source of changes in carbon intensities, reflecting variation in abatement decisions across firms. Second, the increase in the carbon price in later ETS phases along with the tightening of free allowances provide exogenous variation to estimate the emissions-profit link. Finally, meaningful pricing of emissions especially in the later phases make the setting essentially a best-case scenario for finding that lowering emissions increases profits, as much of the prior literature suggests.

For our empirical analysis, we combine emission data from compliance files of the EU Transaction Log with financial data of both public and private companies from Orbis. We match them at the level of the legal entity reporting financial statements and aggregate emissions across all its installations covered under the EU ETS to compute an emission intensity measure scaled by the entity's total assets. Table 1 shows considerable variation in emission intensities across and within industries with the largest emission intensities observable in the electricity sector (see also Greenstone et al. 2023). In Figure 2, we plot the time-series of 90-10 productivity differentials within granular sub-industries in the manufacturing sector. Consistent with Lyubich et al. (2018), we find that carbon emissions productivity (i.e., the inverse of emission intensity) exhibits a much larger dispersion across firms than other standard input-based productivities and that this dispersion decreases toward later phases of the EU ETS.

Our first formal set of analyses aims to establish a baseline relation between firms' emission intensity and operating profits. We focus on intensities to control for firm scale and activity. In Table 2, we find a robust positive association between emission intensity and operating profit (scaled by assets, i.e., return on assets). Importantly, this association strengthens with the inclusion of firm fixed effects, which essentially correlates changes in emissions intensities with changes in operating profits. We also obtain a positive relation with country-year and industry-year fixed

effects, which account for (arbitrary) changes in local regulation or local carbon pricing as well as for industry-level demand shocks that affect production capacity utilization. In terms of economic magnitude, the estimated coefficients translate to an increase of more than €3.00 in same-year operating profits for each additional ton of annual carbon emissions, holding total assets fixed. For manufacturing firms, the estimated magnitude is significantly larger, around €8.00 per additional ton of emissions (see Table OA1).

A key challenge when estimating the link between emissions and profits is that, for firms with positive operating margins, increases in firm activity tend to imply higher profits. Since emissions are highly correlated with firm activity, any positive association with profits could simply reflect differences in firm activity (rather than in emission intensities). We therefore add controls for (changes in) both asset productivity and sales growth. We also estimate variants of our main specification scaling operating profits and emissions by revenues instead of total assets (Table 3, Panel A) and find that the coefficient on emission intensity is stable across all these specifications. Related to this concern, we note that the measurement and scaling of carbon emissions in empirical analyses have been heavily debated in the finance literature (Aswani et al. 2024a and 2024b; Bolton and Kacperczyk 2024). However, we do not find much sensitivity of our results to scaling or to the choice of scalar (Table 3, Panel A), suggesting that concerns about scaling are not first order when working with actual rather than estimated emissions.

Although the EU ETS has the advantage of reliably measured corporate emissions, it also poses challenges. For one, we need to explicitly take into account the role of carbon allowances in our estimation. One concern are windfall profits from generously granted free allowances in early phases of the EU ETS. Any excess free allowances could be profitably sold in secondary carbon markets and the opportunity cost of free allowances may be passed through to product prices (Sijm

et al. 2006). Such windfall profits, if material, could upward bias the association between emissions and corporate profits if carbon-intensive firms obtain more generous allocations of free allowances. What mitigates this concern is that the generous allocations in the early ETS phases also imply very low carbon prices. Nevertheless, we gauge the influence of windfall profits using the transaction-based data from the EU ETS. In Table 3, Panel B we control for the number of carbon allowances (total, sold and excess) or directly adjust operating profits by the value of carbon allowances sold. The coefficient on emission intensity remains positive and comparable in magnitude when controlling for the number of allowances but declines by a third when directly adjusting for carbon allowance sales. Thus, windfall profits from free allocation of carbon allowances have a non-negligible impact on operating profits, but they do not explain the positive association between emission intensities and operating profits we document.

To further rule out a confounding effect of carbon pricing as well as to ascertain that the estimated link between firm emissions and profits is not unique to carbon, we employ data on firms' other air and water pollutants from the European Pollutant Release and Transfer Register (E-PRTR). In Table 9, we aggregate all reported air pollutants excluding carbon emissions for each firm and again find a positive within-firm association between (changes in) air pollutant intensity and (changes in) operating profits, irrespective of asset or revenue scaling. Hence, the positive relation between corporate emissions and profits is neither carbon-specific nor an artefact of the EU ETS, but extends more broadly to other unpriced corporate emissions.

Our analysis so far is silent on the origins of the variation in corporate emission intensities across firms and time. Why do some firms have lower emissions intensities than others and if

emission reductions are costly, why do (some) firms engage in them?[3] To tighten our empirical design and exploit exogenous variation, we leverage the institutional features of the EU ETS. Specifically, we exploit the carbon allowance shortfall produced by ETS regime changes to instrument for changes in emission intensity.[4] In line with prior literature (Dechezleprêtre et al. 2023; Venmans 2016) we find a strong first-stage, that is, shortfalls predict future emission reductions. Figure 3 shows a clear relation between the carbon allowance shortfall at the beginning of each ETS phase and changes in emission intensity over the entire phase thereafter. Even in earlier phases when carbon prices were fairly low, the carbon allowance shortfall seems to be a strong predictor of future emission abatement. Next, we use the change in emission intensity induced by carbon allowance shortfalls in an instrumental variable (IV) design. We find that the positive association between emissions and profitability strengthens considerably for the IV specification relative to the OLS specification in earlier phases of the EU ETS when carbon prices were low (see Table 4). This result makes economic sense as the IV essentially identifies firms that are forced to reduce their emissions due to the shortfall and these firms should have higher abatement costs by revealed preference.

To unpack the documented positive relation between corporate emissions and operating profits, we first examine the relation for other profitability measures that differ in the extent to which they deduct certain cost components. Table 5 shows a very similar economic magnitude for the EBIT margin,[5] but a much weaker relation for the EBITDA margin (about a third of the

[3] The variation in emissions intensities could clearly be endogenously related to firm profits. However, selection likely works against a positive relation as firms for which emission reductions are less costly or even net beneficial are more likely to engage in them.

[4] See Bolton et al. (2026) for a similar idea of using shortfalls in free carbon allowances as a measure of exposure to shocks in EU ETS carbon prices.

[5] Defined as earnings before interest and taxes as % of sales.

magnitude for operating ROA).[6] This result suggests that investments and their depreciation are key drivers of the positive profit relation. We explore this investment channel more directly using two different proxies for firms' tangible asset investments. For both depreciation and capital expenditures, we find a strong inverse relation with emission intensity and these results hold in the OLS as well as the IV specifications (Table 4). Thus, emission reductions require capital investments, which in turn raise annual depreciation and ultimately lower operating profits.

This investment channel raises two questions. First, if decarbonization investments produce sustained carbon emission reductions, then yearly changes in emission intensities do not properly capture the corresponding decarbonization trajectory. Thus, in Table 6, Panel A we measure changes in operating ROA and emission intensity over longer horizons and find that the positive relation between changes in emissions and profits also holds for three- and five-year changes. These longer-run differences also mitigate the concern that short-run differences in emission intensity may reflect temporary variation in production capacity or demand-side shocks. Second, the investment channel raises the question of whether the negative profit impact of emission reductions is simply a short-term effect, which dissipates or even flips in the long-run (Busch et al. 2022). We test this idea by increasingly lagging emission intensity in our main specification. In Table 6, Panel B we find that the positive relation between current emission intensity and (future) profits persists for at least five years with no indication of reversal over this medium-term horizon. For the subsample of public firms, we can analyze the (anticipated) long-run net effects of corporate emission reductions on firm value using Tobin's q. Although the sample is much smaller, we find a significantly positive relation between emissions and firm value in the first ETS phase, which attenuates in the second phase and eventually turns negative in later phases, implying carbon

[6] Definedas earnings before interest, taxes, depreciation and amortization as % of sales.

emissions (and transition risks) became negatively priced in firm value as a future tightening of the EU ETS became foreseeable.

Conceptually, the relation between corporate emissions and profits also depends on a firm's ability to pass through costs as well as the availability of cost-effective carbon abatement technologies within industries (Evdokimova and Millischer 2025). We present evidence consistent with the moderating influence of both factors in Table 7. In Panel A, we run our baseline specification from Table 2 separately for each key industry-sector in our sample. Generally speaking, we find larger coefficients on emission intensity in sectors for which carbon emissions are likely a major (quasi-) input in the production process such as manufacturing or transportation. In contrast, the electricity sector exhibits the weakest association (see Figure 4, Panel C), possibly due to stricter price controls based on cost-plus pricing, allowing pass-through.[7] In Panel B, we estimate the cross-sectional heterogeneity of the profitability-emissions link to 90-10 carbon productivity differentials within sub-industries. The negative interaction indicates that the profit impact from emission reductions is attenuated for firms in industries with larger carbon productivity dispersion and hence some firms with much lower abatement costs.

Finally, we estimate the relation between corporate emissions and profits for each ETS phase and analyze the link's interaction with variation in carbon pricing. When decomposing our sample period into ETS phases I & II (2005-2012), III (2013-2020) and IV (2021-2024), we find a significantly positive link for corporate emissions in the first three phases. Its sign eventually turns significantly negative in the fourth phase (Table 8, Panel A). A similar time-series pattern emerges when focusing on changes in operating ROA over each entire phase and instrumenting emission intensity changes with the carbon allowance shortfall at the beginning of each phase (see Table 8,

[7] The weaker relation in the electricity sector could also reflect the profitability of renewable energy generation.

Panel B). This time-series heterogeneity appears to be driven by changes in the underlying EU ETS carbon price as we document a significantly negative interaction between emission intensity and carbon price that is robust to other ETS phase-specific effects, country-year fixed effects and linear time trends.

Our study makes several contributions to the literature. First, we revisit the frequently-studied and much-debated relation between corporate sustainability and profits in the context of carbon emissions (Friede et al. 2015; Atz et al. 2022). We show, in contrast to many studies in this literature, that this relation is robustly positive as predicted by economic theory and the notion that the costs of carbon emissions are not internalized by firms. As such, the results cast doubt on the common narrative that firms can "Do Well by Doing Good" (Porter and Kramer 2011) or that it pays to be green. Our setting offers several advantages to uncover and re-estimate this fundamental link, including reliable measurement of emissions and matching with firm activity and financial performance for a broad and large sample of private and public firms. We also exploit exogenous variation from ETS regime changes to corroborate our within-firm analysis, which addresses many of the identification concerns that have plagued prior studies. Across all these analyses, we find a positive link between emissions and profits, until carbon prices rise substantially and change the relation, as predicted.

Second, our study contributes to a growing literature on the firm-level economic effects of carbon pricing schemes such as the EU ETS (see Martin et al. 2016 for a detailed review). Most of this literature focuses on the effects of carbon pricing on firm behavior and the costs of the induced real effects, finding significant emission reductions and largely negligible effects on firm profits (e.g., Colmer et al. 2025; Dechezleprêtre et al. 2023). In contrast to these studies, we do not study the impact of the ETS upon introduction, but focus on variation in emission intensities within

the EU ETS, how firms respond to changes in carbon pricing as well as how carbon pricing changes the fundamental link between emissions and operating profits. We also extend this literature by tracking the relation across all four phases of the EU ETS in a large sample of public and private firms. Prior evidence has been restricted to the early phases when carbon prices were low and relatively small samples.

Third, we contribute to the burgeoning literature on the pricing of carbon transition risk in capital markets. Early studies document that firms with greater carbon emissions earn significantly higher stock returns both in the US and globally, suggesting a carbon premium (Bolton and Kacperczyk 2021, 2023). The interpretation of this premium, however, has been debated. Other studies find the premium only for vendor-estimated emissions and unscaled emission levels (Aswani et al. 2024a; Zhang 2024; Atilgan et al. 2025). We contribute to this debate by documenting the fundamental (profit) channel through which carbon pricing can impose transition risks on firms with high emissions or emission intensities. We also demonstrate that firm-level emission *intensity* starts to be priced in firm value long before carbon transition risk materializes due to high carbon prices.

2. Institutional Background

The EU ETS was the first and, until recently, largest cap-and-trade system of carbon emissions. It applies in all EU+EFTA member states and covers installations either exceeding thermal capacity thresholds (> 20 MW) or active in energy-intensive industries (e.g., steel, cement). Its current functioning is as follows. The European Commission sets a maximum cap on the total emissions facilities in scope of the EU ETS can produce during the one-year compliance

period.[8] This cap is typically set in a way as to achieve total emission reductions over time. Firms receive a total number of carbon allowances corresponding to the cap either for free or through an auctioning process. Granting some emissions allowances for free was a response to concerns about carbon leakage in certain industries. At the end of each compliance period, firms must surrender allowances against their actual emissions. Importantly, the emissions of firm installations are verified by independent third-party "verifiers" such as by national technical inspection associations (e.g., TÜV Süd, TÜV Austria, etc.).

The price for carbon emission allowances on secondary markets is then determined by firms with insufficient and excess allowances trading among each other. Based on current and future (expected) carbon prices, firms freely decide whether to make abatement investments and possibly sell some of their allowances rather than using existing allowances or purchasing additional ones to meet their surrendering obligations following a Coasian argument (Coase 1960). Through this market mechanism carbon emissions are aimed to be reduced where it is least costly to do so (European Comission 2026).

The EU ETS has evolved in four different phases since its launch in 2005. Specifically, the total number of carbon allowances and the allocation mechanism (free vs. auctioned) vary significantly across and within the different phases of the EU ETS.[9] The first two phases (2005-2007 & 2008-2012) of the EU ETS were deemed largely experimental and were characterized by generous allocation of free allowances based on historic emission levels ("grandfathering"). In these early phases, the EU ETS operated in a highly decentralized structure in which each member state developed its own National Allocation Plan (NAP) including its cap on the total number of

[8] In earlier phases of the EU ETS, the maximum emissions cap was instead defined by each member state.
[9] So far, there are four phases of the EU ETS: Phase I (2005-2007), Phase II (2008-2012), Phase III (2013-2020) and Phase IV (2021-2030).

national allowances and the allocation mechanism to installations (Ellerman et al. 2016). Emission allowances were also not allowed to be carried over from Phase I to Phase II resulting in carbon prices converging toward zero at the end of the first phase (see Figure 1).

During Phase III (2013-2020) significant changes were made to the allocation mechanism for carbon allowances. First, the EU ETS moved to a centralized allocation of carbon allowances and implemented a single EU-wide cap on carbon emissions which decreased by 1.74% annually during Phase III and 2.2% annually since Phase IV (European Comission 2025). Second, Phase III emphasized the role of benchmarking as the number of freely allocated allowances is based on the average emission rate of the bottom 10% emitting installations in each ETS sector adjusted by a cross-sectoral correction factor which reflects the linear decrease in the total allowances in the system (Ellerman et al. 2016). Third, the distribution of allowances switched increasingly to an auction-based system rather than free allocation. For manufacturing firms, free allocation of allowances was gradually reduced from 80% to 30% between 2013 and 2020 and is planned to be phased out entirely by 2027 (Ellerman et al. 2016). We exploit these regime changes for identification purposes in our empirical designs (see Section 5).

Aside from a pricing scheme for carbon emissions, the European Commission also introduced a pollutant reporting scheme in the form of the European Pollutant Release and Transfer Register (E-PRTR) in 2006. The E-PRTR requires installations in certain industries to report pollutant releases to air, water, and land when exceeding pollutant-specific thresholds. Importantly, it does not set any price or limit on the reported pollutants but is entirely a transparency initiative. The accuracy of reported pollutant quantities is assessed by national competent authorities, for instance, by reference to industry standard audit schemes. Thus, the E-PRTR provides us with verified data on corporate emissions other than carbon that are unpriced.

3. Conceptual Underpinnings

The relation between corporate sustainability (i.e., in some sense the inverse of corporate externalities) and corporate profits has long been debated in economics and the management literature (Griffin and Mahon 1997). Proponents of a negative link argue that sustainability activities are costly to firms and often undertaken at the expense of shareholder value (e.g., Jensen 2010). Others argue that the costs of corporate sustainability can be recouped through greater sales due to better reputation with consumers or through lower marginal costs because sustainability helps firms overcome inefficiencies (e.g., Porter and van der Linde 1995; Kitzmueller and Shimshack 2012).

To guide our empirical analysis, we discuss the key conceptual trade-offs involved in one specific sustainability activity, namely firms' decarbonization decisions. Decarbonization differs from many other sustainability activities in that it is closely tied to the firm's production function as the firm's emissions are determined by the production method it employs such as the energy mix it uses or the carbon filters it installs. At the same time, corporate carbon emissions are a natural starting point to more generally assess the link between sustainability and firm profitability as emissions are likely among the largest negative externalities of corporate activity (e.g., Greenstone et al. 2023) and central to many sustainability initiatives.

When making carbon abatement decisions, firm managers trade off one-time and recurring costs of carbon abatement against the private benefits of lower emissions. These benefits may arise through several channels. First, lowering emissions could improve the firm's reputation with consumers, investors or employees thereby improving revenues, cost of capital or access to talent. Second, carbon abatement could be associated with the adoption of productivity-enhancing technologies that reduce marginal costs (Colmer et al. 2025). Third, carbon abatement could reduce

the firm's exposure to transition risk, for instance, by limiting the expected costs of future environmental regulation. In discussing our empirical results, we return to the extent to which our specifications allow for, or explicitly control for, these channels.

Next, we consider the influence of carbon pricing on firm's decarbonization decisions. Given a market price for carbon under the EU ETS, managers may choose to abate emissions even when net costly absent carbon pricing as long as the marginal abatement cost is below the carbon price (Montgomery 1972). Importantly, however, managers are likely to base these decisions not only on current carbon prices but also on expectations about future carbon prices (Bayer and Aklin 2020). As a result, costly abatement may occur even during periods of relatively low contemporaneous carbon prices if firms expect prices to rise in the future. In such periods, however, there will likely be no direct first-order effect of selling freed-up allowances on contemporaneous operating profits because carbon prices are too low to meaningfully affect operating profits directly.[10] At higher prices, firms are induced to make more costly abatement decisions, but the direct profit impact from selling or avoiding the purchase of additional carbon allowances is now also greater. Given these countervailing forces, the relation between corporate emissions and contemporaneous profits will likely be muted or could even flip as prices for carbon allowances increase. The substantial time-series variation in carbon prices across the different phases of the EU ETS allows us to examine this directly and determine which of these forces (i.e., direct profit impact from abatement costs vs. from allowance sales/avoidance of allowance purchases) dominates in a particular phase.

[10] Note that the same logic works on an opportunity-cost basis when the firm would have to be a net buyer of allowances when deciding not to abate.

Emission reductions can be achieved in several ways with potentially different implications for firm profits. To assess these different sources of variation in emissions, we start from a common representation of the key drivers of total macro-level emissions, namely the Kaya identity (Kaya and Yokobori 1997):

$$CO_2 = Population \times \frac{GDP}{Capita} \times \frac{Energy}{GDP} \times \frac{CO_2}{Energy}$$

We adapt the Kaya identity to the firm-level setting by decomposing firm emissions into:

$$CO_2 = Assets \times \frac{Sales}{Assets} \times \frac{Energy}{Sales} \times \frac{CO_2}{Energy}$$

or equivalently:

$$Emission\ Intensity = \frac{CO_2}{Assets} = \frac{Sales}{Assets} \times \frac{Energy}{Sales} \times \frac{CO_2}{Energy},$$

where $\frac{Sales}{Assets}$ is the firm's asset turnover (or asset productivity), $\frac{Energy}{Sales}$ is a measure of the energy intensity of its production process and $\frac{CO_2}{Energy}$ is the carbon intensity of the energy mix the firm uses for production. This decomposition provides the conceptual basis for scaling by assets but is also useful because it directly identifies the main decarbonization levers (and hence also potential control variables for our empirical specifications). Comparing this decomposition to a DuPont decomposition of operating profitability (RoA) into profit margin ($\frac{Operating\ Profits}{Sales}$) and asset turnover:

$$Operating\ Profitability = RoA = \frac{Operating\ Profits}{Assets} = \frac{Operating\ Profits}{Sales} \times \frac{Sales}{Assets},$$

shows that both $Emission\ Intensity$ and RoA share a common component: the firm's asset turnover $\frac{Sales}{Assets}$. This creates a key empirical challenge when estimating the link between corporate

emissions and profits. A positive association between the two could simply reflect differences in firm activity (sales) or asset turnover, which positively affect both emissions and profits for firms with positive operating margins. In our empirical design, we switch these influences or decarbonization levers on and off by either directly controlling for them or by varying the variable by which we scale emissions. This allows us to assess whether the emissions-profit relation is driven solely by differences in firm size or activity, or instead by variation in energy intensity and the carbon intensity of production.

4. Data and Sample

We obtain verified emissions for installations covered under the EU ETS from EUETS.INFO which pre-processes data from the EU Transaction Log (EUTL).[11] EUETS.INFO is a common source of EU ETS data in the literature and provides us with relational tables between installations, accounts and accountholders scraped from installation operator details in the EUTL (Abrell 2024). We supplement this data with direct compliance records from the EUTL for more recent years. For financial data, we rely on Orbis Bureau van Dijk, which provides financial statement information for a broad sample of public and private companies in Europe. To merge with firm-level financials we aggregate installation-level emissions for each accountholder, which is the level at which the legal entity owning one or more installations is defined.

A key step in compiling our sample is matching accountholders to firms in Orbis. Since we identified major inconsistencies in the matches provided by the European Commission's Joint Research Centre (JRC), we implement our own matching procedure: First, we use GPT to validate and choose among competing existing matches from the EC JRC and European Commission's

[11] The data processing steps are completely tractable on a public Github Repository (Link).

Directorate General GROW (DG GROW) based on name and location information. Second, for the remaining accountholders, we use the Orbis batch search function to identify additional potential matches in three different rounds with varying matching information (from most to least restrictive):

a. National Registration Number, Name, City, Country (*most restrictive*)

b. Name, City, Country

c. Name, Country (*least restrictive*)

Third, we again use GPT to validate the matches generated in the three rounds of Orbis batch searches. When combining validated matches from all rounds, we manually resolve multiple conflicting matches (only 16 instances). Ultimately, we can match 15,864 out of 17,954 EU ETS installations to firms (or legal entities) in Orbis. Any remaining unmatched accountholders or installations are primarily due to changes in firm name (possibly because of reorganizations), non-firm entities (e.g., individuals or public institutions covered in the EU ETS) or limited Orbis coverage of private firms outside Europe.

Another important issue for matching firm financials and emissions is that both are measured at the same level. For instance, a multinational group company may have other foreign subsidiaries/installations outside the scope of the EU ETS for which we do not observe emissions, even though those subsidiaries contribute to the group's global consolidated financials. Although the introduction of firm fixed effects partially addresses any time-invariant mismatch between emissions and financial data, we seek a tighter match by using unconsolidated financials in Orbis, by limiting the sample to accountholders headquartered in countries covered by the EU or UK ETS, and by matching accountholders to subsidiaries in the same country rather than to the parent company, if possible.

Our final sample contains 81,185 firm-year observations on firms' emission intensities spanning primarily the period from 2005 to 2024. Our sample composition closely mirrors the scope of the EU ETS. It is largely comprised of firms in the manufacturing, electricity, transportation and mining sectors with more than half of our observations stemming from manufacturing. The summary statistics for our sample in Table 1 exhibit many of the stylized facts on the cross-sectional distribution of emission intensities established in prior literature. We find considerable variation in emission intensities across and within industries with the largest emission intensities observable in the electricity sector (Greenstone et al. 2023). In Figure 2, we plot the time-series of 90-10 productivity differentials within granular sub-industries in the manufacturing sector. Consistent with Lyubich et al. (2018), we find that carbon emissions productivity (i.e., the inverse of emission intensity) exhibits a much larger dispersion across firms than other standard input-based productivities and that this dispersion decreases toward later phases of the EU ETS. This time-series trend in carbon emissions productivity suggests some convergence in emission intensities within industries which is consistent with the increasingly benchmark-based allocation of carbon allowances during the third phase of the EU ETS.

5. Research Design

5.1. Baseline Specification

Our initial research design focuses on emission intensities to control for firm size and firm activity. Our baseline specification estimates the following linear OLS regression:

$$Operating\ RoA_{it} = \beta_1 Emission\ Intensity_{it} + \alpha_i + \gamma_t + \beta_k X_{it} + \varepsilon_{it}, \quad (1)$$

where $Operating\ RoA_{it}$ is operating profits scaled by the firm's contemporaneous total assets and $Emission\ Intensity_{it}$ is the firm's carbon emissions aggregated across all of the firm's EU ETS facilities and scaled by its total assets. We scale emissions by total assets rather than sales for

congruity with the scalar in the outcome (or LHS) variable. This specification also maps directly into the ROA decomposition (see Section 3). In robustness tests, we later replace $Operating\ RoA_{it}$ with other measures of firm profitability, such as the firm's $EBIT\ Margin_{it}$ or $EBITDA\ Margin_{it}$ which differ in the scalar and the cost components they exclude. We include firm (α_i) and year (γ_t) fixed effects to control for unobserved (time-invariant) firm characteristics determining operating profitability (e.g., industry) and focus on the operating profit impact of changes in emission intensities. X_{it} is a vector of firm-level control variables including $Log(Assets)_{it}$, $Tangible\ Assets\ Turnover_{it}$ and $Financial\ Leverage_{it}$. Our choice of control variables is motivated by the decompositions of firms' emission intensity and operating ROA described in Section 3. In particular, we include (changes in) tangible asset turnover so that we do not obtain a positive association simply because changes in firm activity or asset productivity drive both higher operating profits and firms' emissions intensities. We use a turnover measure based on tangible fixed assets rather than total assets because tangible fixed assets are more closely related to the production assets responsible for corporate emissions.[12] To assess the statistical significance of the OLS coefficient estimates, we use robust standard errors clustered by firm.

5.2. Instrumental Variable Design

Our baseline specification is based on changes in emission intensities. These changes could be endogenously related to changes in firm profits. This endogeneity arises because firms are more likely to engage in emission reductions if these are less costly for them or if high profitability means that the firm can afford the abatement costs. Similarly, changes in emission intensity likely coincide with changes in total assets as firms make carbon abatement investments possibly

[12] Our main results are directionally unchanged when controlling for total assets turnover instead of tangible assets turnover.

introducing a bad control problem. To address these concerns, we leverage the institutional features of the EU ETS for an instrumental variable design in which we also more carefully consider the timing of controls.

Specifically, we exploit changes in the total number of allowances allocated across and within the different phases of the EU ETS. Comparing the current number of allowances granted to prior-year emissions, we define a carbon allowance shortfall measure:

$$Carbon\ Allowance\ Shortfall_{it} = Log(Emissions_{it-1}) - Log(Allocated\ Allowances_{it})$$

In the first stage, we instrument the change in emission intensity with the size of the carbon allowance shortfall which could be negative:

$$\Delta_1 Emission\ Intensity_{it} = \beta_1 Carbon\ Allowance\ Shortfall_{it} + \gamma_{it} + \beta_k X_{it-1} + \varepsilon_{it}, \quad (2)$$

where $\Delta_1 Emission\ Intensity_{it} = Emission\ Intensity_{it} - Emission\ Intensity_{it-1}$, X_{it-1} is a vector of lagged control variables to avoid contamination by the outcome itself and γ_{it} is an industry-year fixed effect.

Next, we use the instrumented changes in emission intensity induced by carbon allowance shortfalls in a second stage of changes in operating profits:

$$\Delta_1 Operating\ RoA_{it} = \beta_1 \Delta_1 \widehat{Emission\ Intensity}_{it} + \gamma_{it} + \beta_k X_{it-1} + \varepsilon_{it}, \quad (3)$$

where X_{it-1} is again the same vector of firm-level controls as in our baseline specification but lagged by one year. Thus, in the IV specification, we essentially estimate the relation between changes in emission intensities that are induced by the ETS and the consequences for profits. We expect this approach to yield a significantly more negative emissions-profit relation than our baseline specification, as firms reducing emissions only in response to a carbon allowance shortfall

likely face higher abatement costs than the average firm voluntarily reducing emissions irrespective of its carbon allowance position.

6. Results

6.1. Baseline Specification

We begin by examining the baseline relation between firms' emission intensity and operating profits. In Table 2, we report estimates from our standard specification (1) and show a robust positive association between firms' emission intensity and their operating return on assets. The estimated magnitude of this association more than doubles when including firm fixed effects consistent with cross-sectional selection working against a positive association as firms with higher operating profits are likely more inclined to lower their emission intensity. The coefficient changes only marginally when controlling for tangible asset turnover, suggesting that changes in firm activity or productivity are not a major driver of the positive association we document. Similarly, including sales growth, which also limits the scope for a potential benefit of decarbonization through reputation-driven sales increases, does not meaningfully change the emissions-profit link. In column (6) we incorporate country-year fixed effects which also account for (arbitrary) changes in local regulation or local carbon pricing and find a similar positive association. Adding industry-year fixed effects in column (7) to capture industry-level shocks to demand or capacity utilization, which could affect both emission intensities and firm profits changes the coefficient only marginally.

In terms of economic magnitude, our estimated coefficients translate to an increase of more than €3.00 in same-year operating profits for each additional ton of annual carbon emissions, holding total assets fixed. As we will show in later sections, this profit impact is quite persistent

over several years such that the aggregate profit impact is likely a multiple of our yearly estimate. For manufacturing firms, we estimate significantly larger magnitudes of around €8.00 per additional ton of emissions (see Table OA1). This suggests that the positive association we report is more pronounced for firms in industries where carbon emissions are a more significant externality in the production process.

In Table OA2, we directly address concerns that the timing of our firm-level controls and scaling variables materially affects our estimates. Panel A reports very similar coefficient estimates when lagging both control variables and the scaling variable (i.e., total assets) to account for new decarbonization investments possibly contaminating the firm's asset figure. In Panel B, we include contemporaneous controls and only lag the scaling variable for operating ROA and emission intensity. Coefficient estimates more than double relative to our baseline results which highlights the importance of aligning the timing of the activity/size scalar and size control in our specification.

6.2. Robustness to Emission Scaling and Carbon Allowance Sales

The measurement and scaling of carbon emissions in empirical analyses have been heavily debated in the finance literature (Aswani et al. 2024a; Bolton and Kacperczyk 2024; Aswani et al. 2024b). We therefore explore the sensitivity of our results to scaling or variations in the variable by which we scale emissions (Table 3, Panel A). When scaling operating profits and emissions by operating revenues and replacing firm assets with revenue as control accordingly (or including both jointly), we again find a stable positive association between emission intensity and operating profits in the same order of magnitude. In columns (4)-(6), the positive emissions-profit link also holds for the unscaled logarithm of corporate emissions. Overall, our results suggest that many of the concerns about emission scaling are not first order when working with actual rather than estimated emissions data.

One of the drawbacks of using verified emissions data from the EU ETS is that we need to explicitly take into account the role of carbon allowances in our estimation. In particular, we need to rule out that the positive association between emission intensity and operating profitability is solely driven by windfall profits from the free allocation of carbon allowances. This is a relevant concern in the early phases of the EU ETS, when firms received generous free allocations. Carbon-intensive firms may have benefited from these allocations, either by selling excess allowances in secondary markets or by passing through the opportunity cost of freely allocated allowances to product prices (Sijm et al. 2006). If such benefits disproportionately accrued to high-emission firms, they could mechanically inflate the estimated relation between emission intensity and profitability.

Table 3, Panel B addresses this concern using transaction-based data from the EU ETS. We first control separately for alternative measures of allowance allocations, including total allowances granted, allowances sold, and excess allowances. We then directly adjust operating profits by subtracting the value of carbon allowances sold. The coefficient on emission intensity remains positive and similar in magnitude when we control for allowance allocations. It declines by about one-third when operating profits are adjusted for allowance sales, indicating that windfall profits from free allowances have a non-negligible effect on operating profits. However, the association between emission intensity and operating profitability remains positive after this adjustment. These results suggest that windfall profits from free allowance allocation contribute to, but do not explain, the positive emissions-profit relation we document.

6.3. Generalizability to Other Unpriced Corporate Emissions

Our data on firms' other air and water pollutants from the European Pollutant Release and Transfer Register (E-PRTR) allows us to explore whether the estimated link between firm

emissions and profits generalizes to corporate emissions other than carbon. This also helps us further rule out that the positive link we document is confounded by the pricing of carbon emissions under the EU ETS as most of these other pollutants are completely unpriced. We first aggregate all reported air pollutants excluding carbon emissions for each firm and estimate the association with operating profits in Table 9. At least within firm, changes in air pollutant intensity are strongly positively associated with changes in operating profits, irrespective of whether we scale the sum of firm-level air pollutants by total assets or revenue.

When including carbon emission reported under the E-PRTR in firms' air pollutant intensity, we find a similar robust positive association albeit with much smaller coefficient estimates (see Table OA6), consistent with the scale of carbon emissions being several orders of magnitude greater than of other firm pollutants. While our sample for firm's water pollutant intensity is limited, Table OA7 also shows a largely positive correlation with operating profits for water pollutant intensity.

Overall, our evidence for other firm pollutants suggests that the positive relation between corporate emissions and profits we document is neither carbon-specific nor an artefact of carbon pricing under the EU ETS, but extends more broadly to other unpriced corporate emissions.

6.4. Instrumental Variable Design

A central question of our analysis so far is where the variation in emission intensities (within-firm) we exploit stems from and why firms engage in carbon abatement when it appears to be net costly. To tighten our empirical design, we use the shortfall in carbon allowances allocated to the firm relative to prior-year emissions to instrument for changes in emission intensity (see also Section 5.2). These changes in emission intensity are more plausibly exogenous because both the number and allocation mechanism of allowances granted are centrally determined and vary

substantially across and within the different phases of the EU ETS. As a result, it is difficult for firms to foresee precisely whether and to what extent they will face an allowance shortfall.

In Figure 3, we visually inspect the relevance of our instrument by plotting changes in emission intensities across each EU ETS phase against the carbon allowance shortfall at the beginning of that phase. We find a strong first-stage: shortfalls significantly predict subsequent emission reductions, consistent with prior evidence (Dechezleprêtre et al. 2023; Venmans 2016). Comparing Panels A to C shows that this relationship holds even in earlier phases when EU ETS prices were fairly low, suggesting that at least some firm managers anticipated a significant tightening of the EU ETS and rising carbon allowance prices in the future (Bayer and Aklin 2020).

Next, we use the change in emission intensity induced by carbon allowance shortfalls in a 2SLS IV estimation of changes in operating profitability. To accommodate for time-series heterogeneity in the profit-emission link, we run the IV estimation separately for phases I-III and IV of the EU ETS largely separating low- and high-carbon pricing periods. Table 4 shows that the positive association between changes in emission intensity and profitability strengthens considerably for the IV specification relative to the OLS specification in earlier phases of the EU ETS. This is economically intuitive as compliers with the shortfall instrument likely face higher abatement costs than firms that voluntarily reduce their emissions independently of their exposure to a carbon allowance shortfall.

6.5. Mechanism

To unpack the mechanism underlying the positive relation between corporate emissions and operating profits, we proceed in two steps. First, we replace ROA with other profitability measures that differ in the extent to which they deduct certain cost components. The idea is that as we move up the income statement to a more pre-cost basis, we can gauge which cost components are key

drivers of the emissions-profit relation. Table 5 shows a very similar economic magnitude for the EBIT margin, but a much weaker relation (about a third of the magnitude for operating ROA) for the EBITDA margin. This points to investments into fixed assets and their depreciation being key drivers of the positive relation we document.

Second, we test this investment channel more directly using specific proxies for firm investment in our financial accounting data from Orbis, namely depreciation in % of contemporaneous sales and capital expenditures (CapEx) in % of prior-year firm assets. For both investment proxies, we find a strong inverse relationship with emission intensity. In fact, the negative association between changes in CapEx and emission intensities strengthens substantially in the IV specification consistent with higher abatement costs for emission reductions induced by a carbon allowance shortfall (see Table 4). Overall, emission reductions seem to imply significant capital investments, which in turn raise annual depreciation and ultimately lower operating profits.

6.6. Time Profile of the Emissions-Profit Relation

In this section, we first check whether the positive profitability-emission link not only holds for short-run variations in emission intensities but also for longer-run, sustained changes in emission intensities consistent with targeted decarbonization investments. This distinction is also important since yearly changes in emission intensity may be more susceptible to temporary demand-side shocks. Thus, in Table 6, Panel A we measure changes in operating ROA and emission intensity over longer horizons and find that the positive relation between changes in emissions and profits also holds over three- and five-year horizons.

As the positive emissions-profit relation seems to be driven primarily by a fixed carbon-abatement investment, which produces sustained emission reductions and is depreciated over time, it raises the question of whether the negative profit impact of emission reductions eventually

attenuates or reverses in the long-run, once these investments are nearly written off (Busch et al. 2022). We test this idea using increasing lags of (changes in) emission intensity in our main specification of operating ROA. In Table 6, Panel B we find that the positive relation between emissions and (future) profits largely persists up until a five-year lag of emission intensity with no indication of reversal over this medium-term horizon. When including all lags up to a five-year horizon the cumulative profit impact of an increase in emission intensity is significantly positive at around €3.20 per additional ton of carbon emissions.

For even longer horizons, we examine Tobin's q to capture the (anticipated) long-run net effects of corporate emission reductions on firm value. While this analysis significantly limits our sample to public firms and introduces some noise into our estimation, Table 6, Panel C suggests a positive relation between emissions and firm value in earlier phases of the EU ETS, which then attenuates or turns negative in later phases. Thus, from ETS Phase II onward, there appears to be some market penalization for greater emission intensities which may incentivize firms to undertake carbon-abatement activities even when net costly over shorter horizons.

6.7. Cross-Sectional Heterogeneity

In this section, we explore the cross-sectional heterogeneity in the relation between corporate emissions and profits. Conceptually, there are at least two factors that should moderate the positive association we find. First, since the negative profit impact is primarily driven by a fixed carbon-abatement investment, it is likely attenuated for firms with greater ability to pass through these costs to consumer (prices). Second, the carbon abatement costs themselves likely vary significantly across industries because of the availability of cost-effective carbon abatement technologies in some industries, but not in others. We test the moderating role of both factors in Table 7.

In Panel A, we run our baseline specification from Table 2 separately for each key industry-sector in our sample. A general pattern emerges in that the relation between corporate emissions and profits tends to be strongest in sectors for which carbon emissions are likely a major byproduct in the production process such as manufacturing or transportation. In contrast, the electricity sector exhibits the weakest association possibly due to greater ability to pass through abatement costs as the sector heavily relies on cost-plus pricing (see also the flatter slope in Figure 4, Panel C).

In Panel B, we proxy for cross-sectional variation in carbon abatement costs (e.g., due to available cost-effective abatement technologies) using the 90-10 carbon productivity differential within sub-industries. The idea is that emission-intensive firms in industries with greater carbon productivity dispersion have likely not fully utilized the carbon abatement technologies available at comparably low marginal abatement cost. Consistent with this idea, we find a robust negative interaction between changes in emission intensity and the industry's carbon productivity dispersion.

6.8. Time-Series Variation in Emissions-Profit Link

Finally, we study how changes in the carbon price affect the fundamental link between emissions and operating profits. As we discussed in Section 3, at higher carbon prices some of the abatement cost may be directly offset by the positive contemporaneous profit impact from selling or avoiding the purchase of additional carbon allowances. We therefore track the direction and magnitude of the relation between corporate emissions and profits over the EU ETS phases and analyze its interaction with carbon prices.

When decomposing our sample period into ETS phases I & II (2005-2012), III (2013-2020) and IV (2021-2024), we find a significantly positive link for corporate emissions in the first three phases. In the fourth phase the sign turns significantly negative (Table 8, Panel A). A similar time-

series pattern emerges in our instrumental variable design when instrumenting emission intensity changes with the carbon allowance shortfall at the beginning of each phase and tracking changes in operating ROA over the entire phase thereafter (see Table 8, Panel B).

Next, we explore whether this time-series variation in the emissions-profit link can be attributed to increases in the carbon price or other institutional features changing across ETS phases. We directly test the interaction between emission intensity and carbon prices in Columns (5)-(8) of Table 8, Panel A, and find that the negative profit effect from reductions in emission intensity is significantly attenuated at higher carbon prices. Importantly, this negative interaction is robust to other ETS phase-specific effects, country-year fixed effects and linear time trends.

7. Conclusion

Understanding the link between corporate emissions and profits and its interaction with carbon pricing is central to both assessing the need for environmental policies and identifying the fundamental channels through which such policies pose transition risk to firms. Much of the empirical evidence points to a positive link between environmental and financial performance consistent with the Porter hypothesis that well-designed environmental regulation can be performance-enhancing by uncovering prior inefficiencies. These results are difficult to reconcile with basic economics and would also contradict the pricing of environmental transition risks. We systematically revisit this fundamental link for one specific sustainability activity, that is firms' carbon abatement. Carbon emissions are arguably the largest negative externalities of corporate activity and hence central to the sustainability debate.

We overcome several challenges in studying the link between corporate carbon emissions and profits. First, we obtain actual, externally verified data on carbon emissions from the European Union's Emissions Trading System (EU ETS) and do not rely on estimated or rating-based

measures. Second, we exploit regime changes in the EU ETS for more plausibly exogenous variation in firms' emission intensities. Third, we carefully address a series of research design issues discussed in prior literature, including emission scaling and sales of freely granted carbon allowances. Fourth, we employ data on both priced carbon emissions and other unpriced firm pollutants released into air and water.

Across all these different research designs, alternative datasets, measurement choices and empirical specifications we find a remarkably robust positive association between carbon emission intensities and firm profits that persists over at least a five-year horizon. Importantly, the negative profit impact from emission reductions flips significantly as carbon prices increase in recent years.

Our results call into question the notion that corporate sustainability pays off financially and that firms therefore have sufficient incentives to decarbonize voluntarily. Instead, our evidence re-emphasizes the need for some form of carbon pricing. Our results also show that carbon pricing meaningfully shapes the trade-offs firms face when making carbon abatement investments implying significant transition risks for firms with high emission (intensity).

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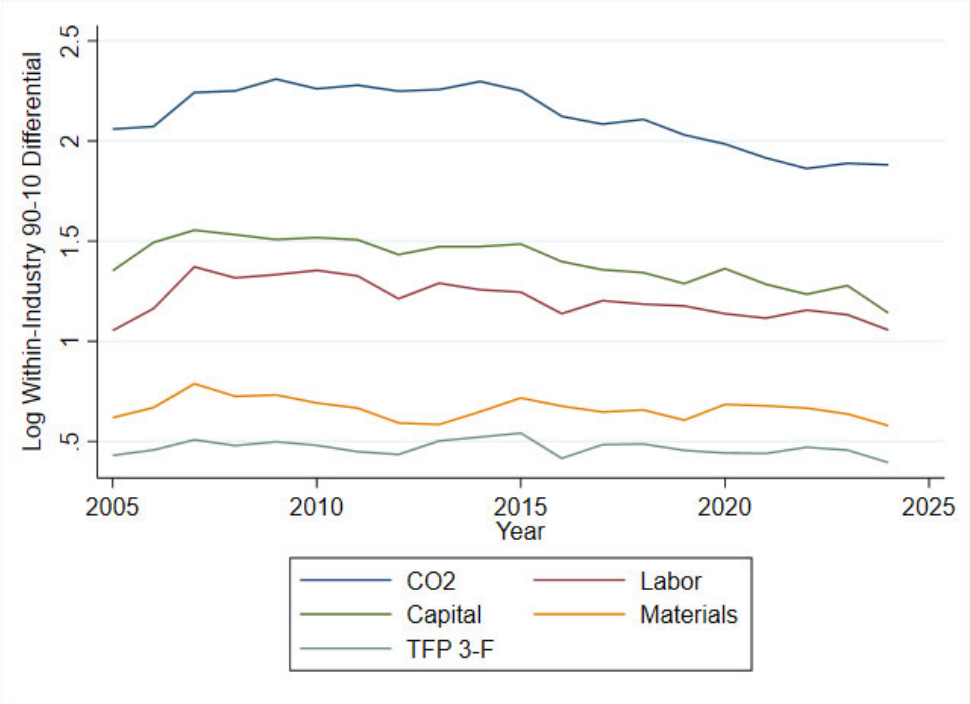
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Figure 1 – Time-Series Trend of EU ETS Carbon Allowance Prices



The figure illustrates the time-series trend of average monthly spot prices for carbon emission allowances under the EU ETS (in € per tonne of carbon emissions). We compute monthly averages from daily closing spot prices of EU ETS allowances (EUA) on the secondary emissions market (European Energy Exchange).

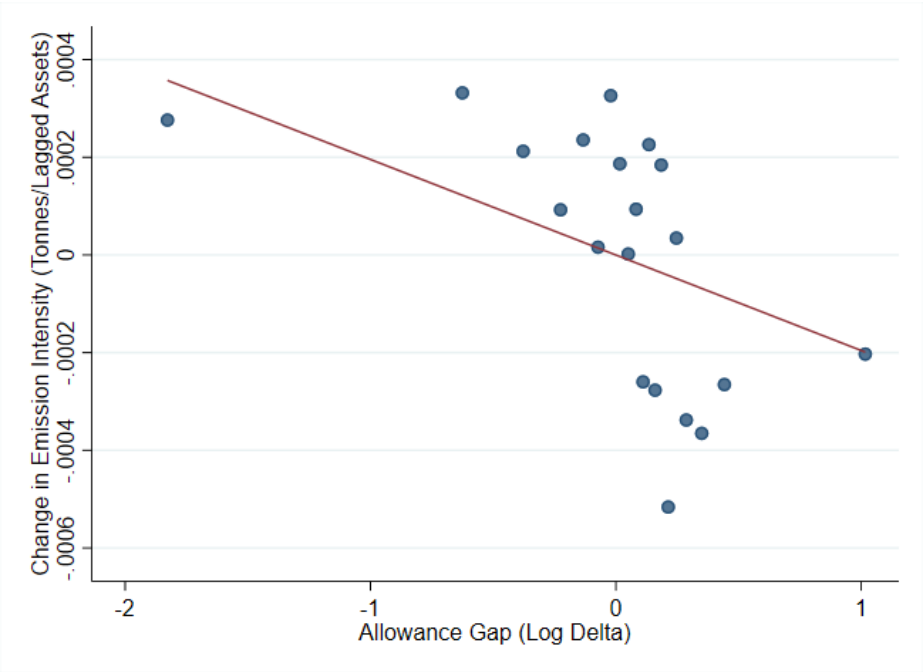
Figure 2 – Time-Series Trend in 90-10 Productivity Differentials – Manufacturing



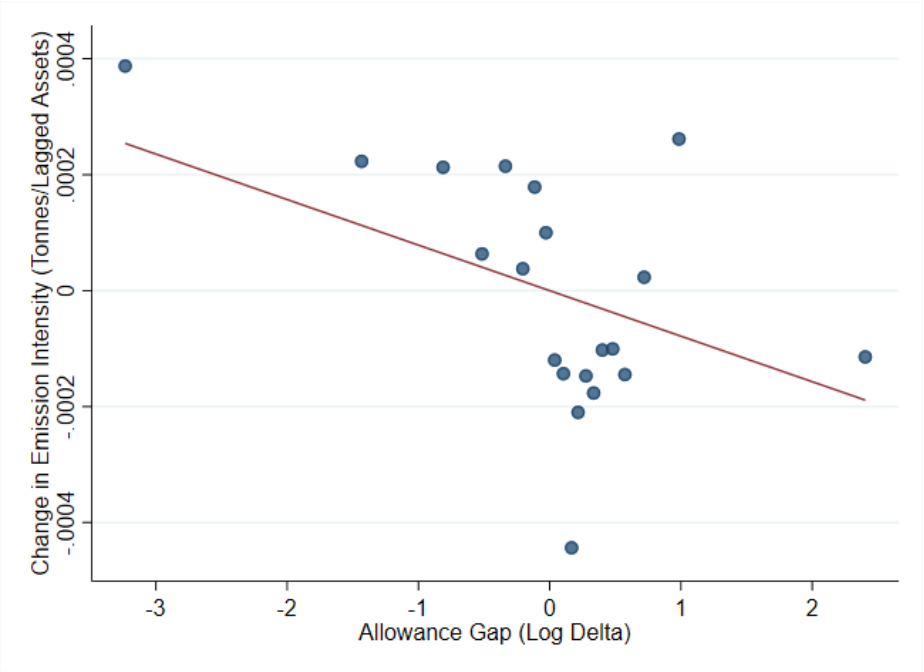
The figure illustrates the time-series trend of average 90-10 productivity differentials within granular NACE 4-digit industries in the manufacturing sector. We compute 90-10 productivity differentials within granular NACE 4-digit industries for several (quasi-) input factors. For example, *CO_2 Productivity* is defined as the logarithm of $\frac{Operating\ Revenue}{Carbon\ Emissions}$. The *Log 90-10 CO_2 Productivity Differential* is the difference between the 90th and 10th percentile in *CO_2 Productivity* within each NACE 4-digit industry. All other productivity factors are computed analogously, replacing *Carbon Emissions* by *Tangible Fixed Assets* (Capital), *No. of Employees* (Labor) and *Material Costs* (Materials). We exclude NACE 4-digit industries with fewer than 10 firms each year.

Figure 3 – Instrument Relevance – Changes in Emission Intensity and Carbon Allowance Shortfall

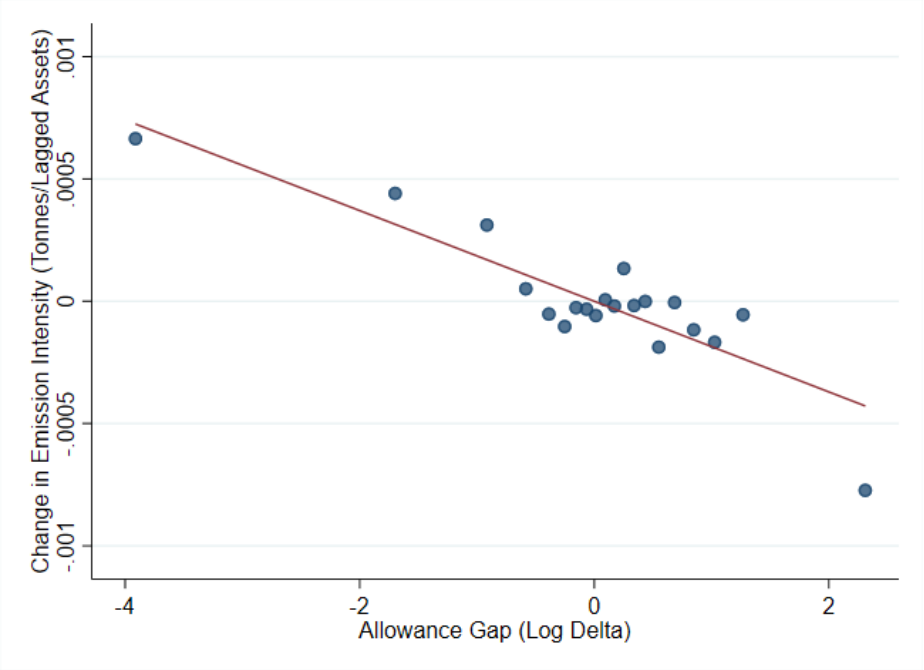
Panel A: Phase II



Panel B: Phase III

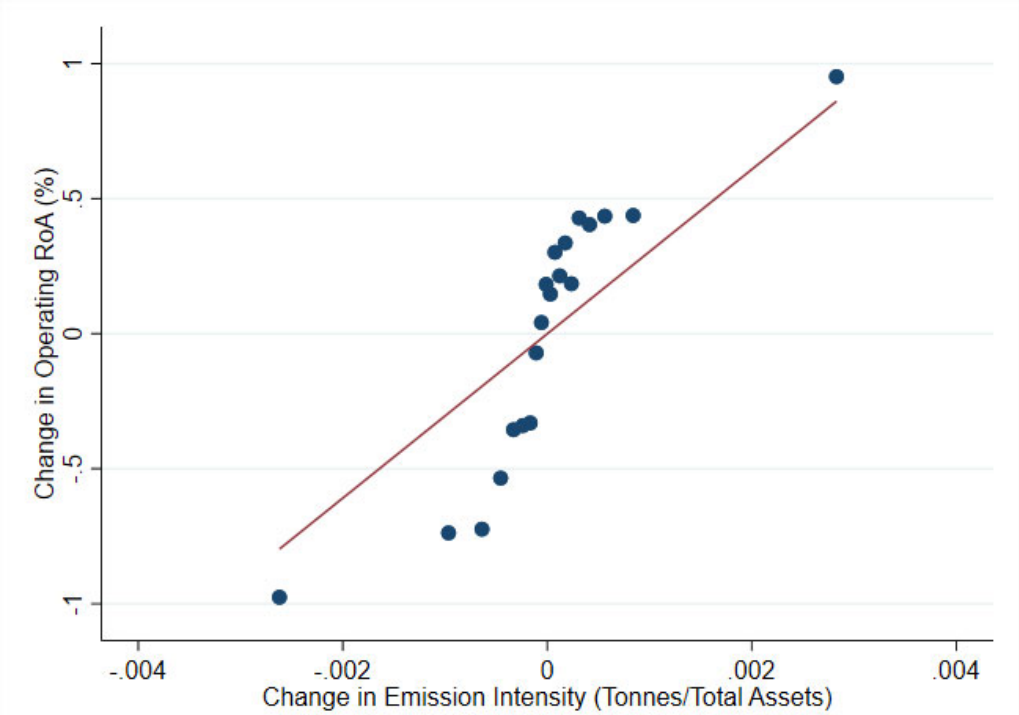


Panel C: Phase IV

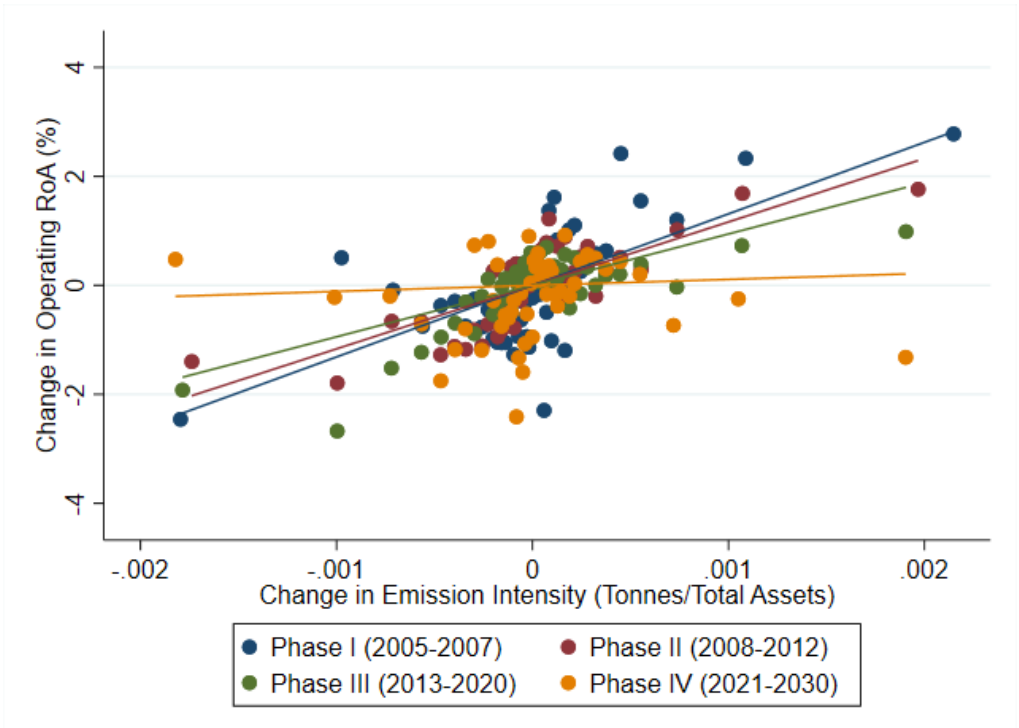


The figure illustrates the relevance of carbon allowance shortfalls as an instrument for changes in emission intensity. We compute changes from beginning to end of each phase in the EU ETS and derive the carbon allowance shortfall at the beginning of each phase as: $Log(Emissions_{t-1}) - Log(Allocated\ Carbon\ Allowances_t)$. We residualize both variables by the firm-level controls from our baseline specification in Table 2 lagged by one year and de-mean by NACE sector fixed-effects. Each panel represents a scatterplot of 20 equal-sized bins of observations. Panel A, B and C restrict the sample to EU ETS Phase II, III and IV, respectively.

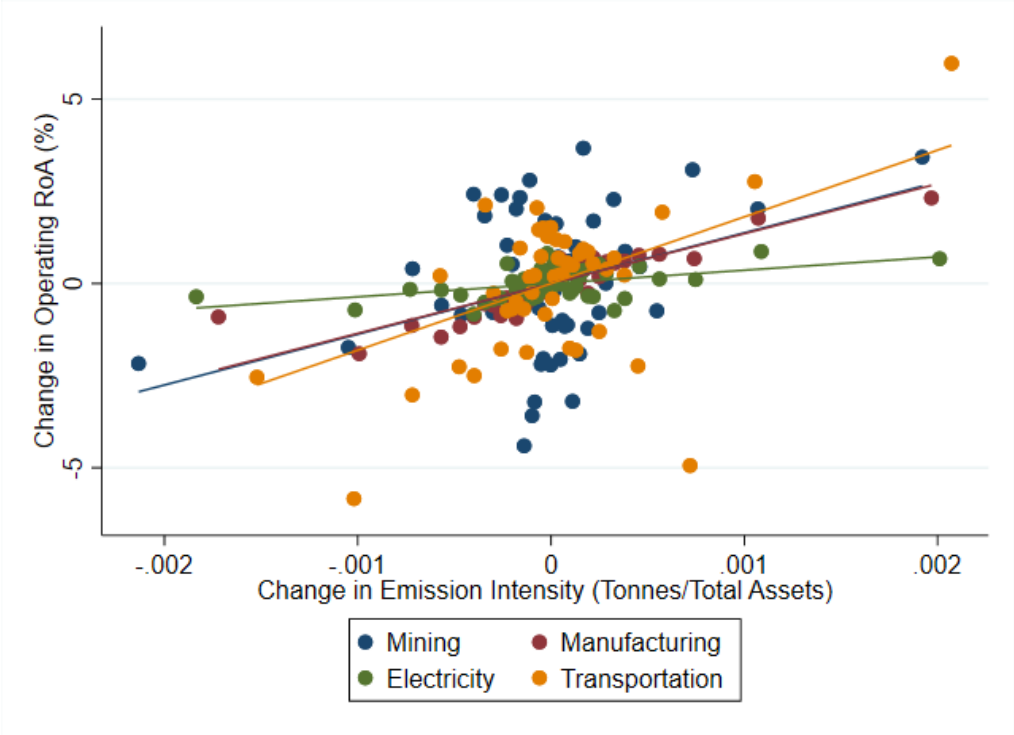
Figure 4 – Operating Profitability and Emission Intensity
Panel A: Emissions scaled by Total Assets



Panel B: Emissions scaled by Total Assets – By EU ETS Phase



Panel C: Emissions scaled by Total Assets – By Key Industries



The figure illustrates the relation between changes in operating RoA and changes in emission intensity. *Operating RoA* is defined as firm-level operating profits (from Orbis) over total assets. *Emission Intensity* are firm-level emissions (in tonnes) aggregated from installation-level compliance data in the EU ETS and scaled by total assets (Panels A, B, C). We residualize both variables by the firm-level controls from our baseline specification in Table 2. Each panel represents a scatterplot of equal-sized bins of observations. Panels B and C are restricted to observations between the 5th and 95th percentile of emission intensities. Panel A plots changes in emission intensity scaled by total assets on the x-axis. Panel B plots bins separately for each phase of the EU ETS. Panel C shows the relation separately for the four key industries.

Table 1 – Descriptive Statistics for Scaled Emissions (kg/€ of Total Assets) by Firm-Level NACE Sector

NACE Sector	N	Mean	SD	p10	p25	Median	p75	p90
Agriculture, Forestry and Fishing	363	1.306	2.689	0.026	0.146	0.344	1.098	3.144
Mining and Quarrying	1941	1.388	2.554	0.025	0.078	0.230	1.603	4.284
Manufacturing	48641	0.930	1.912	0.025	0.100	0.320	0.859	2.331
Electricity, Gas, Steam and Air Conditioning Supply	21537	2.604	3.911	0.016	0.151	0.908	3.653	7.188
Water Supply; Sewerage, Waste Management and Remediation Activities	1155	0.972	2.312	0.003	0.019	0.144	0.807	2.710
Construction	723	1.128	3.010	0.009	0.024	0.104	0.700	3.077
Wholesale and Retail Trade; Repair of Motor Vehicles and Motorcycles	1717	0.929	2.128	0.007	0.060	0.299	0.844	2.096
Transportation and Storage	2474	0.792	1.980	0.005	0.030	0.208	0.731	1.938
Information and Communication	233	0.083	0.306	0.000	0.000	0.001	0.008	0.208
Financial and Insurance Activities	206	0.797	1.231	0.001	0.0510	0.336	0.924	3.149
Real Estate Activities	661	1.529	3.211	0.005	0.068	0.410	1.487	3.792
Professional, Scientific and Technical Activities	813	1.459	3.703	0.005	0.037	0.228	0.836	4.156
Administrative and Support Service Activities	595	1.287	3.101	0.003	0.013	0.101	0.940	4.060
Other Service Activities	126	3.100	6.785	0.005	0.181	0.472	1.824	13.003

Notes: This table presents summary statistics of firm-level emission intensity across NACE industry sectors. To compute emission intensities, we aggregate for each firm emissions verified for compliance with the EU ETS (in kg) across all firm installations and scale emissions by the firm's total assets. We truncate observations of emission intensity that are below the 1st or above the 99th percentile. Our sample excludes any NACE industry sectors with fewer than 100 observations across our sample period.

Table 2 – Operating Profitability and Emission Intensity (tonnes per € Assets)

Dep. Variable: Operating RoA (€/€ Total Assets x 100%)	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Emission Intensity (t/€ Total Assets)	179.98***	318.885***	320.469***	304.337***	248.344***	277.49***	222.806***
	(32.339)	(44.213)	(47.284)	(47.428)	(50.739)	(48.605)	(49.548)
Log(Assets)	0.395***	1.084***	1.052***	1.258***	0.687***	1.277***	1.045***
	(0.041)	(0.163)	(0.173)	(0.176)	(0.191)	(0.176)	(0.175)
Tangible Assets Turnover			0.024***	0.022***	0.015***	0.021***	0.018***
			(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Financial Leverage				-5.389***	-5.49***	-5.666***	-5.100***
				(0.381)	(0.407)	(0.391)	(0.384)
Sales Growth					5.680***		
					(0.183)		
Observations	79,578	79,578	77,016	76,398	67,927	76,389	76,055
Adj R^2	0.016	0.379	0.384	0.389	0.423	0.397	0.425
Firm FE	No	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country-Year FE	No	No	No	No	No	Yes	Yes
Industry-Year FE	No	No	No	No	No	No	Yes
Sample Period most Firms	2005-2024	2005-2024	2005-2024	2005-2024	2005-2024	2005-2024	2005-2024

Notes: This table reports OLS coefficient estimates and (in parentheses) standard errors from regressions of operating return on assets on firm's emission intensities. *Operating RoA* is defined as firm-level operating profits (from Orbis) over total assets. *Emission Intensity* are firm-level emissions (in tonnes) aggregated from installation-level compliance data in the EU ETS and scaled by total assets. The firm-level controls for operating RoA are: *Log(Assets)*, *Tangible Asset Turnover* ($\frac{Operating\ Revenue}{Tangible\ Fixed\ Assets}$), *Financial Leverage* ($\frac{Long-Term\ Debt}{Total\ Assets}$) and *Sales Growth*. All continuous variables that are not logarithmized are trimmed at 1st and 99th percentile. Standard errors are clustered by firm and statistical significance is indicated by *** p<.01, ** p<.05, * p<.1

Table 3 – Operating Profitability and Emission Intensity – Robustness Tests
Panel A: Profit and Emission Scaling

	Revenue Scaling			Unscaled (Log) Emissions		
	Dep. Variable: Operating Profits over Sales (%)			Dep. Variable: Operating RoA (%)		
	(1)	(2)	(3)	(4)	(5)	(6)
Emission Intensity (t/€ Op. Revenue)	202.553***	176.06***	183.756***			
	(65.115)	(62.781)	(62.637)			
Log(Emissions)				0.626***	0.548***	0.150**
				(0.069)	(0.070)	(0.066)
Log(Op. Revenue)	8.808***	8.674***	9.659***			3.439***
	(0.350)	(0.349)	(0.408)			(0.197)
Log(Assets)			-2.047***	0.947***	0.708***	-1.900***
			(0.326)	(0.103)	(0.157)	(0.201)
Tangible Assets Turnover		0.010*	0.004		0.021***	
		(0.006)	(0.006)		(0.004)	
Financial Leverage		-3.637***	-2.642***		-5.317***	-4.146***
		(0.607)	(0.625)		(0.377)	(0.372)
Observations	79385	76524	76524	81132	77460	80009
Adj R^2	0.439	0.446	0.447	0.379	0.387	0.413
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Sample Period most Firms	2005-2024	2005-2024	2005-2024	2005-2024	2005-2024	2005-2024

Notes: This table reports OLS coefficient estimates and (in parentheses) standard errors from regressions of operating return on sales or assets on firm's emission intensities. Panel A examines sensitivity of the relation to the choice of emission scalar and the decision to scale emissions. In the first three columns, we scale emissions by the firm's operating revenue (rather than its total assets) and include *Log(Operating Revenue)* as a control. We also replace return on assets with return on sales (operating profits over total sales) on left-hand side for congruity between scalars. In the last three columns, we replace scaled emission intensity by the unscaled logarithm of emissions (in tonnes). All other controls follow our baseline specification from Table 2, column (4) and are defined accordingly. Continuous variables that are not logarithmized are trimmed at 1st and 99th percentile. Standard errors are clustered by firm and statistical significance is indicated by *** p<.01, ** p<.05, * p<.1

Table 3 – Operating Profitability and Emission Intensity – Robustness Tests
Panel B: Accounting for Carbon Allowances

Dep. Variable: Operating RoA (%)	(1)	(2)	(3)	(4)	RoA adj. for Allowances Sold
Emission Intensity (t/€ Total Assets)	304.337***	254.532***	351.24***	284.14***	209.187***
	(47.428)	(51.726)	(63.414)	(47.102)	(71.186)
Log(Allowances)		0.296***			
		(0.076)			
Log(Allowances sold)			0.097*		
			(0.053)		
Log(Excess Allowances)				-0.138***	
				(0.012)	
Observations	76398	71283	51525	76398	53016
Adj R^2	0.389	0.399	0.444	0.391	0.429
Firm FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes
Sample Period most Firms	2005-2024	2005-2024	2005-2022	2005-2024	2005-2022

Notes: This table reports OLS coefficient estimates and (in parentheses) standard errors from regressions of operating return on assets on firm's emission intensities. Panel B examines sensitivity of the relation to adjustments for windfall profits from sales of freely allocated carbon allowances. Columns (2)-(4) control for the number of yearly emission allowances allocated under EU ETS, the number of allowances sold or the number of allowances held in excess of actual emissions, respectively. Column (5) adjusts left-hand side operating profits for windfall profits from allowances sold by subtracting the value of allowances sold in each year. Columns (3) and (5) only cover years until 2022 because of the three-year reporting delay of transaction data in the EU ETS. *Emission Intensity* and all control variables follow our baseline specification from Table 2 and are defined accordingly. Continuous variables that are not logarithmized are trimmed at 1st and 99th percentile. Standard errors are clustered by firm and statistical significance is indicated by *** p<.01, ** p<.05, * p<.1.

Table 4 – IV Approach: Emission Changes Instrumented with Carbon Allowance Shortfall

	Dependent Variable:								
	Δ_1Operating RoA (€/€ Total Assets$_t$)						Δ_1 CapEx Ratio (€/€ Tangible Assets$_{t-1}$)		
	EU ETS Phase I-III (2005-2020)			EU ETS Phase IV (2021-2024)			EU ETS Phase I-IV		
	OLS	First-Stage	2SLS	OLS	First-Stage	2SLS	OLS	First-Stage	2SLS
Δ_1 Emission Intensity (t per Assets$_t$)	144.286*		1902.4***	-670.00***		-2900.4***	-1235.99***		-976.96*
	(75.640)		(436.03)	(234.072)		(828.194)	(104.43)		(522.29)
Allowance Gap: Log(Emissions$_{t-1}$) - Log(Allowance$_t$)		-0.006***			-0.006***			-0.005***	
		(0.001)			(0.001)			(0.000)	
Log(Assets)$_{t-1}$	-0.030***	0.000***	-0.107***	0.023	0.000***	0.099**	-0.082***	0.000***	-0.083***
	(0.011)	(0.000)	(0.024)	(0.033)	(0.000)	(0.050)	(0.012)	(0.000)	(0.020)
Tangible Assets Turnover$_{t-1}$	-0.005***	-0.000	-0.005**	0.000	-0.000	-0.006	0.019***	-0.000**	0.019***
	(0.002)	(0.000)	(0.002)	(0.006)	(0.000)	(0.007)	(0.002)	(0.000)	(0.003)
Financial Leverage$_{t-1}$	1.020***	0.0001	0.899***	2.479***	0.0001	2.716***	-2.050***	0.0001***	-2.376***
	(0.144)	(0.000)	(0.174)	(0.409)	(0.000)	(0.458)	(0.207)	(0.000)	(0.228)
Observations	53785	51252	51240	14295	12695	12695	56280	52688	52688
Adj R^2	0.029	0.024	-	0.034	0.061	-	0.032	0.026	-
F-stat Instrument	-	210.58	-	-	171.93	-	-	256.51	-
Firm FE	No	No	No	No	No	No	No	No	No
Industry-Sector FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry-Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: This table reports OLS as well as 2SLS-IV coefficient estimates and (in parentheses) standard errors from regressions of yearly changes in operating return on assets and CapEx intensity on yearly changes in firm's emission intensities. *Operating RoA* is defined as firm-level operating profits (from Orbis) over total assets in *t*. *CapEx Intensity* is computed as changes in tangible fixed assets plus depreciation and amortization scaled by lagged total assets in *t*-1. *Emission Intensity* are firm-level emissions (in tonnes) aggregated from installation-level compliance data in the EU ETS and scaled by total assets in *t*. We instrument yearly changes in emission intensity by the logarithm of carbon allowance shortfall relative to prior-year emissions, i.e.: $Log(Emissions_{t-1}) - Log(Allocated\ Carbon\ Allowances_t)$. For exposition, we divide this carbon allowance shortfall measure by 100. All control variables follow our baseline specification from Table 2, but are lagged by one year. *Industry-Sector FE* are NACE Level 1 Sector fixed effects and *Industry-Year FE* are NACE Level 2 (2-digit) industry fixed effects interacted with year fixed effects. Standard errors are clustered by firm and statistical significance is indicated by *** p<.01, ** p<.05, * p<.1.

Table 5 – Operating Profitability and Emission Intensity – Mechanism: Investment Channel

	Dependent Variable:							
	Profitability Measures:				Investment Proxies:			
	EBIT Margin	EBIT Margin	EBITDA Margin	EBITDA Margin	Depreciation (% Sales$_t$)	Depreciation (% Sales$_t$)	CapEx Ratio (% Tangible Assets$_{t-1}$)	CapEx Ratio (% Tangible Assets$_{t-1}$)
Emission Intensity	241.025***	221.057***	102.495*	81.765	-315.876***	-307.294***	-135.71***	-124.124***
(t/€ Total Assets)	(46.883)	(51.003)	(60.627)	(62.961)	(33.700)	(33.171)	(43.985)	(46.886)
Log(Assets)	2.697***	3.042***	3.954***	4.089***	0.446***	0.236**	1.956***	1.836***
	(0.196)	(0.206)	(0.242)	(0.248)	(0.119)	(0.117)	(.165)	(0.175)
Tangible Assets Turnover		0.013***		-0.004		-0.027***		-0.042***
		(0.004)		(0.005)		(0.003)		(0.004)
Financial Leverage		-4.459***		-2.258***		2.914***		1.378***
		(0.484)		(0.572)		(0.280)		(0.456)
Observations	78466	75811	72356	70493	72372	70861	65397	63723
Adj R^2	0.445	0.451	0.577	0.588	0.676	0.676	0.180	0.181
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sample Period most Firms	2005-2024	2005-2024	2005-2024	2005-2024	2005-2024	2005-2024	2005-2024	2005-2024

Notes: This table examines the investment channel underlying the relation between operating RoA and emission intensities. It reports OLS coefficient estimates and (in parentheses) standard errors from regressions of different profitability and investment proxies on firm's emission intensities. In the first four columns we replace operating RoA in the baseline specification from Table 2 with either *EBIT* or *EBITDA* margin (% of operating revenue) as the dependent variable. In the last four columns, we use *Depreciation* (% of operating revenue) and *CapEx* (% of prior-year total tangible fixed assets) as dependent variables. *CapEx Intensity* is computed as changes in tangible fixed assets plus depreciation and amortization scaled by lagged total tangible fixed assets in t-1. All controls follow our baseline specification from Table 2 and are defined accordingly. Continuous variables that are not logarithmized are trimmed at 1st and 99th percentile. Standard errors are clustered by firm and statistical significance is indicated by *** p<.01, ** p<.05, * p<.1.

Table 6 – Time Profile of the Profitability-Emission Link
Panel A: Longer-Run Changes

	Multi-Year Differences						
Dep. Variable: Δ_tOperating RoA (%)	1-Year	3-Year	3-Year	3-Year	5-Year	5-Year	5-Year
	Full	Full	No Overlap	No Overlap	Full	No Overlap	No Overlap
Δ_1Emission Intensity (t/€)	349.781***						
	(79.966)						
Δ_3Emission Intensity (t/€)		349.912***	453.936***	247.921***			
		(64.661)	(95.704)	(90.792)			
Δ_5Emission Intensity (t/€)					292.391***	322.438***	37.387
					(63.777)	(104.354)	(98.072)
Δ_tLog(Assets)	3.813***	1.729***	1.753***	-2.569***	1.104***	0.146	-3.913***
	(0.309)	(0.215)	(0.320)	(0.352)	(0.209)	(0.336)	(0.402)
Δ_tTangible Asset Turnover	0.029***	0.033***	0.025***	0.015**	0.025***	0.022**	0.012
	(0.006)	(0.006)	(0.007)	(0.007)	(0.006)	(0.010)	(0.011)
Δ_tFinancial Leverage	-5.123***	-5.831***	-5.569***	-3.743***	-5.439***	-5.499***	-3.711***
	(0.432)	(0.437)	(0.640)	(0.630)	(0.455)	(0.773)	(0.743)
Δ_tLog(Op. Revenue)				6.458***			6.135***
				(0.335)			(0.419)
Observations	67722	55669	16811	16811	45468	8807	8807
Adj R^2	0.027	0.033	0.039	0.107	0.024	0.014	0.105
Firm FE	No	No	No	No	No	No	No
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sample Period most Firms	2005-2024	2005-2024	2005-2024	2005-2024	2005-2024	2005-2024	2005-2024

Notes: This table examines the relation between corporate financial performance and emission intensity for changes over longer horizons. Panel A reports OLS coefficient estimates and (in parentheses) standard errors from regressions of multi-year changes in operating RoA on multi-year changes in firm's emission intensity. In column (1), we estimate the model for one-year changes, which correspond closely to Table 2. In the other columns, we compute changes over 3-year and 5-year horizons in the remaining columns, i.e., RoA_3-RoA_0. We run these regressions in changes for both the full sample ("Full") and for a sample composed only of observations every 3 or 5 years, respectively ("No Overlap"). Controls are changes over the respective horizon; they otherwise follow our baseline specification from Table 2 column (4) and are defined accordingly. Continuous variables that are not logarithmized are trimmed at 1st and 99th percentile. Standard errors are clustered by firm and statistical significance is indicated by *** p<.01, ** p<.05, * p<.1.

Table 6 – Time Profile of the Profitability-Emission Link
Panel B: Lagged Emission Specification

Dep. Variable: Operating RoA (%)	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Emission Intensity$_{t}$ (t/€)	304.337***						-25.704
	(47.428)						(112.637)
Emission Intensity$_{t-1}$ (t/€)		273.822***					228.046**
		(44.226)					(89.739)
Emission Intensity$_{t-2}$ (t/€))			224.752***				205.052**
			(42.884)				(89.944)
Emission Intensity$_{t-3}$ (t/€))				136.995***			-131.428*
				(41.777)			(74.717)
Emission Intensity$_{t-4}$ (t/€))					118.327***		82.486
					(40.948)		(70.402)
Emission Intensity$_{t-5}$ (t/€))						62.227	-35.579
						(40.665)	(51.333)
Observations	76398	68968	62753	57159	51900	46813	44073
Adj R^2	0.389	0.397	0.408	0.419	0.426	0.430	0.442
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country-Year FE	No	No	No	No	No	No	No
Winsorization	1%	1%	1%	1%	1%	1%	1%

Notes: This table examines the relation between corporate financial performance and emission intensity for changes over different horizons. Panel B reports OLS coefficient estimates and (in parentheses) standard errors from regressions of changes in operating RoA on changes in firm's emission intensity for different lags. In column (1), we estimate the model for one-year contemporaneous changes, which corresponds to Table 2. In the other columns, we replace (changes in) contemporaneous emission intensity with changes in emission intensity for increasing lags up until a five-year lag in column (6). Controls follow our baseline specification from Table 2 column (4) and are defined accordingly. Continuous variables that are not logarithmized are trimmed at 1st and 99th percentile. Standard errors are clustered by firm and statistical significance is indicated by *** p<.01, ** p<.05, * p<.1.

Table 6 – Time Profile of Profitability-Emission Link
Panel C: Tobin's q and Emission Intensity (tonnes per € Assets$_t$)

	EU ETS Phase				
Dep. Variable: Tobin's q_t / Op. RoA_t	I-III (Op. RoA)	I 2005-2007 (Tobin's q)	II 2008-2012 (Tobin's q)	III-IV 2013-2030 (Tobin's q)	I-IV (Tobin's q)
	(1)	(2)	(3)	(4)	(5)
Emission Intensity (t/€ Total Assets$_t$)	613.455**	517.084**	-21.165	-23.344*	-4.031
	(284.048)	(259.444)	(33.461)	(12.737)	(11.761)
Log(Assets)$_t$	1.851*	0.062	-0.090	-0.055	-0.099*
	(0.996)	(0.314)	(0.075)	(0.109)	(0.058)
Financial Leverage$_t$	-4.418**	-0.020	0.070	-0.312**	-0.055
	(2.148)	(0.509)	(0.127)	(0.124)	(0.110)
Asset Growth$_t$	-	0.139	0.024	0.006	0.159*
	-	(0.135)	(0.059)	(0.075)	(0.082)
Industry q	-	0.248	0.833*	0.491***	0.647***
	-	(0.458)	(0.463)	(0.134)	(0.158)
Tangible Asset Turnover$_t$	0.010	-	-	-	-
	(0.009)	-	-	-	-
Observations	1943	228	705	1399	2355
Adj R^2	0.479	0.898	0.854	0.784	0.725
Mean EU ETS Carbon Price	€12.80	€12.90	€14.18	€33.33	€25.14
Firm FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes

Notes: This table examines the relation between corporate financial performance and emission intensity over longer horizons. Panel C reports OLS coefficient estimates and (in parentheses) standard errors from regressions of operating RoA and Tobin's q on firm's emission intensities. Column (1) replicates our baseline specification from Table 2, but for the sample of public firms for which we can compute Tobin's q. In Columns (2)-(5) we replace operating RoA with Tobin's q as the dependent variable. We compute Tobin's q following Doidge et al. (JFE, 2002) as: $\frac{Book\ Value\ of\ Total\ Assets - Book\ Value\ of\ Equity + Market\ Value\ of\ Equity}{Book\ Value\ of\ Total\ Assets}$, all denominated in USD. The firm-level controls for Tobin's q are: *Log(Assets)*, *Financial Leverage* ($\frac{Long-Term\ Debt}{Total\ Assets}$), *Asset Growth* and the average *Industry q*. Continuous variables that are not logarithmized are trimmed at 1st and 99th percentile. Standard errors are clustered by firm and statistical significance is indicated by *** p<.01, ** p<.05, * p<.1.

Table 7 – Cross-Sectional Heterogeneity of Profitability-Emission Link
Panel A: Heterogeneity by NACE Industry Sector

Dep. Variable: Operating RoA (%)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Emission Intensity	304.337***	271.452	798.271***	85.528	121.232	694.627**	1209.692	100.77
(t/€ Total Assets)	(47.428)	(331.297)	(89.913)	(58.124)	(818.474)	(280.665)	(850.293)	(256.502)
Log(Assets)	1.258***	1.458	1.529***	0.945***	2.701**	1.159	-0.137	0.184
	(0.176)	(1.412)	(0.229)	(0.313)	(1.192)	(0.769)	(1.242)	(0.629)
Tangible Assets Turnover	0.022***	-0.023	0.042***	0.012	0.011	0.011	-0.006	0.023
	(0.005)	(0.022)	(0.008)	(0.008)	(0.053)	(0.017)	(0.013)	(0.014)
Financial Leverage	-5.389***	-8.029**	-6.542***	-3.429***	-6.000**	-4.469	-3.095	-1.690
	(0.381)	(3.143)	(0.543)	(0.598)	(2.485)	(3.041)	(2.162)	(1.403)
Observations	76398	1792	46650	19904	1088	1565	2008	3182
Adj R^2	0.389	0.312	0.414	0.358	0.577	0.432	0.400	0.397
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sector	All	Mining	Manufact.	Electricity	Water & Waste Man.	Wholesale & Retail	Transpor-tation	Others

Notes: This table explores how the relation between operating profits and emission intensities varies in the cross-section. Panel A reports OLS coefficient estimates and (in parentheses) standard errors from regressions of operating return on assets on firm's emission intensities separately for each NACE industry sector. All controls follow our baseline specification from Table 2 and are defined accordingly. Continuous variables that are not logarithmized are trimmed at 1st and 99th percentile. Standard errors are clustered by firm and statistical significance is indicated by *** p<.01, ** p<.05, * p<.1.

Table 7 – Cross-Sectional Heterogeneity of Profitability-Emission Link
Panel B: Within-Industry CO_2 Productivity Differentials

Dep. Variable: Operating RoA (%)	(1)	(2)	(3)	(4)
Emission Intensity (t/€ Total Assets)	735.815***	545.596***	162.874	164.582
	(108.341)	(106.708)	(102.144)	(102.115)
Log 90-10 CO_2 Productivity Differential	0.181**	0.172**	0.197***	0.219***
	(0.083)	(0.081)	(0.075)	(0.074)
Emission Intensity x 90-10 Prod. Differential	-103.718***	-72.645***	-30.659	-31.531
	(25.087)	(24.347)	(23.594)	(23.608)
Log(Assets)	1.227***	0.606***	-3.090***	-3.096***
	(0.194)	(0.208)	(0.253)	(0.253)
Tangible Assets Turnover	0.020***	0.012**	0.001	0.001
	(0.005)	(0.005)	(0.006)	(0.006)
Financial Leverage	-5.302***	-5.440***	-3.795***	-3.797***
	(0.411)	(0.436)	(0.431)	(0.430)
Sales Growth		5.53***	3.774***	3.779***
		(0.201)	(0.203)	(0.203)
Log(Op. Revenue)			6.144***	6.138***
			(0.298)	(0.298)
Log 90-10 Capital Prod. Differential				-0.214**
				(0.104)
Observations	64311	57468	57468	57468
Adj R^2	0.385	0.421	0.457	0.457
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Country-Year FE	No	No	No	No

Notes: This table explores how the relation between operating profits and emission intensities varies with within-industry CO2 efficiency differentials. Panel B reports OLS coefficient estimates and (in parentheses) standard errors from regressions of operating return on assets on firm's emission intensities and its interaction with industry-level CO_2 productivity differentials. We compute 90-10 CO_2 productivity differentials within granular NACE 4-digit industries. *CO_2 Productivity* is defined as the logarithm of $\frac{Operating\ Revenue}{Carbon\ Emissions}$. The *Log 90-10 CO_2 Productivity Differential* is the difference between the 90th and 10th percentile in *CO_2 Productivity* within each NACE 4-digit industry. Controls largely follow our baseline specification from Table 2 with the addition of *Log 90-10 Capital Productivity Differential* in Column (4) where *Capital Productivity* is defined as $\frac{Operating\ Revenue}{Tangible\ Fixed\ Assets}$. Continuous variables that are not logarithmized are trimmed at 1st and 99th percentile. Standard errors are clustered by firm and statistical significance is indicated by *** p<.01, ** p<.05, * p<.1.

Table 8 –Time-Series Variation in Profitability-Emission Link
Panel A: OLS Regressions by EU ETS Phase & Carbon Price

	Dep. Variable: Operating RoA (%)							
	EU ETS Phase				Role of the Carbon Price (logged)			
Dep. Variable: Operating RoA (%)	I-IV	I & II 2005-2012	III 2013-2020	IV 2021-2030	Logged	Logged	Logged	Logged
Emission Intensity (t/€ Total Assets)	304.337*** (47.428)	449.335*** (84.522)	372.13*** (113.751)	-597.059** (261.128)	368.456*** (56.092)	348.099*** (58.312)	347.821*** (59.155)	315.736*** (62.682)
Emission Intensity x Log(Carbon Price)					-30.118* (16.645)	-39.856** (17.606)	-39.981** (17.127)	-34.624* (18.251)
Log(Assets)	1.258*** (0.176)	1.818*** (0.355)	0.916*** (0.306)	5.425*** (0.784)	1.244*** (0.176)	1.162*** (0.179)	1.162*** (0.179)	1.167*** (0.180)
Tangible Assets Turnover	0.022*** (0.005)	0.040*** (0.009)	0.026*** (0.006)	0.025* (0.014)	0.022*** (0.005)	0.022*** (0.005)	0.022*** (0.005)	0.022*** (0.005)
Financial Leverage	-5.389*** (0.381)	-5.498*** (0.618)	-4.803*** (0.630)	-8.154*** (1.408)	-5.394*** (0.381)	-5.392*** (0.380)	-5.392*** (0.380)	-5.672*** (0.390)
Observations	76398	27471	33453	14779	76398	76397	76397	76388
Adj R^2	0.389	0.464	0.520	0.441	0.389	0.389	0.389	0.398
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Intensity x ETS Phase	No	No	No	No	No	Yes	Yes	Yes
Linear Time Trend	No	No	No	No	No	No	Yes	Yes
Country-Year FE	No	No	No	No	No	No	No	Yes

Notes: This table explores how the relation between operating profits and emission intensities varies along the time-series and by the carbon price in the EU ETS. Panel A reports OLS coefficient estimates and (in parentheses) standard errors from regressions of operating RoA on firm's emission intensities by EU ETS Phase and interacted with the price for carbon allowances in the EU ETS secondary market. In the first four columns, we run the baseline specification from Table 2 separately for each EU ETS Phase, combining the first two phases since the allocation mechanism and number of carbon allowances was largely similar. In the last four columns we include an interaction between *Emission Intensity* and *Log Carbon Price* defined as the logarithm of the average yearly price for carbon allowances in EU ETS secondary market. All controls follow our baseline specification from Table 2 and are defined accordingly. *Intensity x ETS Phase* is the interaction between emission intensity and a dummy for each EU ETS Phase to flexibly capture other changes in the profitability-emission link due to institutional changes, other changes in the carbon price, between EU ETS phases. Continuous variables that are not logarithmized are trimmed at 1st and 99th percentile. Standard errors are clustered by firm and statistical significance is indicated by *** p<.01, ** p<.05, * p<.1.

Table 8 – Time-Series Variation in Profitability-Emission Link
Panel B: Phase-by-Phase Instrumental Variable Approach

	Multi-Year Differences (Beginning to End of Each Phase)							
Dep. Variable:	ETS Phase							
Δ_t Operating RoA (€/€ Total Assets$_{t-1}$)	All Phases		II 2008-2012		III 2013-2020		IV 2021-2030	
	First-Stage	2SLS	First-Stage	2SLS	First-Stage	2SLS	First-Stage	2SLS
Δ_t Emission Intensity (t per Assets$_{t-1}$)		-13.217		54.387***		41.572		-59.133***
		(8.201)		(20.906)		(25.296)		(12.960)
Allowance Gap: Log(Emissions$_{t-1}$) - Log(Allowance$_t$)	-0.0001***		-0.0002***		-0.0001***		-0.0002***	
	(0.000)		(0.000)		(0.000)		(0.000)	
Log(Assets)$_{t-1}$	0.000***	-0.002**	0.000***	-0.005**	0.000***	-0.008***	0.000***	-0.0002
	(0.000)	(0.001)	(0.000)	(0.003)	(0.000)	(0.002)	(0.000)	(0.002)
Tangible Assets Turnover$_{t-1}$	0.000	-0.000	0.000	-0.000	0.000	-0.0004**	0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Financial Leverage$_{t-1}$	0.000	0.007	-0.0003	0.021	0.000	-0.006	0.000*	0.035*
	(0.000)	(0.007)	(0.000)	(0.016)	(0.000)	(0.014)	(0.000)	(0.019)
Observations	9276	9276	2952	2952	3132	3132	3192	3192
Adj R^2	0.048	-	0.028	-	0.046	-	0.100	-
F-stat Instrument	102.23	-	10.61	-	12.66	-	116.96	-
Firm FE	No	No	No	No	No	No	No	No
Industry Sector FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	No	No	No	No	No	No	No	No

Notes: This table explores how the relation between operating profits and emission intensities varies along the time-series. Panel B reports 2SLS-IV coefficient estimates and (in parentheses) standard errors from regressions of changes in operating RoA on changes in firm's emission intensities over each EU ETS Phase. We compute changes from beginning to end of each phase in the EU ETS and instrument changes in emission intensity over each phase by the logarithm of carbon allowance shortfall at the beginning of each phase, defined as: $Log(Emissions_{t-1}) - Log(Allocated\ Carbon\ Allowances_t)$. All controls follow our baseline specification from Table 2, but are lagged by one year. Continuous variables that are not logarithmized are trimmed at 1st and 99th percentile. Standard errors are clustered by firm and statistical significance is indicated by *** p<.01, ** p<.05, * p<.1.

Table 9 – Operating Profitability and Air Pollutant Intensity (ex-CO_2) – E-PRTR Sample

Dep. Variable: Operating RoA (%)	(1)	(2)	(3)	(4)	(5)	(6)
Total Air (excl. CO) Pollutant Intensity (kg/€ Assets)	8.114	33.260***	20.170**			
	(6.138)	(8.836)	(8.400)			
Total Air (excl. CO) Pollutant Intensity (kg/€ Op. Revenue)				0.821	45.960***	29.780***
				(5.382)	(8.263)	(8.683)
Log(Assets)	0.052	1.868***	2.267***			
	(0.073)	(0.377)	(0.390)			
Log(Op. Revenue)				0.272***	5.254***	5.348***
				(0.078)	(0.437)	(0.458)
Tangible Assets Turnover	0.031**	0.089***	0.090***	0.028**	0.060***	0.061***
	(0.012)	(0.020)	(0.020)	(0.012)	(0.019)	(0.019)
Financial Leverage	-4.446***	-4.968***	-5.092***	-4.428***	-4.509***	-4.448***
	(0.641)	(0.869)	(0.868)	(0.641)	(0.886)	(0.890)
Observations	14209	13390	13390	14149	13332	13332
Adj R^2	0.009	0.440	0.461	0.012	0.474	0.494
Firm FE	No	Yes	Yes	No	Yes	Yes
Year FE	No	No	Yes	No	No	Yes
Country-Year FE	No	No	No	No	No	No

Notes: This table reports OLS coefficient estimates and (in parentheses) standard errors from regressions of operating return on assets on firm's total air pollutant intensity. *Operating RoA* is defined as firm-level operating profits (from Orbis) over total assets. *Air Pollutant Intensity* is the firm-level sum of all non-CO_2 air pollutants (in kg) reported in the European Pollutant Release and Transfer Register (E-PRTR) and scaled by either total assets or operating revenue. Based on our baseline specification in Table 2, the firm-level controls for operating RoA are: *Log(Assets)* or *Log(Operating Revenue)* depending on emission scalar, *Tangible Asset Turnover* ($\frac{Operating\ Revenue}{Tangible\ Fixed\ Assets}$) and *Financial Leverage* ($\frac{Long-Term\ Debt}{Total\ Assets}$). All continuous variables that are not logarithmized are trimmed at 1st and 99th percentile. Standard errors are clustered by firm and statistical significance is indicated by *** p<.01, ** p<.05, * p<.1

Online Appendix:
Corporate Emissions and Profits

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Table OA1 – Operating Profitability and Emission Intensity (kg per € Assets) – Manufacturing Firms

Dep. Variable: Operating RoA (%)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Emission Intensity (kg/€ Total Assets)	0.441***	0.836***	0.698***	0.814***	0.798***	0.660***	0.715***	0.443***
	(0.061)	(0.094)	(0.090)	(0.090)	(0.090)	(0.098)	(0.088)	(0.062)
Log(Assets)	0.454***	1.808***	1.411***	1.376***	1.529***	0.919***	1.517***	0.479***
	(0.058)	(0.206)	(0.217)	(0.227)	(0.229)	(0.244)	(0.228)	(0.059)
Tangible Assets Turnover				0.043***	0.042***	0.039***	0.040***	0.013*
				(0.008)	(0.008)	(0.008)	(0.008)	(0.007)
Financial Leverage					-6.542***	-6.681***	-7.070***	-6.719***
					(0.543)	(0.580)	(0.544)	(0.515)
Sales Growth						7.228***		
						(0.256)		
Observations	47762	47762	47762	46824	46649	41645	46647	46791
Adj R^2	0.031	0.386	0.404	0.409	0.414	0.452	0.427	0.043
Firm FE	No	Yes	Yes	Yes	Yes	Yes	Yes	No
Year FE	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
Country-Year FE	No	No	No	No	No	No	Yes	No
Winsorization	1%	1%	1%	1%	1%	1%	1%	1%
Sample Restriction	Manufact.	Manufact.	Manufact.	Manufact.	Manufact.	Manufact.	Manufact.	Manufact.

Notes: Standard errors are in parentheses and clustered by firm *** p<.01, ** p<.05, * p<.1

Table OA2 – Operating Profitability and Emission Intensity (tonnes per € Assets) – Panel A: Lagged Asset Scalar & Controls

Dep. Variable: Operating RoA (€/€ Total Assets$_{t-1}$ x 100%)	(1)	(2)	(3)	(4)	(5)	(6)
Emission Intensity$_{t-1}$	199.808***	225.24***	229.615***	220.143***	183.003***	215.302***
(t/€ Total Assets$_{t-1}$)	(35.953)	(49.883)	(51.47)	(51.654)	(51.918)	(52.766)
Log(Assets)$_{t-1}$	0.246***	-1.810***	-2.177***	-2.141***	-2.618***	-2.091***
	(0.047)	(0.194)	(0.195)	(0.198)	(0.200)	(0.201)
Tangible Assets Turnover$_{t-1}$			0.011**	0.010**	0.008	0.010**
			(0.005)	(0.005)	(0.005)	(0.005)
Financial Leverage$_{t-1}$				-1.562***	-1.359***	-1.563***
				(0.418)	(0.415)	(0.430)
Sales Growth$_{t-1}$					3.088***	
					(0.170)	
Observations	64079	64079	62466	61942	61089	61930
Adj R^2	0.017	0.397	0.403	0.404	0.414	0.412
Firm FE	No	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Country-Year FE	No	No	No	No	No	Yes
Winsorization	1%	1%	1%	1%	1%	1%
Sample Period most Firms	2005-2024	2005-2024	2005-2024	2005-2024	2005-2024	2005-2024

Notes: Standard errors are in parentheses and clustered by firm *** p<.01, ** p<.05, * p<.1

Table OA2 – Operating Profitability and Emission Intensity (tonnes per € Assets$_{t-1}$) – Panel B: Lagged Asset Scalar & Contemporaneous Controls

Dep. Variable: Operating RoA (€/€ Total Assets$_{t-1}$ x 100%)	(1)	(2)	(3)	(4)	(5)	(6)
Emission Intensity (t/€ Total Assets$_{t-1}$)	267.317***	558.682***	612.14***	592.491***	479.271***	574.69***
	(36.779)	(50.905)	(54.186)	(54.012)	(51.901)	(55.306)
Log(Assets)	0.394***	1.673***	1.781***	2.011***	1.344***	2.049***
	(0.045)	(0.171)	(0.183)	(0.187)	(0.195)	(0.188)
Tangible Assets Turnover			0.022***	0.020***	0.013**	0.020***
			(0.005)	(0.006)	(0.005)	(0.006)
Financial Leverage				-5.814***	-5.819***	-6.125***
				(0.424)	(0.419)	(0.435)
Sales Growth					6.826***	
					(0.208)	
Observations	71442	71442	69481	68912	67928	68903
Adj R^2	0.020	0.386	0.389	0.394	0.426	0.402
Firm FE	No	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Country-Year FE	No	No	No	No	No	Yes
Winsorization	1%	1%	1%	1%	1%	1%
Sample Period most Firms	2005-2024	2005-2024	2005-2024	2005-2024	2005-2024	2005-2024

Notes: Standard errors are in parentheses and clustered by firm *** p<.01, ** p<.05, * p<.1

Table OA3 – Operating Profitability and Emission Intensities by Ownership Structure

Dep. Variable: Operating RoA (%)	Full Sample	Shareholding Companies	No Firm Ownership	Full Sample	Shareholding Companies	No Firm Ownership
Emission Intensity (kg/€ Total Assets)	0.304***	0.302***	0.434***			
	(0.047)	(0.052)	(0.114)			
Emission Intensity (kg/€ Op. Revenue)				0.061*	0.070**	0.045
				(0.033)	(0.035)	(0.083)
Log(Assets)	1.258***	1.097***	3.639***			
	(0.176)	(0.181)	(0.664)			
Tangible Assets Turnover	0.022***	0.018***	0.071***	0.017***	0.014***	0.055***
	(0.005)	(0.005)	(0.015)	(0.005)	(0.005)	(0.016)
Financial Leverage	-5.389***	-5.401***	-5.661***	-5.106***	-5.235***	-3.684***
	(0.381)	(0.397)	(1.327)	(0.369)	(0.385)	(1.247)
Log(Op. Revenue)				5.139***	5.055***	6.419***
				(0.178)	(0.185)	(0.638)
Observations	76397	69687	6710	76247	69529	6718
Adj R^2	0.389	0.388	0.394	0.430	0.429	0.437
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Country-Year FE	No	No	No	No	No	No
Winsorization	1%	1%	1%	1%	1%	1%
Sample Period most Firms	2005-2024	2005-2024	2005-2024	2005-2024	2005-2024	2005-2024

Notes: Standard errors are in parentheses and clustered by firm *** p<.01, ** p<.05, * p<.1

Table OA4 – Time Profile of Profitability-Emission Link –Fixed Sample excl. Phase IV

Dep. Variable: Operating RoA (%)	(1)	(2)	(3)	(4)	(5)	(6)
Emission Intensity$_{t}$ (kg/€)	0.240**					
	(0.101)					
Emission Intensity$_{t-1}$ (kg/€)		0.290***				
		(0.071)				
Emission Intensity$_{t-2}$ (kg/€))			0.227***			
			(0.073)			
Emission Intensity$_{t-3}$ (kg/€))				0.111*		
				(0.065)		
Emission Intensity$_{t-4}$ (kg/€))					0.070	
					(0.055)	
Emission Intensity$_{t-5}$ (kg/€))						0.071*
						(0.042)
Observations	33277	32749	32585	32601	32729	33435
Adj R^2	0.512	0.514	0.514	0.514	0.514	0.512
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm Controls	Yes	Yes	Yes	Yes	Yes	Yes
Country-Year FE	No	No	No	No	No	No
Winsorization	1%	1%	1%	1%	1%	1%

Notes: Standard errors are in parentheses and clustered by firm *** p<.01, ** p<.05, * p<.1

Table OA5 – Operating Profitability (Adj. for Allowances sold) and Emission Intensity – By EU ETS Phase & Carbon Price

	EU ETS Phase				Interaction with Carbon Price			
Dep. Variable: Adj. Operating RoA (%)	I-IV	I & II 2005-2012	III 2013-2020	IV 2021-2030	Absolute	Absolute	Logged	Logged
Emission Intensity (kg/€ Total Assets)	0.209*** (0.071)	0.524*** (0.123)	0.270** (0.133)	No Transaction Data	0.556*** (0.079)	0.520*** (0.082)	0.467*** (0.074)	0.423*** (0.077)
Emission Intensity x Carbon Price					-0.029*** (0.003)	-0.029*** (0.003)	-0.138*** (0.014)	-0.145*** (0.015)
Log(Assets)	1.680*** (0.240)	3.426*** (0.443)	1.678*** (0.361)		1.651*** (0.241)	1.709*** (0.244)	1.631*** (0.240)	1.717*** (0.243)
Tangible Assets Turnover	0.024*** (0.007)	0.054*** (0.015)	0.016* (0.009)		0.025*** (0.007)	0.025*** (0.007)	0.025*** (0.007)	0.025*** (0.007)
Financial Leverage	-4.455*** (0.455)	-4.192*** (0.707)	-4.779*** (0.688)		-4.452*** (0.455)	-4.430*** (0.456)	-4.486*** (0.455)	-4.455*** (0.456)
Observations	53016	22415	30226	-	53016	53016	53016	53016
Adj R^2	0.429	0.465	0.502	-	0.433	0.433	0.431	0.432
Firm FE	Yes	Yes	Yes	-	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	-	Yes	Yes	Yes	Yes
Country-Year FE	No	No	No	-	No	No	No	No
Linear Time Trend	No	No	No	-	No	Yes	No	Yes
Winsorization	1%	1%	1%	-	1%	1%	1%	1%

Notes: Standard errors are in parentheses and clustered by firm *** p<.01, ** p<.05, * p<.1

Table OA6 – Operating Profitability and Air Pollutant Intensity – E-PRTR Sample – AIR (incl. Carbon)

Dep. Variable: Operating RoA (%)	(1)	(2)	(3)	(4)	(5)	(6)
Total Air Pollutant Intensity (kg/€ Assets)	0.062**	0.100**	0.103**			
	(0.028)	(0.044)	(0.041)			
Total Air Pollutant Intensity (kg/€ Op. Revenue)				0.025	0.150***	0.125***
				(0.022)	(0.047)	(0.047)
Log(Assets)	0.005	1.608***	2.214***			
	(0.070)	(0.356)	(0.377)			
Log(Op. Revenue)				0.260***	4.596***	4.788***
				(0.073)	(0.462)	(0.490)
Tangible Assets Turnover	0.029**	0.089***	0.092***	0.028**	0.060***	0.062***
	(0.012)	(0.019)	(0.019)	(0.012)	(0.018)	(0.018)
Financial Leverage	-4.404***	-4.681***	-4.789***	-4.439***	-4.211***	-4.094***
	(0.620)	(0.824)	(0.825)	(0.623)	(0.839)	(0.845)
Observations	14894	14048	14048	14866	14022	14022
Adj R^2	0.010	0.441	0.462	0.012	0.470	0.492
Firm FE	No	Yes	Yes	No	Yes	Yes
Year FE	No	No	Yes	No	No	Yes
Country-Year FE	No	No	No	No	No	No
Winsorization Total Air Pollutant Intensity	1%	1%	1%	1%	1%	1%

Notes: Standard errors are in parentheses and clustered by firm *** p<.01, ** p<.05, * p<.1

Table OA7 – Operating Profitability and Water Pollutant Intensity – E-PRTR Sample – WATER

Dep. Variable: Operating RoA (%)	(1)	(2)	(3)	(4)	(5)	(6)
Total Water Pollutant Intensity (kg/€ Assets)	-1.261	7.861**	8.012**			
	(2.721)	(3.470)	(3.672)			
Total Water Pollutant Intensity (kg/€ Op. Revenue)				0.158	2.608	3.042
				(1.408)	(4.123)	(3.877)
Log(Assets)	-0.071	1.894***	1.901***			
	(0.119)	(0.620)	(0.640)			
Log(Op. Revenue)				0.130	3.515***	3.452***
				(0.129)	(0.669)	(0.709)
Tangible Assets Turnover	0.017	0.071***	0.069***	0.018	0.063**	0.063**
	(0.013)	(0.025)	(0.024)	(0.013)	(0.026)	(0.026)
Financial Leverage	-1.074	-3.416**	-3.081*	-1.317	-2.243	-1.908
	(1.036)	(1.672)	(1.672)	(1.032)	(1.683)	(1.664)
Observations	5319	4899	4899	5321	4902	4902
Adj R^2	0.001	0.420	0.447	0.001	0.429	0.455
Firm FE	No	Yes	Yes	No	Yes	Yes
Year FE	No	No	Yes	No	No	Yes
Country-Year FE	No	No	No	No	No	No
Winsorization Total Water Pollutant Intensity	1%	1%	1%	1%	1%	1%

Notes: Standard errors are in parentheses and clustered by firm *** p<.01, ** p<.05, * p<.1

Figure OA1 – Trends in Emission Intensity across Industries

