# Are carbon emissions associated with stock returns?*

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**Comments welcome.**

**Abstract:**

Socially conscious investors are interested in assessing whether reducing firms' carbon emissions can improve stock returns and operating performance. An influential emerging literature documents strong correlations between emissions and both stock returns and operating performance. We re-examine that data, using a sample of 2,729 U.S. firms from 2005-2019, and conclude that these associations are driven by a combination of three factors. First, unscaled raw emissions (in metric tons of $CO_2$), the variable typically used in academic literature, is correlated with stock returns but emissions intensity (emissions scaled by firm size), a more commonly used measure in practice, is not. Second, stock returns are correlated only with unscaled emissions *estimated* by the vendor compiling emissions data, but not with unscaled emissions *actually disclosed* by individual firms; we show that vendor-estimated emissions exhibit systematic differences from firm-disclosed emissions. Third, the positive correlation between stock returns and raw emissions reflects industry clustering in that stock returns of firms in industries with high emission intensity (e.g., energy and mining) have lagged behind those of firms in industries with low emission intensity (e.g., technology). Along similar lines, the associations between emissions and operating performance disappear once we account for firm size, industry clustering and estimated versus disclosed emissions. Investors might want to be cautious about assuming that carbon emissions are priced by equity markets. To be clear, we say nothing about the desirability (or lack thereof) of disclosing and/or cutting carbon emissions.

Keywords: Carbon Emissions, Alpha, Stock Returns, Operating Performance, Tobin's Q, Trucost, Estimated Emissions

JEL classification: M14, G23, G34

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## 1. Introduction

In this paper we evaluate whether carbon emissions are associated with stock returns, operating performance and Tobin's Q for a sample of 2,729 U.S. firms from 2005-2019. There is considerable interest in the disclosure and eventual reduction of carbon emissions generated by U.S. firms among the new administration led by President Biden,[1] the SEC,[2] large index providers such as BlackRock,[3] socially conscious investors,[4] proxy advisors,[5] and the media.[6] Investors are also interested in understanding whether reduction of emissions by firms in their portfolio can contribute to greater expected stock returns and better operating performance. In response to such demand among policy makers and practitioners, a few influential recent papers (e.g., Matsumura, Prakash, and Vera-Munoz 2014; Garvey, Iyer, and Nash 2018; Bolton and Kacperczyk 2020; In, Park, and Monk 2019) find strong associations between carbon emissions and fundamental measures of firms' financial performance such as stock returns, operating profitability, and Tobin's Q.

Within accounting and finance, the carbon emissions literature cumulatively proposes two hypotheses to link carbon risk to stock returns. The efficient market hypothesis is that forward looking investors seek compensations or premiums for holding stocks of high carbon emitters, fearing risks associated with the potential introduction of large carbon taxes by governments and/or associated remedial costs to clean up carbon pollution imposed by regulators, society or courts. This argument suggests a positive association between emissions and stock returns. The alternate hypothesis is that investors either ignore carbon risk or misprice

[1] https://joebiden.com/climate-plan/
[2] https://www.sec.gov/news/speech/lee-playing-long-game-110520
[3] https://www.nytimes.com/2020/01/14/business/dealbook/larry-fink-blackrock-climate-change.html
[4] https://documents.nuveen.com/Documents/Nuveen/Default.aspx?uniqueId=CB6DF5E9-6268-4389-8317-E2B1C569398E
[5] https://www.issgovernance.com/esg/climate-solutions/carbon-risk-rating/
[6] https://www.ft.com/content/7ab0bfb0-b37c-463d-b132-0944b6fe8e8b

it. If carbon risks were not viewed as substantial or if investors simply ignored such risk, one would expect no association between emissions and returns. If investors misprice carbon risk, one would expect negative associations between emissions and stock returns. Interpreting the implications of carbon risk for operating profitability depends on which state of the world holds for stock returns. A risk premium story would suggest a positive correlation between emissions and operating profits. A mispricing story or an ignorance story would suggest a negative or a null association between emissions and operating profits.

We take a closer look at this collective evidence on emissions and valuation in the current paper. We document several stylized facts related to emissions and stock returns. First, prior academic literature uses unscaled emissions or changes in unscaled emissions as the key independent variable in testing the link between emissions and returns. We show that unscaled emissions are strongly correlated with firm size, industry composition and time. Moreover, regulators' choice of carbon emissions metric to underpin carbon taxes and other emissions-reduction schemes is crucial as such schemes become increasingly common. The high correlation between unscaled ("raw") emissions and firm size suggests that regulators may want to be cautious about designing emissions reduction schemes around raw emissions as opposed to than metrics that account for firm size.

Second, because stock returns are also correlated with firm size, industry composition and time, correcting for these confounds eliminates the correlation documented before between stock returns and emissions. Third, roughly 80% of emissions figures in the standard emissions databases are estimated by the data vendor as opposed to voluntarily disclosed by firms. Curiously, the correlation between stock returns and emissions is driven entirely by vendor-estimated emissions, as opposed to firm-disclosed emissions. We view this as an especially important point for researchers and practitioners to understand because data coverage has significantly expanded in recent years (e.g., since 2016 in the Trucost database that we study).

However, virtually all of this coverage expansion reflects an increase in vendor-estimated emissions rather than firm-disclosed emissions. Given that estimated emissions are themselves correlated strongly with size, industry composition and time – for example, the correlation between estimated emissions and sales is 0.73, while the correlation between disclosed emissions and sales is only 0.24 – the link between returns and estimated emissions weaken or disappear when we control for these confounds. For robustness, we also explore three other variants of emissions (growth in emissions, carbon intensity measured as unscaled emissions/revenue and change in carbon intensity) with similar results.

We find similar outcomes when we consider the relation between various measures of operating profitability (return on assets (ROA), EBITDA, return on sales (ROS)) and emissions. That is, correcting for confounds introduced by firm size, industry composition and time weakens or eliminates associations between operating profitability and the four versions of emissions discussed here. Moreover, the correlation documented by prior work between Tobin's Q and emissions is not robust to the issues highlighted here (confounds associated with size, industry composition, autocorrelation in emissions, and results stemming from estimated emissions as opposed to disclosed emissions).

Our findings suggest that socially conscious investors, policymakers and academics may want to be cautious in interpreting correlations between carbon emissions and either valuation constructs (Tobin's Q and stock returns) or fundamental accounting data (operating profitability). To be clear, we take no position on whether disclosing and/or cutting emissions is desirable or not. Rather, our paper is a comment on the methodological architecture underlying associations documented by prior research between emissions and firm valuation.

The remainder of the paper is laid out as follows. Section 2 reviews why emissions may be priced and related literature. Section 3 describes the data. Sections 4 and 5 report analyses

related to whether emissions are associated with future stock returns, fundamental measures of firm performance (operating profitability) or firm value (Tobin's *Q*). Section 6 concludes.

## 2. Why should emissions be associated with stock returns, profitability or Tobin's Q?

### *2.1 Stock returns*

A relatively large emerging literature investigates whether climate risk is reflected in operating performance, valuation, stock returns and cost of capital (e.g., Andersson, Bolton, and Samama 2016, Baldauf, Garlappi, and Yannelis 2018, Bakkensen and Barrage 2018, Bernstein, Gustafson, and Lewis 2020, Chava 2014, Giglio, Maggiori, Rao, Stroebel, and Weber 2018, Hong, Li, and Xu 2019, Krueger, Sautner, and Starks 2019). Our focus in this paper is specifically on carbon risk measured using $CO_2$ emissions. We view this measure as of first-order importance given its prevalence in academic literature, the media, and amongst ESG rating agencies.[7] To keep the task manageable, we focus on three influential papers: (i) Bolton and Kacperczyk (2020), who document an association between unscaled emissions and stock returns and operating profitability; (ii) Garvey et al. (2018), who find a negative link between change in unscaled emissions and productivity, which is measured as a transformed version of operating profitability; and (iii) Matsumura et al. (2014) who show that firms with higher emissions are associated with lower firm values. In related work, In, Park, and Monk (2019) find a stock returns alpha by buying (shorting) low (high) emission stocks.

The emissions literature posits two hypotheses to link carbon risk, measured using carbon emissions, to stock returns. The efficient market hypothesis suggests that informed, future-oriented investors seek compensation for holding stocks of disproportionately higher carbon emitters. Such compensation would manifest as a risk premium, observable as a positive

[7] For instance, Sustainalytics provides as a supplementary product to its main ESG ratings a "Carbon Solutions Suite" and frequently references decarbonization commitments in its blog posts (e.g., https://www.sustainalytics.com/esg-blog/the-race-to-net-zero-decarbonization-commitments-in-the-oil-gas-industry/). Several other ratings providers offer similar products.

relation between measures of carbon risk (based on emissions) and stock returns. One could also argue that higher carbon risk likely exposes the firm to cash flow shocks in the future potentially due to a carbon tax likely to be imposed by governments or remedial environmental costs that the emitter might be forced to incur on behalf of the taxpayer. Khan, Serafeim and Yoon (2016) claim that firms that have disproportionately reduced their carbon emissions may be able to generate higher than expected earnings. The alternate hypothesis is that investors either ignore carbon risk or misprice it. In such a scenario, we would expect either a null or a negative association respectively between emissions and stock returns.

*2.2 Operating profitability*

It is useful to consider what, if any, the link between emissions and firm profitability ought to be. A negative correlation between emissions and stock returns might suggest that emissions can cause subsequent clean up-costs or carbon taxes or inefficient use of productive resources as in Garvey et al. (2018). One would expect such costs to be reflected in the future cash outflows of high-emissions firms, because higher cost of equity and potentially debt capital would potentially lead to under-investment in capital projects which in turn might result in lower operating performance.

Alternatively, the positive link between stock returns and emissions, documented by Bolton and Kacpercyzk (2020), is consistent with the hypothesis that higher emissions implies higher risk or other factors that happen to be associated with both stock returns and emissions. With the omitted variable (risk) explanation, we would expect no (a positive) relation between emissions and cash flows. Of course, a null result between returns and emissions casts doubt on both a cash flow and a risk-based link between emissions and operating performance.

*2.3 Tobin's Q*

If emissions were associated with negative (positive) operating performance, one would expect Tobin's Q to be negatively (positively) associated with emissions. Matsumura et al. (2014) document a negative association between emissions and firm values, consistent with this expectation. The absence of a robust association between stock returns/operating profits and emissions would be consistent with no association between Tobin's Q and emissions.

## 3. Data and Results

*3.1 Financial data*

Our primary carbon emissions database is Trucost, which provides carbon emissions data for both U.S. and global firms from 2005-2019. We merge Trucost data with stock returns data from CRSP and fundamental financial data from COMPUSTAT by matching on CUSIP number. The intersection of CRSP, COMPUSTAT and Trucost provides us with a sample of 2,729 unique firms corresponding to 214,229 firm-month observations.[8] We outline our process for arriving at the set of 2,729 distinct firms in Table 1.

*3.2 Emissions data*

We obtain emissions data from Trucost. Trucost uses various publicly disclosed sources, such as company financial reports (annual reports, financial statements, 10-K/20-F reports, regulatory filings), environmental data sources (corporate social responsibility [CSR], sustainability, or environmental reports, the Carbon Disclosure Project, Environmental Protection Agency filings), and data published on company websites or other public sources.[9]

[8] Out of 4,023 firms covered by Trucost's US database, we retain firms that meet the following criteria: (i) ISIN and CUSIP identifiers are not missing; (ii) the firm is US incorporated; (iii) the firm's status is not "out of business"; and (iv) emissions and returns data is not missing.

[9] https://www.spglobal.com/spdji/en/documents/additional-material/faq-trucost.pdf

In the event a firm does not disclose emissions data voluntarily, Trucost states that it uses an environmentally extended input-output (EEIO) model to estimate environmental impacts for a company's own operations and across its entire global supply chain. The EEIO model combines industry-specific environmental impact data with quantitative macroeconomic data on the flow of goods and services between different sectors in the economy.

Emissions data are usually reported under the Greenhouse Gas (GHG) protocol and is measured in tons of $CO_2$ (carbon dioxide) per year. The GHG protocol specifies three scopes of emissions. Scope 1 reflects direct emissions sources that are owned or controlled by a company. For example, scope 1 includes the emissions produced by the internal combustion engines of a trucking company's trucking fleet. Scope 2 emissions are from the consumption of purchased electricity, steam, or other sources of energy generated upstream from a company's direct operations. Scope 3 encompasses all other emissions associated with a company's operations that are not directly owned or controlled by the company.[10] Scope 3 emissions include several sources of indirect emissions in both the company's supply chain and from use by customers of the company's products. For example, if a shipping company purchases a truck from a truck manufacturer, the emissions caused by the shipping company's usage of the truck contributes toward the shipping company's scope 1 emissions and the manufacturer's scope 3 emissions. Given the expansive definition of scope 3 emissions, scope 3 represents the majority of a company's emissions footprint in most industries.[11] We provide descriptive statistics for all variables in Table 2.

[10] Scope 3 emissions arise from two sources: upstream or downstream. Upstream sources reflect purchased goods and services, purchased capital goods, fuel and energy related activities, transportation and distribution of raw materials, waste generated in operations in the upstream input suppliers, business travel, employee commuting, leased assets. Downstream sources include transportation and distribution of products sold, processing, use and end-of-life treatment of sold products, investments in other businesses that generate emissions and leasing out assets to businesses that generate emissions.

[11] For more details on scope 3 emissions, please refer to https://www.epa.gov/climateleadership/scope-3-inventory-guidance

*3.3 Trucost expanded coverage in 2016*

Table 3, Panel A depicts the yearly distribution of observations found in the Trucost database. As can be seen from Columns (1) and (2), coverage in Trucost ranges from 690 to 859 distinct firms for years between 2005 and 2015. Beginning in 2016, Trucost substantially expanded its coverage, nearly tripling from 2015 to 2016; most of this expanded coverage is a result of Trucost estimating emissions figures for these firms, an issue we discuss in greater detail in Section 3.7. The number of firms covered between 2016 and 2019 ranges from 1992 to 2645 distinct firms. Because we conduct returns tests at the firm-month level following Bolton and Kacperczyk (2020), the number of observations corresponds to approximately 12 times the number of firms per year.[12]

Panel B of Table 3 details coverage of firms sorted by industry based on 6-digit GICS industry classification. The five most represented industries in terms of number of distinct firms are (i) banks (230 firms); (ii) biotechnology (179 firms); and (iii) REITs (168 firms); (iv) software (118 firms); and (v) oil, gas and consumable fuels (98 firms). Apart from oil and gas, these industries are those that one would not expect to be large emitters of greenhouse gases.

*3.4 Industry variation with emissions*

Table 4, Panel A reports average emissions per firm from 2005-2019. The average scope 1 emissions per firm from 2005 to 2015 is 2.58 million tons with little variation during that period. However, average scope 1 emissions per firm falls significantly from 2016-2019 to 0.68 million tons. Similar reductions can be seen in average scope 2 and scope 3 emissions. This change is attributable to the substantial expansion of Trucost coverage to smaller firms (mostly through estimating data, as we will discuss later on).

[12] Certain firm-years may have returns data missing for some months. When a company has dual-class shares we also include return observations for both share classes, which is why the number of observations is sometimes greater than 12 times the number of distinct firms. In untabulated analyses, we verify that the deletion of dual-class shares does not alter any reported inferences.

Table 4, Panel B reports average annual firm-level scope 1 emissions, in terms of both raw emissions and emissions intensity, for each of the 69 distinct GICS six-digit industry classifications. Industries with the largest scope 1 emissions are independent power producer industries (34.16 million tons per firm), electric utilities (33.6 million tons per firm), multi-utilities (18.51 million tons per firm), airlines (17.02 million tons per firm) and oil, gas & consumable fuels (7.83 million tons on average per firm). Industries that report the largest carbon intensity measure for scope 1 emissions, defined as emissions scaled by firm revenues as in Garvey et al. (2018), are similar to the ones above: electric utilities (4,392.65 tons per million dollars of revenue), independent power and renewable electricity providers (3,483.46 tons per million dollars of revenue), multi-utilities (2,468 tons per million dollars of revenue), airlines (1,074.43 tons per million dollars of revenue), construction materials (942.80 tons per million dollars of revenue) and the marine industry (777 tons per million dollars of revenue). Differences between the top emitters in terms of absolute emissions and emissions intensity are attributable to variation in firm size across industries in our sample.

Turning now to scope 2 emissions, we see from Table 4 Panel C that the industries with the highest scope 2 emissions (reflecting energy consumed in the process of business operations) are food and staples retailing (2.26 million tons per firm), automobiles (2 million tons per firm), diversified telecommunication services (1.55 million tons per firm), chemicals (1.13 million tons), and paper products (1.07 million tons). There is more difference between industries with the highest absolute emissions and emissions intensity for scope 2 relative to scope 1. From Table 4 Panel C, we also see that industries with the highest scope 2 carbon emissions intensity are metals & mining (181.87 tons per million dollars of revenue); electric utilities (149.03 tons per million dollars of revenue), construction materials (140.32 tons per tons per million dollars of revenue) and paper (116.12 tons per million dollars of revenue).

In terms of scope 3 emissions, in Table 4 Panel D we observe the highest absolute scope 3 emissions in automobiles (average of 18.299 million tons), food products (13.04 million tons), oil and gas (8.16 million tons), tobacco (8.14 million tons), and beverages (6.27 million tons). This differs substantially from the set of industries with the highest levels of emissions intensity in Table 4 Panel C; scope 3 carbon emissions intensity is highest for food products (818.23 tons per million dollars of revenue), metals and mining (534.87 tons per million dollars of revenue), beverages (399.37 tons per million dollars of revenue), auto components (365.12 tons per million dollars of revenue), and chemicals (363.81 tons per million dollars of revenue).

A key takeaway from the discussion above is the substantial difference in the definition of "high emissions" firms and industries when considering raw emissions versus emissions intensity. The former is closely correlated with firm size; we discuss the importance of this correlation for inferences about the relation between emissions and stock returns below.

*3.5 Firm size is highly correlated with unscaled emissions and returns*

In Table 5, Panel A we present data on correlations between the three types of carbon emissions (scope 1, 2, and 3) in terms of both raw emissions and emissions intensity. We observe that the three types of emissions are highly correlated with one another in Panel A; the Pearson correlation between the natural logarithm of scope 1 emissions and the natural logarithm of scope 2(3) emissions is 0.988 (0.999).

In Panel B we observe a strong correlation between raw emissions and three measures of firm size (the natural logarithms of market capitalization, the number of employees, and net sales). For instance, the correlation between log scope 1 emissions and log sales is 0.719, with log market cap is 0.523 and with log employees is 0.611. The log of scope 3 emissions exhibits an even higher correlation with all three measures of firm size. This likely reflects measurement limitations; because scope 3 emissions are harder for the firm to directly measure, they are

more likely to be estimated by the data vendor. The correlations reported in Table 5, Panel B suggest that a key component of the models used to estimate scope 3 emissions is firm size.

*3.6 Carbon intensity neutralizes the impact of firm size on emissions*

The high mechanical correlation between unscaled emissions and firm size motivates the need to rely on a transformation of the emissions measure scaled by firm size. As noted previously, practitioners most commonly rely on emissions divided by revenue as a measure of emissions intensity. In our tests going forward that rely on emissions intensity measures, we therefore report results based on unscaled emissions divided by revenue. Our results remain unchanged when we instead scale emissions by the number of employees or the firm's market capitalization. As can be seen from Table 5, Panel B, the correlation between carbon intensity and firm size is much lower. For instance, the correlations between scope 1 emissions intensity and log market cap, log employees, and log sales are 0.082, 0.045, and 0.125, respectively. We observe similarly low figures for the correlations between scope 2 and 3 emissions intensity and firm size. Hence, measuring carbon emissions in terms of intensity, rather than its raw value, effectively neutralizes any mechanical correlation with firm size.

Table 4, Panel A reports average carbon intensity measures per firm for each year in the sample. Scope 1 emissions intensity is 387.37 tons per million dollars of revenue in 2005 and falls steadily over time until 2015. Unscaled emissions numbers for firms remain relatively constant over this period, suggesting that the fall in carbon intensity reflects increases in these firms' revenues over the sample period. We observe a significant drop in scope 1 emissions intensity in 2016, concurrent with Trucost's data coverage expansion in that year.

Interestingly, we also observe differences in the relation between scope 1 and scope 3 carbon emissions intensity between the pre- and post- data expansion periods. Average yearly scope 1 emissions intensity per firm is substantially higher than the average yearly scope 3

emissions intensity in each year between 2005 and 2015. For instance, in 2005 (2015), the average carbon intensity of scope 1 emissions is 387.37 (242.35) tons per million dollars of revenue, whereas those numbers are substantially higher than the average carbon intensity of scope 3 emissions in 2005 (2015) at 226.17 (151.28) tons per million dollars of revenue. However, subsequent to the expansion of coverage of firms by Trucost in 2016, we observe a substantial drop in average firm-level scope 1 emissions but no such drop in firm-level scope 3 emissions, to the point where scope 1 emissions (both raw and in terms of emissions intensity) are below scope 3 emissions in each of the four post-expansion years.

*3.7 Autocorrelation in emission numbers*

Another potential issue in interpreting carbon emissions data is the potential for autocorrelation. The autocorrelation curve for annual emission variables, in un-tabulated work, signifies that these variables follow an AR(1) process. In particular, the autocorrelation coefficients for first annual lag range between 0.5 and 0.7. High correlations between current-year emissions one-year-prior emissions are unsurprising and suggestive of a world where emissions do not change much over time unless firm adopts a new technology to curb emissions. These data suggest the need to recognize the presence of autocorrelation in emission numbers in subsequent analyses and raise questions about what exactly a contemporaneous correlation between emissions and stock returns might reflect.

*3.8 Self-disclosed versus estimated values of emissions*

Trucost data contains a mix of emissions data directly disclosed by firms as well as Trucost-estimated emissions figures for non-disclosing firms. Busch, Johnson, Pioch, and Kopp (2018) document a high correlation (around 0.97) among the disclosed values of emissions reported by various commercial data providers such as CDP (Carbon Disclosure

Project), Trucost, MSCI, Sustainalytics, and Thomson Reuters. However, the correlation among the estimated values reported by these vendors is only 0.66. This pattern raises concerns about the validity of proprietary estimation methods used by data providers.

Table 6 highlights the pervasive nature of vendor-estimated, rather than firm-disclosed, values of emissions in the data. As can be seen in the rightmost column of Panel A, the proportion of estimated values is as high as 86% in 2005, the first year for which Trucost is available. Voluntary disclosure of emissions steadily increases such that estimated values fall to a sample low of 54% in 2015. However, the large increase in coverage starting in 2015 is driven almost entirely by estimated values. The number of firms voluntarily disclosing emissions during this time period increased relatively slowly from 396 in 2015 to 540 in 2018. Eighty percent of observations reported by Trucost in 2018 are estimated. Data for 2019 appears to be incomplete, as of when we obtained the data (in October 2020), in that only 1992 firms are covered.

Panel B of Table 6 lists the proportion of observations that are estimated versus disclosed in the top ten and bottom ten industries, by proportion of observations estimated, for industries with at least 10 distinct firms. The industries reporting the lowest proportion of estimated emissions are (i) airlines (7%); (ii) multi-utilities (7%); (iii) technology, hardware, storage and peripherals (40%); (iv) containers and packaging (44%); and (v) food products (44%). The industries reporting the highest proportion of estimated emissions are (i) diversified consumer services (100%); (ii) health care technology (100%); (iii) thrifts and mortgage finance (100%); (iv) REITs (100%); and (v) biotechnology (93%). Perhaps more worrisome, several industries populated by large numbers of firms such as banks (230 firms), REITs (168

firms), software (118 firms), biotechnology (193 firms) and speciality retail (84 firms) are dominated by estimated emissions (in excess of 80% of observations).[13]

To compare the distributions of estimated and disclosed values, we employ two approaches. First, we plot the kernel densities of each of these three types of emissions (see Appendix B for these plots). A density plot visualizes the distribution of data over a continuous interval. The chart is, in effect, a variation of a histogram that uses kernel smoothing to plot values. The estimated scope 1 and scope 2 emissions are smaller than disclosed scope 1 and 2 emissions for firms in the dataset. That pattern flips for scope 3 emissions in that disclosed values are smaller. We view these findings as reflective of the fact that larger firms are more likely to disclose emissions, especially for the later part of the sample when Trucost expands its coverage; as a result, estimated emissions are more prevalent in smaller firms (which would, by nature of their size, have lower absolute emissions).

Second, we test for systematic differences in Trucost-estimated versus firm-disclosed emissions. To do so, we exploit the fact that firms gradually began disclosing emissions figures more frequently over the sample period (see Table 6); we observe 431 firms which have Trucost-estimated emissions figures during parts of the sample period before subsequently disclosing emissions figures. If Trucost's estimates are a fully accurate reflection of the idiosyncratic components of firms' business models beyond industry and size, we should not observe any statistically significant within-firm difference between estimated and disclosed figures. We test this assertion using the following set of regression models:

$$Emissions_{it} = \alpha_0 + \alpha_1 Estimated_{it} + \alpha_2\, Controls_{it} + \theta_i + \gamma_t + \varepsilon_{it} \qquad (1)$$

[13] We provide a full list of industries and the proportion of observations that are estimated versus disclosed for each of those industries in Internet Appendix Table IA1.

In Equation (1), $Emissions_{it}$ reflects the natural logarithm of either scope 1, 2, or 3 emissions while $Estimated_{it}$ is an indicator variable that equals 1 if the corresponding emissions figure was estimated. For example, if $Emissions_{it}$ reflects scope 3 emissions, then $Estimated_{it}$ equals one if firm *i*'s scope 3 emissions figure corresponding to month-year *t* is vendor-estimated and zero if firm *i*'s scope 3 emissions figure corresponding to month-year *t* is firm-disclosed. The quantities $\theta_i$ and $\gamma_t$ denote firm and year fixed effects, respectively.

The presence of the firm fixed effect $\theta_i$ means that the coefficient $\alpha_1$ on $Estimated_{it}$ is driven by *within-firm* changes over time in emissions disclosure status (and, as such, identified entirely by the 431 distinct firms that have both estimated and disclosed emissions at some point during the sample period. If Trucost estimates are accurate, then disclosure should reveal no new information about the firm's levels of emissions and, in this case, we would expect $\alpha_1$ to be statistically insignificant. Conversely, if Trucost estimates are systematically biased upward (downward), we would expect $\alpha_1$ to be positive (negative).

Results from estimating Equation (1) are presented in Table 7. In Columns (1) – (3) we begin by estimating the most basic form of Equation (1), including only firm and time fixed effects and the indicator $Estimated_{it}$ on the right-hand side. We see that Trucost's scope 1 emissions appear to be systematically biased upward, while Trucost-provided scope 2 and 3 emissions appear to be systematically biased downward. In Columns (4) – (6) we introduce several control variables, based on those in Bolton and Kacperczyk (2020). Our results continue to hold. In addition, we observe a strong correlation between emissions (all of scope 1, 2, and 3) and log sales, sales growth, and PP&E; this result suggests that firm size and sales growth are the primary drivers of emissions estimation models.

We document later in the paper that abnormal returns to carbon emissions, reflected in prior papers such as Bolton and Kacperczyk (2020), are primarily attributable to emissions estimated by the vendor, as opposed to emissions disclosed by the firm itself. Given the results

in Table 7, these findings suggest that any documented correlation between returns and emissions merely reflects a correlation between returns and size.

## 4. Do carbon emissions explain stock returns?

Bolton and Kacperczyk (2020) document a strong correlation between emissions and contemporaneous stock returns. We replicate their findings and extend them to argue that the association they document is attributable to a combination of three factors: (i) emissions is a proxy for firm size and emissions scaled by size lose their predictive power for returns; (ii) the link between emissions and returns is clustered in industries that have significantly under- or over-performed during the sample period; and (iii) the association between emissions and returns is attributable to vendor-estimated, not voluntarily disclosed, emissions numbers by firms. To construct the building blocks leading up to those findings, we first consider a two-way sort of returns for combinations of firm size and unscaled emissions, outlined below.

### *4.1 Portfolios of unscaled emissions intersected by firm size*

We begin our main empirical analyses with a handful of simple portfolio-based tests. Our objective is to document that firm size and industry composition are omitted variables in the association between emissions and future returns.

To illustrate our point regarding size, in Table 8, Panel A we construct a two-way iterative sort of firms. We first sort firms into quintiles of sales; then, *within* each quintile of sales, we sort each firm into quintiles based on emissions (for a total of 25 buckets). This approach mitigates the effect of size in comparing firms' stock return performance as a function of emissions. Within each size quintile, we then construct a hedging portfolio where we buy low-emissions firms (in the bottom quintile of emissions) and sell high-emissions firms (in the

top quintile of emissions). The cells in the 5x5 table provided in Table 8, Panel A are contemporaneous monthly stock returns, consistent with the factor-mimicking portfolio design choice followed by Bolton and Kacperczyk (2020).[14] We find no alphas associated with any the five long-short portfolios (one within each sales quintile).

*4.2 Portfolios of unscaled emissions intersected with industry clusters*

In this section, we consider the returns to emissions within industries to highlight the importance of accounting for industry heterogeneity in returns tests. We begin by first illustrating industry heterogeneity in emissions. To do so, we first partition the sample according to quintiles of raw carbon emissions. Then, within each quintile, we report the number of firm-month observations by industry. These numbers are reported in Table 8, Panel B. We observe considerable heterogeneity. For example, 57.7% (7,147 out of 12,383) of energy firm-months are in the top quintile of emissions, while 68.7% (23,574 out of 34,337) of financial firm-months are in the bottom quintile of emissions. This breakdown underscores the importance of accounting for potential industry clustering in emissions-based tests.

We further highlight the importance of industry clustering in Panel C of Table 8. We calculate returns by industry within each emissions quintile. We then calculate within-industry alphas for each of the eleven major GICS sectors, constructed using a hedge portfolio long on the bottom quintile of emissions and short the top quintile of emissions; we find virtually no evidence of *within*-industry alphas based on these portfolios.[15] Conversely, considering the sample as a whole, we do observe an alpha from the hedge portfolio that goes long on the bottom quintile of emissions and short on the top quintile of emissions. This result is consistent with the findings in In, Park and Monk (2019). However, we argue that this result likely reflects

[14] Substituting contemporaneous monthly returns with next month's returns does not change these inferences.
[15] The only exception is in Consumer Staples, and this result is likely spurious; there are only 60 firm-months, representing two distinct firms, in the bottom quintile of emissions.

the industry composition of the various emissions quintiles. For example, Panel C highlights that the bottom quintile of scope 1 emissions is dominated by the financial sector, healthcare, and information technology; these three industries' stock returns are among the highest, as illustrated by Panel C.[16] Conversely, the top quintile of scope 1 emissions is dominated by energy firms, materials, utilities, and industrials, which exhibit lower returns. Hence, an "emissions alpha" appears to simply represent a portfolio that is long on high-technology and financial firms and short on industrial, utility, and energy firms. To further highlight this point, in Panel D of Table 8 we decompose emissions quintile-wide returns according to the weighted contribution from each industry (i.e., the number of firms in the corresponding cell in Panel B times the returns figure in the corresponding cell in Panel C). From this exercise it is again apparent that the low returns for firms in the top quintile of emissions may be driven by the high weight (7,147 out of 42,759 firm-month observations) and low returns (0.43%) of the energy sector while the high returns for firms in the bottom quintile of emissions are driven by financial services, healthcare, and information technology firms.

A skeptical reader would posit that for whatever reason stocks of certain industries have done well in this period while stocks of other industries have languished. An advocate for the hypothesis that carbon risk is priced needs to clearly articulate how lower or higher carbon emissions in certain industries would exactly map into the stock returns of these industries. For instance, the advocate can argue that the underperformance of the energy sector signifies investors' disenchantment with the high levels of carbon emitted by that industry. But for this argument to have merit, the advocate must spell out why lower carbon emissions in the

[16] We observe a negative alpha from a strategy that buys low-emissions firms and sells high-emissions firms within certain industries. This alpha is statistically significant in the industrials sector, which likely reflects heterogeneity in the notion of productivity across industries. For example, more productive industrial firms likely have greater plant utilization and capacity, both of which would be directly proportional to net emissions for these firms.

technology sector might be responsible for the outperformance of stocks in the technology sector such as Apple, Netflix, Facebook and Google.

*4.3 Regression of returns on emissions*

To formally document the association between returns and emissions, we extend the cross-sectional specification used in Bolton and Kacperczyk (2020) by (i) introducing industry fixed effects; and (ii) by clustering standard errors at the industry and month-year level as both stock price performance and emissions are correlated with industry and time. For all three categories of emissions, the independent variable, "Emissions," can take one of four forms: (i) companies' unscaled emissions; (ii) year-over-year growth in unscaled emissions; (iii) carbon intensity; and (iv) change in carbon intensity. These four independent variables are meant to cover the most-commonly used carbon variables in prior academic work and in practice. We estimate the following cross-sectional regression model:

$$RET_{it} = \alpha_0 + \alpha_1 \, Emissions_{it} + \alpha_2 \, Controls_{it} + \gamma_t + \delta_{industry} + \varepsilon_{it} \qquad (2)$$

The dependent variable (RET) is monthly returns for a firm *i.* As mentioned, the main independent variable *Emissions* takes the form of log unscaled emissions, growth in unscaled emissions, carbon intensity for scope 1, scope 2, and scope 3 emissions.[17] For robustness, following Garvey et al. (2018), we also investigate change in carbon intensity as an additional independent variable. The vector of controls includes a host of firm-specific variables known to be associated with stock returns, following Bolton and Kacperczyk (2020). These variables are the natural logarithm of sales (LOGSALES), return on equity (ROE), leverage

[17] Trucost provides emissions data according to calendar year. Hence, following Bolton and Kacperczyk (2020), we match returns with emissions in the same calendar year. In untabulated work, we find that our results are robust to substituting lagged values of control variables for contemporaneous values.

(LEVERAGE), the ratio of capital expenditures to assets (INVEST/A), industry Herfindahl concentration index (HHI), the natural logarithm of property, plant, and equipment (LOGPPE), sales growth (SALESGR), and growth in earnings per share (EPSGR). The coefficients $\gamma_t$ and $\delta_{industry}$ represent month-year and GICS industry fixed effects. Standard errors are two-way clustered at the 6-digit GICS industry and month-year level.

Table 9 presents results from estimating Equation (1). The dependent variable $RET_{it}$ is the monthly return of individual stock *i* in month-year *t*, consistent with Bolton and Kacperczyk (2020).[18] The primary independent variable of interest is emissions corresponding to the calendar year of month-year *t*. Panel A shows the results for the baseline scenario and for reduced controls. Columns (1)-(3) show the negative association between returns and emissions documented earlier. However, controlling for firm size in columns (4)-(6) renders the coefficient on emissions insignificant.

Bolton and Kacperczyk (2020) hypothesize and find that carbon risk is reflected in the data as a positive association between emissions and monthly stock returns.[19] The results presented thus far suggest that the positive association they document is an artefact of control variable selection choices. Besides $LOGSALE_{it}$ or the natural logarithm of firm *i*'s total sales at the end of year *t*, Bolton and Kacperczyk (2020) introduce the control variables detailed on the preceding page. Panel B suggests that introduction of either Log PPE or INVEST/A flips the sign on emissions to positive. In essence, the risk-based explanation for emissions is sensitive to the introduction of specific control variables to the regression specification.[20]

[18] Following Bolton and Kacperczyk (2020), in a sensitivity test we drop 106 firm-month observations where returns are greater than 100%. We also check outliers of stock returns; the 1st and 99th percentile of stock returns are -29% and 34%, respectively. Our results are not driven by outliers beyond these two cutoff points; when we re-run our specifications using winsorized returns (at the 1% level), our results continue to hold.

[19] We work with contemporaneous monthly returns to be consistent with the design choice adopted by Bolton and Kacperczyk (2020). In Internet Appendix Table IA3, we re-estimate Equation (2) using one month ahead returns and find identical inferences to those reported.

[20] Following Bolton and Kacperczyk (2020), we winsorize LEVERAGE and INVEST/A at the 2.5% level, and SALESGR and EPSGR at the 0.5% level. Our inferences are robust to winsorizing at the 1% level instead.

Columns 1-3 of Table 9 Panel C report the complete specifications estimated by Bolton and Kacperczyk (2020). Consistent with their reported specifications, the coefficients on log scope 1, 2 and 3 emissions are positive and statistically significant. Note that columns (1)-(3) do not (i) incorporate industry fixed effects; (ii) adjust cluster standard errors by industry and month-year. Instead, standard errors are not clustered on any dimension.

Columns (4)-(6) relax one of these constraints in that industry fixed effects are introduced. Consistent with the industry patterns associated with stock returns mentioned earlier in section 3, the coefficient on emissions loses statistical significance. Columns (7)-(9) represent an even more rigorous econometric regimen in that standard errors are now clustered at both the industry level and month-year level. This is necessary because errors in returns (and emissions) are correlated within industry and over time, especially within months. The coefficients on emissions continue to remain insignificant. It is useful to note that, regardless of the specification used, the following variables retain statistical significance: (i) positive coefficients on ROE and on sales growth; and (ii) negative coefficients on leverage and investments. These control variables suggest that returns are higher for growing and profitable firms and lower for firms with greater leverage and investments.

Panels D, E and F of Table 9 report the results of similar regressions with one change: carbon intensity, change in unscaled emissions and change in carbon intensity replaces log of unscaled emissions as the primary independent variable of interest. As can be seen, apart from the change in unscaled emissions, there is no significant association between any of these three variants of emissions and stock returns.

In Table 10, we turn to potential differences in vendor-estimated and firm-provided disclosures. We partition the sample according to whether the emissions figure for a given firm-year corresponds to disclosed or estimated figures. In Columns (1) – (3) of Panel A, we estimate

Equation (1) for firm-disclosed emissions observations and show that the coefficient on disclosed values of unscaled emissions is statistically insignificant. In contrast, in Columns (4) – (6), we re-estimate Equation (1) only for vendor-estimated emissions observations and find that the coefficient on estimated values of unscaled emissions is positive and significant at the 1% level (shown in columns (4) – (6)). This suggests that the positive relation between returns and emissions found by Bolton and Kacperczyk (2020) stems mainly from estimated emission values generated by Trucost using proprietary models. This result is surprising as one would expect firms' voluntary disclosures to be more reliable than emissions estimated by a vendor. Moreover, estimated emissions are highly correlated with firm size as we illustrate in Table 7.

In Panels B, C, and D of Table 10, we re-run the estimation in Panel A but using as our emissions variable emissions intensity (in Panel B), year-over-year growth in carbon emissions (in Panel C), and the year-over-year absolute change in carbon emissions intensity (in Panel D). We find mixed evidence of a positive relation between estimated emissions intensity and stock returns; however, we find no relation between firm-disclosed emissions intensity and returns. Similarly, in Panel C, we find robust evidence that estimated emissions growth is associated with *higher* stock returns but no evidence of a relation between firm-disclosed emissions growth and returns. This result may be driven by the importance of net sales and/or sales growth in Trucost's emissions estimation procedure: in un-tabulated analyses we observe that the univariate correlation between sales growth and *disclosed* emissions growth is 0.249, while the correlation between sales growth and *estimated* emissions growth is nearly three times at high at 0.726. Finally, in Panel D, we observe limited evidence of a correlation between the year-over-year change in scope 3 emissions and stock returns – but no results for scope 1 or scope 2. Given that scope 3 emissions are often not disclosed even when scope 1 emissions are disclosed, we interpret Table D as consistent with there being no relation between the change in disclosed emissions intensity and stock returns.

In sum, the association between returns and unscaled emissions documented by prior work is attributable to (i) unscaled emissions being correlated with firm size; (ii) industry clustering in returns and emissions; and (iii) estimated emissions numbers generated by Trucost, as opposed to self-disclosed emissions variables by firms.

## 5. Do carbon emissions explain firm performance?

### *5.1. Profitability*

One possible explanation for our results thus far is that carbon emissions may have an *indirect* effect on firm performance through a relation with firm fundamentals. To assess this possibility, we directly test the relation between emissions and measures of firm-level financial performance. We use five popular measures of profitability or operating performance defined as follows: (i) EBIT $\text{Margin}_{it}$, which is the ratio of earnings before interest and taxes by sales for firm *i* in year *t*; (ii) EBITDA $\text{Margin}_{it}$ ,which is the ratio of earnings before interest, taxes, depreciation, and amortization by sales for firm *i* in year *t*; (iii) $\text{ROA}_{it}$, which is return on assets, and is measured as the ratio of operating income after depreciation to total assets for firm *i* in year *t*; (iv) $\text{ROS}_{it}$, which is return on sales, measured as the ratio of operating income after depreciation to sales for firm *i* in year *t*; and (v) Tobin's Q, which is measured as the ratio of (market value of equity plus book value of assets minus book value of equity) to total assets.

To examine the association between operating performance and emissions, we estimate the following regression:

$$Performance_{it} = \alpha_0 + \alpha_1 Emissions_{it} + \alpha_2 Controls_{it} + \gamma_t + \delta_{industry} + \varepsilon_{it} \quad (2)$$

The dependent variable, $Performance_{it}$, is one of the five measures described above for firm *i* and month-year t.[21] The main independent variable *Emissions* takes the form of log

[21] Although all variables in Equation (2) are measured at the firm-month year level, we also estimate the model at the firm-year level. Our findings (untabulated) are unchanged if we instead estimate Equation (2) at the firm-year level.

of unscaled emissions, growth in unscaled emissions, carbon intensity and the change in carbon intensity. We use the same controls as in the return specification. To address the time invariant and industry invariant unobservables, month-year fixed effects ($\gamma_{t}$) and industry fixed effects ($\delta_{industry}$) are introduced. Standard errors are clustered by industry and month-year to address the concern that profitability and emissions are correlated for the same industry and over time.

Table 11 reports the regression results. For brevity, we tabulate results using only scope 1 emissions. Panel A shows that EBIT margin, EBITDA margin and ROS are positively associated with the log of unscaled scope 1 emissions. However, Panel B suggests that carbon intensity is not associated with any of these profitability measures. Similar null results are seen in Panels C and D for the other two variants of emissions (the growth in carbon emissions in Panel C, and the change in carbon intensity in Panel D).[22]

*5.2. Tobin's Q*

Finally, we report analyses that relates Tobin's Q, a proxy for firm value, with emissions. In particular, the denominator of Tobin's Q is the sum of the market value of equity and book value of assets minus book value of equity. The denominator is the book value of assets. Results from the estimation of equation (3) related to Tobin's Q are represented in the Column (5) of each of Panels A-D in Table 11. Consistent with Matsumura et al. (2014), the natural logarithm of unscaled scope 1 emissions is negatively correlated with Tobin's Q in Column (5) of Table 11 Panel A. However, the association between Tobin's Q and other transformations of carbon emissions is mixed or statistically insignificant. For instance, in Column (5) of Panel B of Table 11, carbon intensity is uncorrelated with Tobin's Q. In column

[22] Garvey et al. (2018) show that the change in carbon intensity is negatively associated with future ROA. We confirm their results (see Internet Appendix Table IA2) using the same specification. However, this result is sensitive to model specification: when we instead use the control variables from Bolton and Kacperczyk, we no longer find a significant relation between the change in carbon intensity and future ROA.

(5) of Panel C of Table 11, surprisingly, growth in unscaled scope 1 emissions is positively associated with Tobin's Q. However, in Column (5) of Table 11 Panel D, change in carbon intensity is not associated with Tobin's Q.

*5.3 Disclosed Emissions*

We next re-estimate the specifications provided in Table 11 but limiting the sample to disclosed (rather than estimated) emissions. We report results from these specifications in Table 12. In all four panels – that is, for all four carbon emissions variables – we find no relation between disclosed emissions and any of our four measures of profitability (EBIT margin, EBITDA margin, ROA, and ROS). We find two specifications where disclosed emissions are negatively related to Tobin's Q (Column (5) of Panel A and Column (10) of Panel C) and two where we find no association (column 5 of Panel B and column 5 of Panel D). In sum, Table 12, Panels A-D show that disclosed values of emissions, under all four transformations of the independent variable, are uncorrelated with profitability.

## 6. Conclusion

Research on climate finance has exploded in recent years driven by demand for such work by both policy and practice. Researchers have documented mixed results with respect to the value relevance of $CO_2$ emissions. For instance, Bolton and Kacperczyk (2020) and Garvey et al. (2018) document a positive relation between unscaled carbon emissions and stock returns and operating profitability while Matsumura et al. (2014) find a negative relation between Tobin's Q and emissions.

Consistent with Bolton and Kacperczyk (2020), we find a positive relation between the natural logarithm unscaled emissions (or growth in unscaled emissions) and stock returns. However, these results weaken or disappear once we (i) scale emissions by firm size (revenue);

(ii) add industry fixed effects to account for industry clustering in emissions and returns; and (iii) cluster standard errors of a regression of returns on emissions at industry and time. To probe the nature of the emission data further, we partition the emissions data into observations where the firm voluntarily discloses $CO_2$ data versus those estimated by the vendor of such data. We find that the association between stock returns and unscaled emissions in Bolton and Kacperczyk (2020) comes entirely from estimated values rather than values disclosed by firms. This is curious as one would expect self-disclosed emissions by firms to be more reliable than emissions numbers estimated by the vendor. Moreover, estimated emissions themselves are strongly correlated with firm size, industry composition and time.

Consistent with Garvey et al (2018), we confirm a negative association between profitability (measured as return on assets) and change in carbon intensity using the same specification as given in their paper. However, these results are not robust to controls for size, industry fixed effects and standard errors clustered at the industry and month level. Moreover, the association between emissions and profitability is found only estimated values and not for disclosed ones. Similar mixed or statistically insignificant inferences are obtained when we consider the earlier correlations documented between Tobin's Q and unscaled emissions.

In sum, this paper shows that the positive or negative relation between carbon emissions and stock returns, profitability and firm value documented in past papers is driven by omitted variable bias (size, industry and time). We also document that results in these papers stem mostly from values estimated by vendors using proprietary models rather than from values self-disclosed by individual firms.

Researchers, practitioners and policymakers might want to be careful about interpreting an association between carbon emissions with valuation and fundamental firm characteristics such as operating profitability. To be clear, we say nothing about the desirability or otherwise of disclosing or cutting carbon emissions. Instead, the paper is intended to explore research

design choices that underlie documented correlations between emissions and valuation and profitability outcomes.

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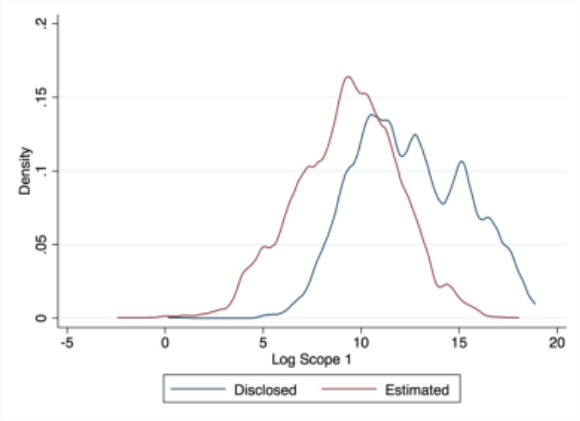
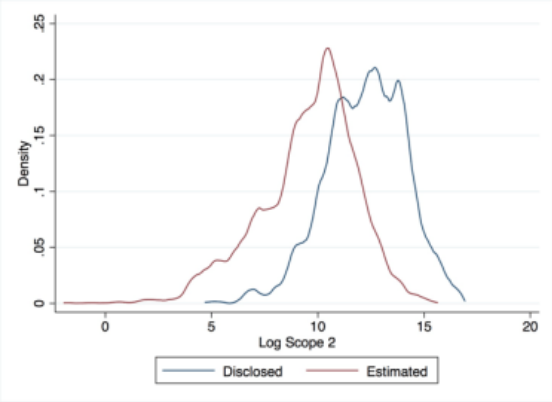
# APPENDIX
## Appendix A: Variable Definitions

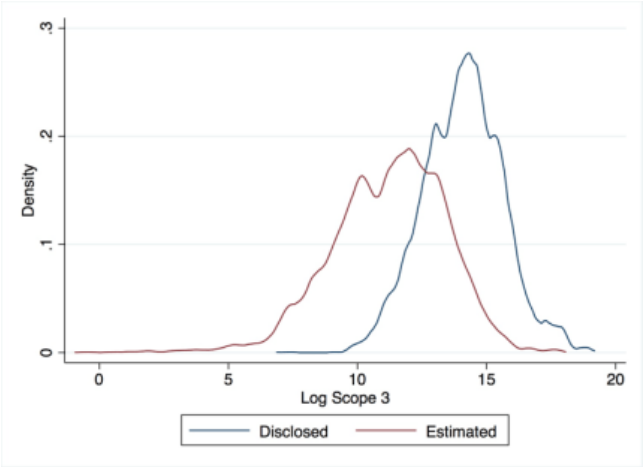
| Variable | Definition | Data Source |
|---|---|---|
| Returns | Monthly stock return (expressed in percentage). | CRSP |
| ROS | Return on sales, measured as the ratio of operating income after depreciation to total year-end sales. | COMPUSTAT |
| ROA | Return on assets, measured as the ratio of operating income after depreciation to year-end total assets. | COMPUSTAT |
| Tobin's Q | (Market value of equity plus total assets minus book value of equity) divided by year total assets. | COMPUSTAT |
| EBIT Margin | Ratio of earnings before interest and taxes to total sales at year end. | COMPUSTAT |
| EBITDA Margin | Ratio of earnings before interest, taxes, depreciation, and amortization to total sales at year end. | COMPUSTAT |
| HHI | Herfindahl concentration index of firm sales with respect to the industry. | COMPUSTAT |
| ROE | Return on equity, measured as the ratio of net income divided by the value of its equity. | COMPUSTAT |
| Invest / A | Ratio of capital expenditures divided by year-end total assets. | COMPUSTAT |
| Log PPE | Natural logarithm of property, plant, and equipment. | COMPUSTAT |
| Leverage | Ratio of long-term debt to assets. | COMPUSTAT |
| SalesGR | Change in annual firm revenues normalized by prior-year revenue. | COMPUSTAT |
| EPSGR | Change in annual earnings per share normalized by prior-year earnings per share. | I/B/E/S |
| Log Market Cap | Natural logarithm of total market capitalization of a firm in a given year. | Compustat |
| Number of Employees | Number of employees working for a firm in a given year. | Compustat |
| Log Sale | Logarithm of total sales of a firm in a given year. | Compustat |
| Log Scope 1 | Natural logarithm of scope 1 emissions (measured in tons of $CO_2$). Scope 1 emissions cover direct emissions from establishments that are owned or controlled by the company and include all emissions from fossil fuels used in production. | Trucost |
| Log Scope 2 | Natural logarithm of scope 2 emissions (measured in tons of $CO_2$). Scope 2 emissions come from the generation of purchased heat, steam, and electricity consumed by the company. | Trucost |
| Log Scope 3 | Natural logarithm of scope 3 emissions (measured in tons of $CO_2$). Scope 3 emissions are caused by the operations and products of the company but occur from sources not owned or controlled by the company. | Trucost |
| Scope 1 Growth | Change in scope 1 emissions divided by prior-year scope 1 emissions. | Trucost |
| Scope 2 Growth | Change in scope 2 emissions divided by prior-year scope 3 emissions. | Trucost |
| Scope 3 Growth | Change in scope 3 emissions divided by prior-year scope 3 emissions. | Trucost |
| Carbon Intensity Scope 1 | Ratio of scope 1 emissions (tons $CO_2$) to revenues (millions of dollars). | Trucost |
| Carbon Intensity Scope 2 | Ratio of scope 2 emissions (tons $CO_2$) to revenues (millions of dollars). | Trucost |
| Carbon Intensity Scope 3 | Ratio of scope 3 emissions (tons $CO_2$) to revenues (millions of dollars). | Trucost |
| Change in Carbon Intensity Scope 1 | Year-over-year change in scope 1 emissions intensity. | Trucost |
| Change in Carbon Intensity Scope 2 | Year-over-year change in scope 2 emissions intensity. | Trucost |
| Change in Carbon Intensity Scope 3 | Year-over-year change in scope 3 emissions intensity. | Trucost |
| Disclosed Values | Indicator variable for whether emissions values are disclosed. We label an observation as containing disclosed values if it obtained its scope 1 emissions figure from any of the following sources: exact value from CDP disclosure, value derived from CDP disclosure, value split from data provided in CDP disclosure, value from fuel gas disclosure provided to CDP, and stack gas data disclosure. | Trucost |
| Estimated Values | Indicator variable for whether emissions values are estimated by Trucost. Estimated values reflect observations for which scope 1 emissions are estimated by Trucost using proprietary models. | Trucost |

## Appendix B: Kernel Density Curves – Disclosed vs. Vendor- Estimated Emissions

These graphs provide kernel density curves for log scope 1, log scope 2, and log scope 3 emissions data from Trucost, based on both firm-disclosed and vendor-estimated values. The kernel density curve uses an Epanechnikov kernel function with bandwidth of one-half of the standard deviation of the smoothing kernel. Please refer to Appendix A for variable definitions.



## Table 1: Sample Selection

This table outlines the process we use to select the firms underlying our sample from Trucost's North America carbon emissions database.

| Filters | | Number of Distinct Firms |
|---|---|---|
| Start: Firms in Trucost North America database | | 4,028 |
| Less: Firms labeled by Trucost as being based outside the continental US | (552) | 3,476 |
| Less: Non-US incorporated firms (S&P US firms) | (600) | 2,876 |
| Less: Firms missing ISIN/CUSIP | (79) | 2,797 |
| Less: Firms not matched with COMPUSTAT and CRSP | (41) | 2,756 |
| Less: Firms missing stock returns or emissions data | (27) | 2,729 |

## Table 2: Summary Statistics

This table provides summary statistics for variables used in our main regressions (i.e., Table 9). Following Bolton and Kacperczyk (2020), we winsorize different variables at different values; where we do so, we provide the winsorization cutoff based on the percentage of observations in each tail of the distribution. Please refer to Appendix A for variable definitions.

| Variable | Mean | Median | Standard Deviation | Winsorization cutoff (%) |
|---|---|---|---|---|
| **Dependent Variables** | | | | |
| Monthly Returns (%) | 1.097 | 1.002 | 11.688 | - |
| ROS | -0.107 | 0.13 | 1.718 | 1 |
| ROA | 0.057 | 0.06 | 0.139 | 1 |
| Tobin's Q | 2.039 | 1.53 | 1.438 | 1 |
| EBIT Margin | -0.107 | 0.06 | 1.718 | 1 |
| EBITDA Margin | -0.083 | 0.09 | 1.892 | 1 |
| **Emissions Variables** | | | | |
| Log Scope 1 Emissions | 10.088 | 10.049 | 3.035 | - |
| Log Scope 2 Emissions | 10.228 | 10.438 | 2.473 | - |
| Log Scope 3 Emissions | 11.947 | 12.128 | 2.41 | - |
| Scope 1 Intensity | 1.316 | 0.141 | 4.072 | 2.5 |
| Scope 2 Intensity | 0.307 | 0.18 | 0.351 | 2.5 |
| Scope 3 Intensity | 1.430 | 1.403 | 0.879 | 2.5 |
| Scope 1 Growth | 0.076 | 0.033 | 0.300 | 2.5 |
| Scope 2 Growth | 0.103 | 0.040 | 0.337 | 2.5 |
| Scope 3 Growth | 0.073 | 0.042 | 0.215 | 2.5 |
| Change in Scope 1 Intensity | -0.047 | -0.001 | 0.630 | 1 |
| Change in Scope 2 Intensity | -0.001 | -0.003 | 0.101 | 1 |
| Change in Scope 3 Intensity | 0.000 | 0.000 | 0.002 | 1 |
| **Controls** | | | | |
| Log Market Cap | 8.067 | 8.09 | 1.69 | - |
| Log Sales | 7.483 | 7.581 | 1.817 | - |
| Log PPE | 5.981 | 6.073 | 2.225 | 2.5 |
| ROE (in %) | 6.901 | 10.234 | 31.855 | 2.5 |
| Invest/A | 0.036 | 0.023 | 0.04 | 2.5 |
| Book to Market | 0.482 | 0.407 | 0.359 | 2.5 |
| SaleGR | 0.125 | 0.067 | 0.394 | 0.5 |
| EPSGR | -0.029 | 0.026 | 3.421 | 0.5 |
| HHI | 0.157 | 0.111 | 0.13 | - |
| Leverage | 0.233 | 0.207 | 0.195 | 2.5 |

## Table 3: Yearly and Industry Distribution of Number of Firms and Observations

This table shows the distribution of the number of firms and firm-month observations for the full estimation sample (representing firms in the intersection of Trucost, CRSP, and Compustat coverage). Panel A provides data on observations by year, while Panel B provides data on observations by industry.

### *Panel A: Yearly Distribution*

This table shows the yearly distribution of the number of firms and firm-month observations for the full estimation sample (representing firms in the intersection of Trucost, CRSP, and Compustat coverage).

| Year | Distinct Firms | Firm-Month Observations |
|---|---|---|
| 2005 | 700 | 8,549 |
| 2006 | 706 | 8,600 |
| 2007 | 693 | 8,453 |
| 2008 | 690 | 8,515 |
| 2009 | 709 | 8,708 |
| 2010 | 704 | 8,669 |
| 2011 | 715 | 8,799 |
| 2012 | 727 | 8,913 |
| 2013 | 800 | 9,738 |
| 2014 | 829 | 10,082 |
| 2015 | 859 | 10,532 |
| 2016 | 2,369 | 28,465 |
| 2017 | 2,509 | 30,164 |
| 2018 | 2,645 | 31,881 |
| 2019 | 1,992 | 24,161 |
| Full Sample | 2,729 | 214,229 |

*Panel B: Industry Distribution*

| GICS | Industry | Distinct Firms | Firm-Month Observations |
|---|---|---|---|
| 101010 | Energy Equipment & Services | 52 | 4,028 |
| 101020 | Oil, Gas & Consumable Fuels | 98 | 8,355 |
| 151010 | Chemicals | 59 | 4,967 |
| 151020 | Construction Materials | 7 | 689 |
| 151030 | Containers & Packaging | 16 | 2,376 |
| 151040 | Metals & Mining | 33 | 3,242 |
| 151050 | Paper & Forest Products | 7 | 435 |
| 201010 | Aerospace & Defense | 33 | 2,818 |
| 201020 | Building Products | 25 | 1,858 |
| 201030 | Construction & Engineering | 27 | 2,059 |
| 201040 | Electrical Equipment | 29 | 2,532 |
| 201050 | Industrial Conglomerates | 6 | 793 |
| 201060 | Machinery | 93 | 8,395 |
| 201070 | Trading Companies & Distributors | 33 | 2,400 |
| 202010 | Commercial Services & Supplies | 51 | 4,455 |
| 202020 | Professional Services | 35 | 2,520 |
| 203010 | Air Freight & Logistics | 11 | 1,008 |
| 203020 | Airlines | 11 | 872 |
| 203030 | Marine | 3 | 276 |
| 203040 | Road & Rail | 28 | 2,346 |
| 203050 | Transportation Infrastructure | 1 | 60 |
| 251010 | Auto Components | 24 | 1,737 |
| 251020 | Automobiles | 6 | 810 |
| 252010 | Household Durables | 43 | 3,686 |
| 252020 | Leisure Products | 17 | 1,214 |
| 252030 | Textiles, Apparel & Luxury Goods | 26 | 2,136 |
| 253010 | Hotels, Restaurants & Leisure | 72 | 6,012 |
| 253020 | Diversified Consumer Services | 23 | 1,998 |
| 255010 | Distributors | 6 | 541 |
| 255020 | Internet & Direct Marketing Retail | 25 | 1,864 |
| 255030 | Multiline Retail | 12 | 1,785 |
| 255040 | Specialty Retail | 84 | 7,492 |
| 301010 | Food & Staples Retailing | 20 | 1,885 |
| 302010 | Beverages | 11 | 1,860 |
| 302020 | Food Products | 38 | 3,761 |
| 302030 | Tobacco | 6 | 477 |
| 303010 | Household Products | 9 | 1,049 |
| 303020 | Personal Products | 12 | 874 |
| 351010 | Health Care Equipment & Supplies | 92 | 6,277 |
| 351020 | Health Care Providers & Services | 60 | 5,053 |
| 351030 | Health Care Technology | 19 | 1,023 |
| 352010 | Biotechnology | 179 | 8,087 |
| 352020 | Pharmaceuticals | 59 | 2,920 |
| 352030 | Life Sciences Tools & Services | 24 | 2,159 |
| 401010 | Banks | 230 | 14,427 |
| 401020 | Thrifts & Mortgage Finance | 42 | 2,414 |
| 402010 | Diversified Financial Services | 5 | 349 |
| 402020 | Consumer Finance | 25 | 1,641 |
| 402030 | Capital Markets | 65 | 6,199 |
| 402040 | Mortgage Real Estate Investment Trusts | 34 | 1,674 |
| 403010 | Insurance | 70 | 7,621 |

| | | | |
|---|---|---|---|
| 451020 | IT Services | 71 | 5,419 |
| 451030 | Software | 118 | 6,880 |
| 452010 | Communications Equipment | 34 | 2,419 |
| 452020 | Technology Hardware, Storage & Peripherals | 19 | 1,871 |
| 452030 | Electronic Equipment, Instruments & Components | 53 | 4,294 |
| 453010 | Semiconductors & Semiconductor Equipment | 64 | 5,739 |
| 501010 | Diversified Telecommunication Services | 18 | 1,364 |
| 501020 | Wireless Telecommunication Services | 7 | 691 |
| 502010 | Media | 47 | 4,787 |
| 502020 | Entertainment | 20 | 1,579 |
| 502030 | Interactive Media & Services | 17 | 1,173 |
| 551010 | Electric Utilities | 27 | 3,568 |
| 551020 | Gas Utilities | 11 | 937 |
| 551030 | Multi-Utilities | 15 | 2,114 |
| 551040 | Water Utilities | 9 | 836 |
| 551050 | Independent Power and Renewable Electricity Producers | 5 | 469 |
| 601010 | Equity Real Estate Investment Trusts | 168 | 13,429 |
| 601020 | Real Estate Management & Development | 18 | 1,151 |

## Table 4: Yearly and Industry Distribution of Carbon Emissions

*Panel A: Yearly Distribution of Carbon Emissions*

This table shows the yearly distribution of total carbon emissions and carbon intensity per firm. Column (2)-(4) show the yearly distribution of total carbon emissions for scope 1, scope 2 and scope 3. Column (5)-(7) provide yearly distribution of carbon intensity for scope 1, scope 2, and scope 3. All variables are defined in Appendix A.

| | Carbon Emissions | | | Carbon Intensity | | |
|---|---|---|---|---|---|---|
| Year | Scope 1 | Scope 2 | Scope 3 | Scope 1 | Scope 2 | Scope 3 |
| 2005 | 2,668,653 | 334,616 | 2,690,746 | 387.37 | 35.82 | 226.17 |
| 2006 | 2,479,067 | 388,577 | 2,471,110 | 315.28 | 38.52 | 200.42 |
| 2007 | 2,879,432 | 431,273 | 2,583,982 | 295.90 | 37.67 | 189.04 |
| 2008 | 2,826,499 | 487,236 | 2,319,337 | 267.71 | 39.84 | 162.64 |
| 2009 | 2,546,851 | 426,567 | 2,209,255 | 280.18 | 41.56 | 181.80 |
| 2010 | 2,712,481 | 458,462 | 2,364,297 | 276.39 | 40.91 | 171.06 |
| 2011 | 2,796,321 | 472,956 | 2,564,335 | 262.92 | 39.03 | 168.51 |
| 2012 | 2,583,049 | 463,398 | 2,573,500 | 268.25 | 38.18 | 162.30 |
| 2013 | 2,332,113 | 429,522 | 2,334,366 | 260.33 | 38.46 | 160.25 |
| 2014 | 2,318,945 | 453,798 | 2,188,704 | 241.11 | 55.50 | 149.02 |
| 2015 | 2,240,545 | 441,955 | 1,922,495 | 242.35 | 56.70 | 151.28 |
| 2016 | 838,532 | 186,068 | 882,716 | 131.17 | 33.50 | 139.20 |
| 2017 | 834,325 | 179,222 | 949,472 | 132.58 | 34.83 | 142.81 |
| 2018 | 819,281 | 170,940 | 934,741 | 121.45 | 32.56 | 132.33 |
| 2019 | 240,998 | 54,832 | 294,582 | 72.49 | 24.57 | 110.84 |

*Panel B: Scope 1 Emissions by Industry*

This panel shows average raw scope 1 emissions as well as average scope 1 emissions intensity for firm-years in each of the 69 distinct six-digit GICS industries. All variables are defined in Appendix A.

| GICS | Industry | Raw Scope 1 Emissions | Scope 1 Emissions Intensity |
|---|---|---|---|
| 101010 | Energy Equipment & Services | 464,497 | 188.42 |
| 101020 | Oil, Gas & Consumable Fuels | 7,837,752 | 573.70 |
| 151010 | Chemicals | 3,245,775 | 440.38 |
| 151020 | Construction Materials | 1,163,078 | 942.80 |
| 151030 | Containers & Packaging | 1,865,806 | 241.65 |
| 151040 | Metals & Mining | 3,590,588 | 557.49 |
| 151050 | Paper & Forest Products | 1,187,580 | 394.13 |
| 201010 | Aerospace & Defense | 229,165 | 19.20 |
| 201020 | Building Products | 313,106 | 91.31 |
| 201030 | Construction & Engineering | 248,237 | 100.93 |
| 201040 | Electrical Equipment | 49,171 | 25.42 |
| 201050 | Industrial Conglomerates | 1,668,187 | 73.38 |
| 201060 | Machinery | 157,150 | 43.34 |
| 201070 | Trading Companies & Distributors | 83,295 | 34.99 |
| 202010 | Commercial Services & Supplies | 1,009,012 | 248.36 |
| 202020 | Professional Services | 18,020 | 6.78 |
| 203010 | Air Freight & Logistics | 4,381,417 | 164.15 |
| 203020 | Airlines | 17,028,837 | 1,074.43 |
| 203030 | Marine | 1,047,149 | 777.95 |
| 203040 | Road & Rail | 1,935,181 | 243.35 |
| 203050 | Transportation Infrastructure | 427,222 | 253.72 |
| 251010 | Auto Components | 190,375 | 20.35 |
| 251020 | Automobiles | 944,273 | 13.03 |
| 252010 | Household Durables | 171,809 | 36.36 |
| 252020 | Leisure Products | 40,164 | 17.89 |
| 252030 | Textiles, Apparel & Luxury Goods | 92,201 | 31.56 |
| 253010 | Hotels, Restaurants & Leisure | 609,078 | 76.55 |
| 253020 | Diversified Consumer Services | 32,226 | 20.60 |
| 255010 | Distributors | 173,083 | 23.59 |
| 255020 | Internet & Direct Marketing Retail | 181,206 | 7.71 |
| 255030 | Multiline Retail | 193,759 | 12.62 |
| 255040 | Specialty Retail | 128,699 | 16.68 |
| 301010 | Food & Staples Retailing | 1,001,097 | 22.05 |
| 302010 | Beverages | 700,197 | 43.36 |
| 302020 | Food Products | 1,147,700 | 114.05 |
| 302030 | Tobacco | 330,145 | 13.55 |
| 303010 | Household Products | 957,789 | 60.63 |
| 303020 | Personal Products | 70,985 | 26.01 |
| 351010 | Health Care Equipment & Supplies | 50,597 | 17.35 |
| 351020 | Health Care Providers & Services | 205,274 | 15.94 |
| 351030 | Health Care Technology | 5,466 | 7.44 |
| 352010 | Biotechnology | 13,385 | 17.57 |
| 352020 | Pharmaceuticals | 202,122 | 17.33 |
| 352030 | Life Sciences Tools & Services | 31,050 | 13.89 |
| 401010 | Banks | 6,029 | 1.16 |
| 401020 | Thrifts & Mortgage Finance | 395 | 0.97 |
| 402010 | Diversified Financial Services | 70,743 | 18.32 |
| 402020 | Consumer Finance | 7,041 | 1.20 |
| 402030 | Capital Markets | 3,767 | 1.36 |
| 402040 | Mortgage Real Estate Investment Trusts | 4,971 | 4.27 |
| 403010 | Insurance | 22,833 | 1.72 |
| 451020 | IT Services | 29,590 | 4.93 |
| 451030 | Software | 7,674 | 4.63 |
| 452010 | Communications Equipment | 21,742 | 15.48 |

| | | | |
|---|---|---|---|
| 452020 | Technology Hardware, Storage & Peripherals | 142,800 | 30.26 |
| 452030 | Electronic Equipment, Instruments & Components | 67,056 | 21.22 |
| 453010 | Semiconductors & Semiconductor Equipment | 147,027 | 38.30 |
| 501010 | Diversified Telecommunication Services | 201,175 | 6.11 |
| 501020 | Wireless Telecommunication Services | 25,159 | 5.11 |
| 502010 | Media | 20,969 | 3.50 |
| 502020 | Entertainment | 90,600 | 5.88 |
| 502030 | Interactive Media & Services | 16,354 | 3.95 |
| 551010 | Electric Utilities | 33,611,613 | 4,392.65 |
| 551020 | Gas Utilities | 852,319 | 263.73 |
| 551030 | Multi-Utilities | 18,513,566 | 2,468.00 |
| 551040 | Water Utilities | 56,520 | 99.62 |
| 551050 | Independent Power and Renewable Electricity Producers | 34,166,773 | 3,483.46 |
| 601010 | Equity Real Estate Investment Trusts | 53,693 | 20.36 |
| 601020 | Real Estate Management & Development | 20,480 | 14.69 |

*Panel C: Scope 2 Emissions by Industry*

This panel shows average raw scope 2 emissions as well as average scope 3 emissions intensity for firm-years in each of the 69 distinct six-digit GICS industries. All variables are defined in Appendix A.

| GICS | Industry | Raw Scope 2 Emissions | Scope 2 Emissions Intensity |
|---|---|---|---|
| 101010 | Energy Equipment & Services | 86,845 | 26.95 |
| 101020 | Oil, Gas & Consumable Fuels | 1,048,688 | 72.49 |
| 151010 | Chemicals | 1,137,617 | 140.32 |
| 151020 | Construction Materials | 232,031 | 121.14 |
| 151030 | Containers & Packaging | 885,013 | 106.91 |
| 151040 | Metals & Mining | 1,076,416 | 181.87 |
| 151050 | Paper & Forest Products | 457,469 | 116.12 |
| 201010 | Aerospace & Defense | 337,958 | 25.39 |
| 201020 | Building Products | 215,980 | 56.34 |
| 201030 | Construction & Engineering | 61,514 | 17.48 |
| 201040 | Electrical Equipment | 70,397 | 26.18 |
| 201050 | Industrial Conglomerates | 764,044 | 36.01 |
| 201060 | Machinery | 147,033 | 28.31 |
| 201070 | Trading Companies & Distributors | 46,332 | 14.42 |
| 202010 | Commercial Services & Supplies | 62,584 | 23.06 |
| 202020 | Professional Services | 37,165 | 10.11 |
| 203010 | Air Freight & Logistics | 353,653 | 14.86 |
| 203020 | Airlines | 117,653 | 4.83 |
| 203030 | Marine | 34,530 | 21.00 |
| 203040 | Road & Rail | 88,513 | 12.27 |
| 203050 | Transportation Infrastructure | 54,477 | 32.82 |
| 251010 | Auto Components | 281,374 | 36.17 |
| 251020 | Automobiles | 2,005,152 | 20.71 |
| 252010 | Household Durables | 143,173 | 26.52 |
| 252020 | Leisure Products | 54,698 | 19.81 |
| 252030 | Textiles, Apparel & Luxury Goods | 96,629 | 27.04 |
| 253010 | Hotels, Restaurants & Leisure | 380,397 | 71.32 |
| 253020 | Diversified Consumer Services | 94,194 | 69.01 |
| 255010 | Distributors | 122,237 | 16.68 |
| 255020 | Internet & Direct Marketing Retail | 339,311 | 24.01 |
| 255030 | Multiline Retail | 863,768 | 46.30 |
| 255040 | Specialty Retail | 354,416 | 39.25 |
| 301010 | Food & Staples Retailing | 2,260,035 | 33.29 |
| 302010 | Beverages | 472,054 | 30.48 |
| 302020 | Food Products | 617,388 | 48.70 |
| 302030 | Tobacco | 345,663 | 13.21 |
| 303010 | Household Products | 1,066,230 | 57.14 |
| 303020 | Personal Products | 42,939 | 16.69 |
| 351010 | Health Care Equipment & Supplies | 67,400 | 18.97 |
| 351020 | Health Care Providers & Services | 289,814 | 19.28 |
| 351030 | Health Care Technology | 6,484 | 7.42 |
| 352010 | Biotechnology | 15,123 | 22.78 |
| 352020 | Pharmaceuticals | 215,003 | 21.73 |
| 352030 | Life Sciences Tools & Services | 47,059 | 17.77 |
| 401010 | Banks | 58,441 | 3.33 |
| 401020 | Thrifts & Mortgage Finance | 1,193 | 2.42 |
| 402010 | Diversified Financial Services | 87,981 | 21.70 |
| 402020 | Consumer Finance | 54,663 | 7.87 |
| 402030 | Capital Markets | 38,043 | 8.32 |
| 402040 | Mortgage Real Estate Investment Trusts | 21,083 | 19.86 |
| 403010 | Insurance | 37,805 | 3.30 |
| 451020 | IT Services | 105,059 | 11.20 |
| 451030 | Software | 51,995 | 8.22 |
| 452010 | Communications Equipment | 75,331 | 16.57 |

| | | | |
|---|---|---|---|
| 452020 | Technology Hardware, Storage & Peripherals | 293,315 | 22.59 |
| 452030 | Electronic Equipment, Instruments & Components | 128,689 | 29.97 |
| 453010 | Semiconductors & Semiconductor Equipment | 204,697 | 42.44 |
| 501010 | Diversified Telecommunication Services | 1,555,041 | 29.14 |
| 501020 | Wireless Telecommunication Services | 109,883 | 14.26 |
| 502010 | Media | 66,355 | 10.98 |
| 502020 | Entertainment | 135,006 | 13.94 |
| 502030 | Interactive Media & Services | 312,589 | 16.38 |
| 551010 | Electric Utilities | 798,976 | 149.03 |
| 551020 | Gas Utilities | 22,702 | 11.26 |
| 551030 | Multi-Utilities | 550,873 | 64.86 |
| 551040 | Water Utilities | 92,008 | 46.36 |
| 551050 | Independent Power and Renewable Electricity Producers | 69,672 | 7.91 |
| 601010 | Equity Real Estate Investment Trusts | 91,639 | 64.49 |
| 601020 | Real Estate Management & Development | 63,857 | 42.64 |

*Panel D: Scope 3 Emissions by Industry*

This panel shows average raw scope 3 emissions as well as average scope 3 emissions intensity for firm-years in each of the 69 distinct six-digit GICS industries. All variables are defined in Appendix A.

| GICS | Industry | Raw Scope 3 Emissions | Scope 3 Emissions Intensity |
|---|---|---|---|
| 101010 | Energy Equipment & Services | 1,102,553 | 258.64 |
| 101020 | Oil, Gas & Consumable Fuels | 8,168,938 | 201.39 |
| 151010 | Chemicals | 2,621,048 | 363.81 |
| 151020 | Construction Materials | 878,822 | 472.42 |
| 151030 | Containers & Packaging | 2,692,098 | 391.67 |
| 151040 | Metals & Mining | 3,326,545 | 534.87 |
| 151050 | Paper & Forest Products | 808,877 | 272.03 |
| 201010 | Aerospace & Defense | 2,923,396 | 174.45 |
| 201020 | Building Products | 848,761 | 317.98 |
| 201030 | Construction & Engineering | 562,266 | 202.89 |
| 201040 | Electrical Equipment | 789,617 | 266.20 |
| 201050 | Industrial Conglomerates | 4,636,339 | 225.70 |
| 201060 | Machinery | 1,682,392 | 324.82 |
| 201070 | Trading Companies & Distributors | 197,988 | 63.86 |
| 202010 | Commercial Services & Supplies | 440,719 | 173.13 |
| 202020 | Professional Services | 113,540 | 34.24 |
| 203010 | Air Freight & Logistics | 2,046,971 | 94.81 |
| 203020 | Airlines | 2,375,303 | 135.42 |
| 203030 | Marine | 179,764 | 116.41 |
| 203040 | Road & Rail | 636,082 | 107.18 |
| 203050 | Transportation Infrastructure | 193,482 | 116.98 |
| 251010 | Auto Components | 2,141,244 | 365.12 |
| 251020 | Automobiles | 18,299,331 | 324.09 |
| 252010 | Household Durables | 1,304,561 | 238.47 |
| 252020 | Leisure Products | 728,168 | 262.62 |
| 252030 | Textiles, Apparel & Luxury Goods | 1,152,166 | 190.84 |
| 253010 | Hotels, Restaurants & Leisure | 600,922 | 122.61 |
| 253020 | Diversified Consumer Services | 155,344 | 99.26 |
| 255010 | Distributors | 378,625 | 53.61 |
| 255020 | Internet & Direct Marketing Retail | 873,148 | 60.29 |
| 255030 | Multiline Retail | 1,449,293 | 70.10 |
| 255040 | Specialty Retail | 676,600 | 72.94 |
| 301010 | Food & Staples Retailing | 6,038,132 | 105.38 |
| 302010 | Beverages | 6,273,917 | 399.37 |
| 302020 | Food Products | 13,045,781 | 818.23 |
| 302030 | Tobacco | 8,146,452 | 353.33 |
| 303010 | Household Products | 4,651,963 | 271.71 |
| 303020 | Personal Products | 546,560 | 130.26 |
| 351010 | Health Care Equipment & Supplies | 573,920 | 139.70 |
| 351020 | Health Care Providers & Services | 1,739,824 | 69.12 |
| 351030 | Health Care Technology | 39,341 | 46.17 |
| 352010 | Biotechnology | 106,609 | 80.65 |
| 352020 | Pharmaceuticals | 1,317,103 | 106.32 |
| 352030 | Life Sciences Tools & Services | 313,823 | 116.42 |
| 401010 | Banks | 140,356 | 21.37 |
| 401020 | Thrifts & Mortgage Finance | 10,974 | 20.31 |
| 402010 | Diversified Financial Services | 3,024,457 | 342.36 |
| 402020 | Consumer Finance | 233,553 | 26.79 |
| 402030 | Capital Markets | 153,211 | 36.15 |
| 402040 | Mortgage Real Estate Investment Trusts (REITs) | 19,272 | 32.40 |
| 403010 | Insurance | 334,401 | 30.50 |
| 451020 | IT Services | 275,046 | 42.14 |
| 451030 | Software | 186,587 | 39.07 |
| 452010 | Communications Equipment | 614,347 | 114.66 |

| | | | |
|---|---|---|---|
| 452020 | Technology Hardware, Storage & Peripherals | 3,146,521 | 149.64 |
| 452030 | Electronic Equipment, Instruments & Components | 465,454 | 149.72 |
| 453010 | Semiconductors & Semiconductor Equipment | 663,989 | 152.58 |
| 501010 | Diversified Telecommunication Services | 1,693,760 | 53.87 |
| 501020 | Wireless Telecommunication Services | 336,343 | 53.90 |
| 502010 | Media | 410,518 | 65.51 |
| 502020 | Entertainment | 477,441 | 54.36 |
| 502030 | Interactive Media & Services | 562,012 | 47.39 |
| 551010 | Electric Utilities | 2,787,080 | 334.82 |
| 551020 | Gas Utilities | 776,014 | 260.48 |
| 551030 | Multi-Utilities | 2,244,533 | 301.97 |
| 551040 | Water Utilities | 42,336 | 73.42 |
| 551050 | Independent Power and Renewable Electricity Producers | 1,455,942 | 188.81 |
| 601010 | Equity Real Estate Investment Trusts (REITs) | 85,323 | 43.92 |
| 601020 | Real Estate Management & Development | 88,984 | 65.66 |

## Table 5: Correlations

This table shows univariate correlations corresponding to our main emissions and financial performance variables. Panel A provides correlations between our main emissions measures; Panel B provides correlations between our main emissions measures and three measures of firm size; and Panel C provides correlations between our measures of firm performance and profitability. Please refer to Appendix A for variable definitions

.

### *Panel A: Correlation between Emissions Variables*

This panel shows univariate correlations between log emissions and emissions intensity for scope 1, 2, and 3 emissions.

| Correlation Table | | | | | | |
|---|---|---|---|---|---|---|
| | Log Scope 1 | Log Scope 2 | Log Scope 3 | Carbon Intensity Scope1 | Carbon Intensity Scope2 | Carbon Intensity Scope3 |
| Log Scope 1 | 1 | | | | | |
| Log Scope 2 | 0.988 | 1 | | | | |
| Log Scope 3 | 0.999 | 0.993 | 1 | | | |
| Carbon Intensity Scope 1 | 0.960 | 0.919 | 0.954 | 1 | | |
| Carbon Intensity Scope 2 | 0.910 | 0.926 | 0.919 | 0.889 | 1 | |
| Carbon Intensity Scope 3 | 0.749 | 0.651 | 0.731 | 0.878 | 0.673 | 1 |

### *Panel B: Correlation between Emissions and Firm Size*

This panel shows univariate correlations between carbon emissions and firm size.

| | Log Market Cap | Log Employees | Log Sales | Log Scope 1 | Log Scope 2 | Log Scope 3 | Carbon Intensity Scope 1 | Carbon Intensity Scope 2 | Carbon Intensity Scope 3 |
|---|---|---|---|---|---|---|---|---|---|
| Log Market Cap | 1 | | | | | | | | |
| Log Employees | 0.658 | 1 | | | | | | | |
| Log Sales | 0.800 | 0.874 | 1 | | | | | | |
| Log Scope 1 | 0.523 | 0.611 | 0.719 | 1 | | | | | |
| Log Scope 2 | 0.650 | 0.735 | 0.840 | 0.804 | 1 | | | | |
| Log Scope 3 | 0.667 | 0.806 | 0.901 | 0.852 | 0.880 | 1 | | | |
| Carbon Intensity Scope 1 | 0.082 | 0.045 | 0.125 | 0.542 | 0.130 | 0.235 | 1 | | |
| Carbon Intensity Scope 2 | 0.062 | 0.058 | 0.104 | 0.399 | 0.506 | 0.232 | 0.237 | 1 | |
| Carbon Intensity Scope 3 | 0.047 | 0.181 | 0.198 | 0.517 | 0.351 | 0.541 | 0.344 | 0.338 | 1 |

*Panel C: Correlation in Financial Performance Measures*

This panel shows univariate correlations between measures of firm correlation between measures of firms' financial performance.

| | ROS | ROA | Tobin's Q | EBIT Margin | EBITDA Margin |
|---|---|---|---|---|---|
| ROS | 1.000 | | | | |
| ROA | 0.624 | 1.000 | | | |
| Tobin's Q | -0.155 | 0.064 | 1.000 | | |
| EBIT Margin | 1.000 | 0.624 | -0.155 | 1.000 | |
| EBITDA Margin | 0.998 | 0.606 | -0.158 | 0.998 | 1.000 |

## Table 6: Disclosed vs. Estimated Values

This table provides a breakdown of the number of firms and firm-month observations with disclosed vs. vendor-estimated figures. We define a firm to have estimated emissions if its scope 1 emissions are estimated by the vendor. In Panel A we provide the distribution of disclosed vs. estimated observations by year; in Panel B we provide the distribution of disclosed vs. estimated observations by industry. For brevity, in Panel B we show only the top 10 and bottom 10 industries, for industries with at least 10 distinct firms, according to the percentage of observations with estimated values.

*Panel A: Estimated Values by Year*

| | Full Sample | | Disclosed Values | | Estimated Values | | % Observations with Estimated Values |
|---|---|---|---|---|---|---|---|
| Year | Firms | Observations | Firms | Observations | Firms | Observations | |
| 2005 | 700 | 8,549 | 99 | 1,199 | 601 | 7,350 | 86 |
| 2006 | 706 | 8,600 | 124 | 1,515 | 582 | 7,085 | 82 |
| 2007 | 693 | 8,453 | 165 | 2,009 | 528 | 6,444 | 76 |
| 2008 | 690 | 8,515 | 190 | 2,317 | 500 | 6,198 | 72 |
| 2009 | 709 | 8,708 | 235 | 2,875 | 474 | 5,833 | 67 |
| 2010 | 704 | 8,669 | 280 | 3,434 | 424 | 5,235 | 60 |
| 2011 | 715 | 8,799 | 314 | 3,840 | 401 | 4,959 | 56 |
| 2012 | 727 | 8,913 | 337 | 4,113 | 390 | 4,800 | 54 |
| 2013 | 800 | 9,738 | 354 | 4,308 | 446 | 5,430 | 56 |
| 2014 | 829 | 10,082 | 374 | 4,568 | 455 | 5,514 | 55 |
| 2015 | 859 | 10,532 | 396 | 4,844 | 463 | 5,688 | 54 |
| 2016 | 2369 | 28,465 | 446 | 5,447 | 1923 | 23,018 | 81 |
| 2017 | 2509 | 30,164 | 491 | 6,004 | 2018 | 24,160 | 80 |
| 2018 | 2645 | 31,881 | 540 | 6,627 | 2105 | 25,254 | 80 |
| 2019 | 1992 | 24,161 | 101 | 1,207 | 1891 | 22,954 | 95 |
| | | 214,229 | | 54,307 | | 159,922 | 75 |

*Panel B: Top Ten and Bottom Ten Industries by Highest Percent of Estimated Values*

This panel presents the top ten and bottom ten industries in our sample according to the percentage of emissions observations that are estimated rather than disclosed, for industries with at least ten distinct firms. We define a firm to have estimated emissions if its scope 1 emissions are estimated by Trucost.

| GICS | Industry | Distinct Firms | Firm-Month Observations | % Obs. with Estimated Emissions | |
|---|---|---|---|---|---|
| 253020 | Diversified Consumer Services | 23 | 1,998 | 100 | |
| 351030 | Health Care Technology | 19 | 1,023 | 100 | |
| 401020 | Thrifts & Mortgage Finance | 42 | 2,414 | 100 | |
| 402040 | Mortgage Real Estate Investment Trusts | 34 | 1,674 | 100 | |
| 551020 | Gas Utilities | 11 | 937 | 99 | Top 10 |
| 352010 | Biotechnology | 179 | 8,087 | 93 | |
| 201030 | Construction & Engineering | 27 | 2,059 | 91 | |
| 502010 | Media | 47 | 4,787 | 91 | |
| 201070 | Trading Companies & Distributors | 33 | 2,400 | 90 | |
| 401010 | Banks | 230 | 14,427 | 90 | |
| 203010 | Air Freight & Logistics | 11 | 1,008 | 61 | |
| 301010 | Food & Staples Retailing | 20 | 1,885 | 59 | |
| 302020 | Food Products | 38 | 3,761 | 49 | |
| 151010 | Chemicals | 59 | 4,967 | 47 | |
| 151030 | Containers & Packaging | 16 | 2,376 | 44 | Bottom |
| 452020 | Technology Hardware, Storage & Peripherals | 19 | 1,871 | 40 | 10 |
| 302010 | Beverages | 11 | 1,860 | 39 | |
| 203020 | Airlines | 11 | 872 | 7 | |
| 551030 | Multi-Utilities | 15 | 2,114 | 7 | |
| 551010 | Electric Utilities | 27 | 3,568 | 5 | |
| | Full Sample | 2,729 | 214,229 | 75 | |

## Table 7: Do Estimated Emissions Systematically Differ from Disclosed Emissions?

This table estimates an emissions prediction model for each of scope 1, 2, and 3 emissions. In Columns (1), (2), and (3) the dependent variable is the natural logarithm of scope 1, 2, and 3 emissions, respectively. In Column (1) the independent variable of interest is Scope 1 Estimated, an indicator for whether the firm's scope 1 emissions corresponding to month-year *t* are vendor-estimated; in Column (2), the independent variable of interest is Scope 2 Estimated, an indicator for whether the firm's scope 2 emissions corresponding to month-year *t* are vendor-estimated; and in Column (3) the independent variable of interest is Scope 3 Disclosed, an indicator for whether the firm's scope 3 emissions corresponding to month-year *t* are vendor-estimated. Columns (1) – (3) include firm and month-year fixed effects but no other control variables. Columns (4) – (6) replicate the specifications in Columns (1) – (3) but with the inclusion of control variables. Standard errors are two-way clustered by firm and month-year. Please refer to Appendix A for variable definitions. We report standard errors in parentheses beneath coefficient estimates. In all panels, *, **, and *** indicate statistical significance at 10% ,5%, and 1% levels, respectively.

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| VARIABLES | Log Scope 1 | Log Scope 2 | Log Scope 3 | Log Scope 1 | Log Scope 2 | Log Scope 3 |
| Scope 1 Estimated Indicator | 0.379*** | | | 0.485*** | | |
| | (0.069) | | | (0.068) | | |
| Scope 2 Estimated Indicator | | -0.242*** | | | -0.141** | |
| | | (0.064) | | | (0.061) | |
| Scope 3 Estimated Indicator | | | -0.141*** | | | -0.040*** |
| | | | (0.031) | | | (0.013) |
| Log Sales | | | | 0.877*** | 0.876*** | 1.011*** |
| | | | | (0.044) | (0.045) | (0.032) |
| HHI | | | | -0.008 | 0.092 | -0.102 |
| | | | | (0.209) | (0.168) | (0.116) |
| Book to Market | | | | 0.017 | 0.048 | 0.002 |
| | | | | (0.032) | (0.035) | (0.020) |
| SaleGR | | | | 0.139*** | 0.119*** | 0.113*** |
| | | | | (0.027) | (0.025) | (0.024) |
| EPSGR | | | | -0.000 | -0.003*** | 0.000 |
| | | | | (0.001) | (0.001) | (0.001) |
| Leverage | | | | 0.020 | -0.056 | -0.021 |
| | | | | (0.096) | (0.094) | (0.058) |
| Log PPE | | | | 0.057** | 0.106*** | 0.039** |
| | | | | (0.027) | (0.028) | (0.019) |
| ROE | | | | 0.000 | -0.000 | 0.000 |
| | | | | (0.000) | (0.000) | (0.000) |
| Invest/A | | | | -0.353 | 0.284 | -0.473*** |
| | | | | (0.325) | (0.378) | (0.170) |
| Constant | | | | 3.381*** | 2.939*** | 4.255*** |
| | | | | (0.280) | (0.275) | (0.193) |
| Observations | 214,227 | 214,227 | 214,227 | 197,186 | 197,186 | 197,186 |
| R-squared | 0.970 | 0.950 | 0.073 | 0.981 | 0.967 | 0.992 |
| Firm FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Month-Year FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Clustering | Yes | Yes | Yes | Yes | Yes | Yes |

## Table 8: Emissions and Firm Size

This table presents descriptive statistics and univariate tests to illustrate the relation between emissions and firm size. In Panel A we first construct quintiles of sales; then, within each sales quintile, we construct quintiles of emissions. We document average monthly stock returns for these 25 partitions. In Panels B and C we first partition the sample according to scope 1 emissions then, within each quintile of emissions. In Panel B we provide a frequency table of industry composition within each of the five size quintiles. In Panel C, we provide weighted average returns, using the overall average returns for each industry, within each of the five emissions quintiles. Panel D provides a matrix that calculates a weighted average of industry-level stock returns within each emissions quintile to illustrate industry tilts within emission portfolios.

### *Panel A: Returns by Quintiles of Scope 1 Emissions Within Quintiles of Sales*

This panel provides a 5x5 matrix of monthly returns based on portfolio sorts along two dimensions: scope 1 emissions and net sales. For each month from 2005-2019, we partition firms into quintiles based on net sales; then, within these sales quintiles, we additionally partition firms into quintiles based on their scope 1 emissions. We provide average monthly returns for each of the 25 portfolios generated by this partitioning strategy. We then calculate the alpha, if any, that would be attained from a hedging strategy of buying low-emission firms (i.e., the bottom emissions quintile, which is quintile 1) within each sales quintile and selling the high-emissions firms (i.e., the top emissions quintile, which is quintile 5) within each sales quintile. We also provide t-statistics for these alphas. Please refer to Appendix A for variable definitions.

| | | Sales Quintile | | | | |
|---|---|---|---|---|---|---|
| *Returns by:* | | 1=Low | 2 | 3 | 4 | 5=High |
| Scope 1 Emissions Quintile | 1=Low | 1.060 | 0.912 | 1.072 | 1.094 | 1.025 |
| | 2 | 1.361 | 1.511 | 1.147 | 0.998 | 1.050 |
| | 3 | 1.302 | 1.041 | 1.178 | 1.066 | 0.902 |
| | 4 | 1.313 | 1.146 | 1.001 | 1.014 | 0.839 |
| | 5=High | 1.416 | 0.955 | 1.121 | 0.864 | 1.085 |
| Alpha (Emissions Low – Emissions High) | | -0.356 | -0.043 | -0.048 | 0.230 | -0.059 |
| *t*-statistic of difference | | -1.51 | -0.25 | -0.29 | 1.46 | -0.42 |

## *Panel B: Number of Firm-Months by Industry Within Quintiles of Scope 1 Emissions*

This panel provides a matrix of the number of firm-month observations based on a two-dimensional sort. We first sort observations according to their quintile of emissions within firm-month; then, within emissions quintiles, we separate observations into one of eleven industry sectors defined by GICS.

| *Number of firm-month obs. in:* | | Communication Services | Consumer Discretionary | Consumer Staples | Energy | Financials | Healthcare | Industrials | Information Technology | Materials | Real Estate | Utilities | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | |
| | 1=Low | 2,093 | 938 | 60 | 240 | **23,574** | 6,800 | 1,344 | **4,985** | 161 | 2,582 | 138 | 42,915 |
| Scope 1 | 2 | 3,700 | 3,747 | 436 | 771 | 7,135 | 7,489 | 4,466 | **9,026** | 167 | 5,851 | 70 | 42,858 |
| Emissions | 3 | 2,122 | 9,630 | 1,466 | 1,281 | 2,701 | 4,924 | 8,660 | 6,544 | 777 | 4,152 | 578 | 42,835 |
| Quintile | 4 | 1,241 | 10,087 | 3,748 | 2,944 | 712 | 4,421 | 9,790 | 4,519 | 3,174 | 1,624 | 602 | 42,862 |
| | 5=High | 438 | 4,825 | 4,196 | **7,147** | 215 | 1,885 | 8,180 | 1,548 | 7,418 | 371 | 6,536 | 42,759 |

## *Panel C: Average Returns by Industry Within Quintiles of Scope 1 Emissions*

This panel provides industry-level stock returns for each of the 11 GICS industry sectors within each quintile of emissions; returns correspond to the firm-month observations determined via the procedure in Panel C (e.g., the value of 0.063 for energy in scope 1 corresponds to the 240 observations, documented in Panel C, that are in the energy sector within the sample-wide bottom quintile of emissions). The "alphas" at the bottom of the table, and the corresponding t-statistic, reflects to the abnormal returns that would be earned from a hedge portfolio that goes long on the firms in the lowest quintile (quintile 1) of scope 1 emissions and short on the firms in the highest quintile (quintile 5) of scope 1 emissions for the given industry.

| | | Communication Services | Consumer Discretionary | Consumer Staples | Energy | Financials | Healthcare | Industrials | Information Technology | Materials | Real Estate | Utilities | Full Sample |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | |
| | 1=Low | 1.277 | 1.141 | 6.065[23] | 0.063 | **0.933** | 1.370 | 0.043 | **1.811** | 1.590 | 1.367 | 0.896 | 1.128 |
| Scope 1 | 2 | 0.674 | 1.079 | 1.990 | 1.332 | 1.028 | 1.886 | 1.223 | **1.460** | 2.114 | 1.097 | 1.669 | 1.293 |
| Emissions | 3 | 0.755 | 1.099 | 1.559 | 0.190 | 0.926 | 1.279 | 1.373 | 1.261 | 1.294 | 0.652 | 1.501 | 1.126 |
| Quintile | 4 | 0.858 | 0.855 | 1.092 | 0.128 | 1.159 | 1.116 | 1.267 | 1.401 | 0.939 | 0.815 | 1.084 | 1.017 |
| | 5=High | 0.997 | 0.768 | 0.524 | **0.433** | 0.619 | 0.946 | 1.111 | 1.628 | 1.320 | 0.966 | 0.948 | 0.919 |
| Alpha (Low – High) | | 0.280 | 0.373 | **5.541** | -0.370 | 0.313 | 0.424 | -1.068 | 0.183 | 0.269 | 0.400 | -0.052 | **0.209** |
| *t*-statistic | | 0.46 | 0.92 | **5.34** | -0.42 | 0.52 | 0.80 | -3.03 | 0.48 | 0.28 | 0.68 | -0.11 | **2.55** |

[23] This is an extreme outlier, likely driven by the fact that only two distinct firms in the bottom quintile of scope 1 emissions are in the consumer staples industry (22nd Century Group and Monster Beverage Inc.)

*Panel D: Weighted Average Returns Within Scope 1 Emissions Quintiles*

This panel provides a matrix that calculates a weighted average of industry-level stock returns within each emissions quintile. The figures in Columns (1) – (11) are calculated using average monthly returns for firms within the intersection of the given industry and emissions quintile as well as the relative weight of each industry within each emissions quintile. For example, the value of 0.062 corresponding to emissions quintile 1 (row 1) and communication services (column 1) is calculated as 2,093/42,915 * 1.277; the fraction represents the weight of the 2,093 communication services firm-months within the 42,915 total firm-months in the bottom quintile by scope 1 emissions (obtained from Panel C), while 1.277 is the average monthly return for communication services firms that are in the bottom quintile of emissions where quintiles are taken over the full sample (obtained from Panel D). The value in the last column, labelled "Full Sample", corresponds to the overall return for the emissions quintile (which is also equal to the sum of the weighted industry returns figures in Columns (1) – (11)).

| | | Communication Services | Consumer Discretionary | Consumer Staples | Energy | Financials | Healthcare | Industrials | Information Technology | Materials | Real Estate | Utilities | Full Sample |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | |
| Scope 1 Emissions Quintile Weighted Returns | 1 | 0.062 | 0.025 | 0.008 | 0.000 | 0.512 | 0.217 | 0.001 | 0.210 | 0.006 | 0.082 | 0.003 | 1.128 |
| | 2 | 0.058 | 0.094 | 0.020 | 0.024 | 0.171 | 0.330 | 0.127 | 0.307 | 0.008 | 0.150 | 0.003 | 1.293 |
| | 3 | 0.037 | 0.247 | 0.053 | 0.006 | 0.058 | 0.147 | 0.278 | 0.193 | 0.023 | 0.063 | 0.020 | 1.126 |
| | 4 | 0.025 | 0.201 | 0.096 | 0.009 | 0.019 | 0.115 | 0.289 | 0.148 | 0.070 | 0.031 | 0.015 | 1.017 |
| | 5 | 0.010 | 0.087 | 0.051 | 0.072 | 0.003 | 0.042 | 0.213 | 0.059 | 0.229 | 0.008 | 0.145 | 0.919 |

## Table 9: Stock Returns and Carbon Emissions

This table provides results from estimating regressions of stock returns on four measures of carbon emissions. In Panels A, B, and C we estimate the relation between monthly stock returns and the natural logarithm of raw scope 1, 2, and 3 carbon emissions. The dependent variable in all panels is monthly stock returns, expressed as a percentage. In Panels D, E, and F we replace the emissions variables with carbon emissions intensity, the year-over-year growth in carbon emissions, and the year-over-year change in carbon emissions intensity, respectively. Please refer to Appendix A for variable definitions. We report standard errors in parentheses. In all panels, *, **, and *** indicate statistical significance at 10%, 5%, and 1% levels, respectively.

### *Panel A: Log Emissions*

This panel provides results from regressions of monthly returns on log emissions. In Columns (1), (2), and (3) we report results from regressions of returns on scope 1, 2, and 3 emissions, respectively, as well as month-year fixed effects (but no other control variables). Columns (4) – (6) replicate Columns (1) – (3) but with the addition of firm sales as a control.

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| VARIABLES | Ret | Ret | Ret | Ret | Ret | Ret |
| Log Scope1 | -0.027*** | | | -0.008 | | |
| | (0.008) | | | (0.011) | | |
| Log Scope2 | | -0.035*** | | | -0.001 | |
| | | (0.010) | | | (0.017) | |
| Log Scope3 | | | -0.035*** | | | 0.018 |
| | | | (0.010) | | | (0.022) |
| Log Sale | | | | -0.052*** | -0.060** | -0.083*** |
| | | | | (0.019) | (0.024) | (0.030) |
| Constant | 1.372*** | 1.453*** | 1.515*** | 1.566*** | 1.556*** | 1.498*** |
| | (0.085) | (0.105) | (0.126) | (0.108) | (0.111) | (0.127) |
| Observations | 214,229 | 214,229 | 214,229 | 214,132 | 214,132 | 214,132 |
| R-squared | 0.181 | 0.181 | 0.181 | 0.181 | 0.181 | 0.181 |
| Month-Year | Yes | Yes | Yes | Yes | Yes | Yes |

### *Panel B: Impact of Controls and Fixed Effects*

This panel provides results from regressions of monthly returns on log scope 1 emissions, illustrating the impact of adding various control variables one at a time on the conclusions that can be drawn about this relation.

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| VARIABLES | Ret | Ret | Ret | Ret | Ret | Ret |
| Log Scope 1 | -0.038*** | -0.027*** | -0.008 | 0.006 | 0.030** | 0.024* |
| | (0.008) | (0.008) | (0.011) | (0.011) | (0.013) | (0.012) |
| Log Sale | | | -0.052*** | -0.057*** | 0.024 | -0.081*** |
| | | | (0.019) | (0.019) | (0.024) | (0.020) |
| Leverage | | | | -0.681*** | | |
| | | | | (0.122) | | |
| Log PPE | | | | | -0.127*** | |
| | | | | | (0.021) | |
| Invest / A | | | | | | -3.641*** |
| | | | | | | (0.643) |
| Constant | 1.484*** | 1.372*** | 1.566*** | 1.625*** | 1.384*** | 1.595*** |
| | (0.088) | (0.085) | (0.108) | (0.109) | (0.120) | (0.108) |
| Observations | 214,229 | 214,229 | 214,132 | 213,439 | 199,931 | 213,403 |
| R-squared | 0.000 | 0.181 | 0.181 | 0.182 | 0.179 | 0.181 |
| Month-Year | No | Yes | Yes | Yes | Yes | Yes |

*Panel C: Stock Returns and Log Total Emissions*

This panel provides results from regressions of monthly stock returns on the natural logarithm of scope 1, 2, and 3 emissions and including the full set of control variables. In Columns (1), (2), and (3) we estimate regressions using month-year fixed effects but neither industry fixed effects nor clustering of standard errors; in Columns (4), (5), and (6) we add industry fixed effects (but not clustering of standard errors); and in Columns (7)-(9) we include industry fixed effects, month-year fixed effects, as well as clustering of standard errors by both industry and month-year. Please refer to Appendix A for variable definitions.

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
|---|---|---|---|---|---|---|---|---|---|
| VARIABLES | Ret | Ret | Ret | Ret | Ret | Ret | Ret | Ret | Ret |
| Log Scope 1 | 0.052*** | | | -0.015 | | | -0.015 | | |
| | (0.014) | | | (0.023) | | | (0.026) | | |
| Log Scope 2 | | 0.066*** | | | -0.014 | | | -0.014 | |
| | | (0.020) | | | (0.029) | | | (0.039) | |
| Log Scope 3 | | | 0.056** | | | -0.025 | | | -0.025 |
| | | | (0.025) | | | (0.043) | | | (0.064) |
| Log Sales | -0.081*** | -0.124*** | -0.108*** | -0.086** | -0.083* | -0.072 | -0.086 | -0.083 | -0.072 |
| | (0.028) | (0.034) | (0.037) | (0.037) | (0.043) | (0.054) | (0.068) | (0.081) | (0.088) |
| HHI | -0.309* | -0.339* | -0.327* | -1.472*** | -1.471*** | -1.474*** | -1.472** | -1.471** | -1.474** |
| | (0.185) | (0.185) | (0.185) | (0.446) | (0.446) | (0.446) | (0.587) | (0.587) | (0.586) |
| SaleGR | 0.946*** | 0.943*** | 0.947*** | 0.943*** | 0.943*** | 0.944*** | 0.943*** | 0.943*** | 0.944*** |
| | (0.063) | (0.063) | (0.063) | (0.065) | (0.065) | (0.065) | (0.223) | (0.224) | (0.224) |
| EPSGR | 0.011 | 0.011 | 0.011 | 0.010 | 0.010 | 0.010 | 0.010 | 0.010 | 0.010 |
| | (0.007) | (0.007) | (0.007) | (0.007) | (0.007) | (0.007) | (0.011) | (0.011) | (0.011) |
| Leverage | -0.450*** | -0.463*** | -0.410*** | -0.646*** | -0.646*** | -0.649*** | -0.646* | -0.646* | -0.649* |
| | (0.134) | (0.135) | (0.134) | (0.149) | (0.149) | (0.150) | (0.340) | (0.340) | (0.338) |
| Log PPE | -0.045* | -0.017 | -0.024 | 0.021 | 0.019 | 0.019 | 0.021 | 0.019 | 0.019 |
| | (0.024) | (0.023) | (0.023) | (0.029) | (0.029) | (0.029) | (0.045) | (0.044) | (0.045) |
| ROE | 0.011*** | 0.011*** | 0.011*** | 0.011*** | 0.011*** | 0.011*** | 0.011*** | 0.011*** | 0.011*** |
| | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.002) | (0.002) | (0.002) |
| Invest/A | -3.817*** | -3.755*** | -3.364*** | -5.017*** | -4.991*** | -5.022*** | -5.017*** | -4.991*** | -5.022*** |
| | (0.749) | (0.750) | (0.734) | (0.877) | (0.878) | (0.877) | (1.577) | (1.595) | (1.582) |
| Constant | 1.565*** | 1.580*** | 1.471*** | 2.169*** | 2.155*** | 2.225*** | 2.169*** | 2.155*** | 2.225*** |
| | (0.130) | (0.130) | (0.152) | (0.184) | (0.181) | (0.243) | (0.374) | (0.389) | (0.457) |
| Observations | 197,348 | 197,348 | 197,348 | 197,348 | 197,348 | 197,348 | 197,348 | 197,348 | 197,348 |
| R-squared | 0.183 | 0.183 | 0.183 | 0.184 | 0.184 | 0.184 | 0.184 | 0.184 | 0.184 |
| Industry | No | No | No | Yes | Yes | Yes | Yes | Yes | Yes |
| Month-Year | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Clustering | No | No | No | No | No | No | Yes | Yes | Yes |

*Panel D: Stock Returns and Carbon Intensity*

This panel provides results from regressions of monthly stock returns on scope 1, 2, and 3 carbon emissions intensity and including the full set of control variables. In Columns (1), (2), and (3) we estimate regressions using month-year fixed effects but neither industry fixed effects nor clustering of standard errors; in Columns (4), (5), and (6) we add industry fixed effects (but not clustering of standard errors); and in Columns (7)-(9) we include industry fixed effects, month-year fixed effects, as well as clustering of standard errors by both industry and month-year. Please refer to Appendix A for variable definitions.

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
|---|---|---|---|---|---|---|---|---|---|
| VARIABLES | Ret | Ret | | Ret | Ret | | Ret | Ret | |
| Carbon Intensity Scope 1 | 0.012* | | | 0.007 | | | 0.007 | | |
| | (0.006) | | | (0.009) | | | (0.010) | | |
| Carbon Intensity Scope 2 | | 0.142* | | | -0.023 | | | -0.023 | |
| | | (0.073) | | | (0.095) | | | (0.140) | |
| Carbon Intensity Scope 3 | | | 0.012 | | | -0.027 | | | -0.027 |
| | | | (0.017) | | | (0.031) | | | (0.030) |
| Log Sales | -0.037 | -0.045* | -0.049* | -0.094*** | -0.098*** | -0.098*** | -0.094 | -0.098* | -0.098 |
| | (0.027) | (0.026) | (0.026) | (0.033) | (0.033) | (0.033) | (0.057) | (0.057) | (0.059) |
| HHI | -0.304 | -0.300 | -0.324* | -1.476*** | -1.475*** | -1.481*** | -1.476** | -1.475** | -1.481** |
| | (0.186) | (0.186) | (0.186) | (0.446) | (0.446) | (0.446) | (0.588) | (0.589) | (0.587) |
| SaleGR | 0.946*** | 0.946*** | 0.946*** | 0.943*** | 0.942*** | 0.941*** | 0.943*** | 0.942*** | 0.941*** |
| | (0.063) | (0.063) | (0.063) | (0.065) | (0.065) | (0.065) | (0.224) | (0.224) | (0.223) |
| EPSGR | 0.011 | 0.011 | 0.011 | 0.010 | 0.010 | 0.010 | 0.010 | 0.010 | 0.010 |
| | (0.007) | (0.007) | (0.007) | (0.007) | (0.007) | (0.007) | (0.011) | (0.011) | (0.011) |
| Leverage | -0.386*** | -0.405*** | -0.385*** | -0.648*** | -0.648*** | -0.651*** | -0.648* | -0.648* | -0.651* |
| | (0.133) | (0.134) | (0.133) | (0.149) | (0.150) | (0.150) | (0.340) | (0.340) | (0.339) |
| Log PPE | -0.033 | -0.025 | -0.020 | 0.015 | 0.019 | 0.019 | 0.015 | 0.019 | 0.019 |
| | (0.025) | (0.023) | (0.023) | (0.029) | (0.029) | (0.029) | (0.043) | (0.043) | (0.045) |
| ROE | 0.011*** | 0.011*** | 0.011*** | 0.011*** | 0.011*** | 0.011*** | 0.011*** | 0.011*** | 0.011*** |
| | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.002) | (0.002) | (0.002) |
| Invest/A | -3.120*** | -3.288*** | -3.140*** | -4.965*** | -5.005*** | -5.059*** | -4.965*** | -5.005*** | -5.059*** |
| | (0.727) | (0.731) | (0.727) | (0.879) | (0.877) | (0.879) | (1.560) | (1.593) | (1.580) |
| Constant | 1.637*** | 1.632*** | 1.648*** | 2.107*** | 2.130*** | 2.163*** | 2.107*** | 2.130*** | 2.163*** |
| | (0.129) | (0.129) | (0.129) | (0.171) | (0.172) | (0.176) | (0.404) | (0.399) | (0.403) |
| Observations | 197,348 | 197,348 | 197,348 | 197,348 | 197,348 | 197,348 | 197,348 | 197,348 | 197,348 |
| R-squared | 0.183 | 0.183 | 0.183 | 0.184 | 0.184 | 0.184 | 0.184 | 0.184 | 0.184 |
| Industry | No | No | No | Yes | Yes | Yes | Yes | Yes | Yes |
| Month-Year | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Clustering | No | No | No | No | No | No | Yes | Yes | Yes |

*Panel E: Growth in Carbon Emissions*

This panel provides results from regressions of monthly stock returns on the year-over-year growth in scope 1, 2, and 3 carbon emissions and including the full set of control variables. In Columns (1), (2), and (3) we estimate regressions using month-year fixed effects but neither industry fixed effects nor clustering of standard errors; in Columns (4), (5), and (6) we add industry fixed effects (but not clustering of standard errors); and in Columns (7)-(9) we include industry fixed effects, month-year fixed effects, as well as clustering of standard errors by both industry and month-year. Please refer to Appendix A for variable definitions.

| VARIABLES | (1) Ret | (2) Ret | (3) Ret | (4) Ret | (5) Ret | (6) Ret | (7) Ret | (8) Ret | (9) Ret |
|---|---|---|---|---|---|---|---|---|---|
| Scope 1 Growth | 0.579*** | | | 0.524*** | | | 0.524*** | | |
| | (0.107) | | | (0.108) | | | (0.170) | | |
| Scope 2 Growth | | 0.216** | | | 0.180* | | | 0.180 | |
| | | (0.096) | | | (0.097) | | | (0.135) | |
| Scope 3 Growth | | | 0.955*** | | | 0.870*** | | | 0.870* |
| | | | (0.174) | | | (0.176) | | | (0.473) |
| Log Sales | -0.007 | -0.004 | -0.009 | -0.054 | -0.057 | -0.060* | -0.054 | -0.057 | -0.060 |
| | (0.028) | (0.028) | (0.028) | (0.035) | (0.035) | (0.035) | (0.054) | (0.053) | (0.053) |
| HHI | -0.271 | -0.235 | -0.259 | -1.533*** | -1.541*** | -1.516*** | -1.533** | -1.541*** | -1.516** |
| | (0.194) | (0.194) | (0.194) | (0.468) | (0.468) | (0.468) | (0.585) | (0.580) | (0.574) |
| SaleGR | 0.672*** | 0.836*** | 0.570*** | 0.636*** | 0.795*** | 0.544*** | 0.636** | 0.795*** | 0.544** |
| | (0.087) | (0.087) | (0.099) | (0.089) | (0.089) | (0.101) | (0.254) | (0.278) | (0.256) |
| EPSGR | 0.017** | 0.017** | 0.016** | 0.014* | 0.014* | 0.014* | 0.014 | 0.014 | 0.014 |
| | (0.007) | (0.007) | (0.007) | (0.007) | (0.007) | (0.007) | (0.012) | (0.012) | (0.013) |
| Leverage | -0.182 | -0.161 | -0.162 | -0.550*** | -0.536*** | -0.547*** | -0.550 | -0.536 | -0.547 |
| | (0.142) | (0.142) | (0.142) | (0.160) | (0.160) | (0.160) | (0.334) | (0.333) | (0.334) |
| Log PPE | -0.021 | -0.025 | -0.018 | 0.028 | 0.029 | 0.033 | 0.028 | 0.029 | 0.033 |
| | (0.025) | (0.025) | (0.025) | (0.031) | (0.031) | (0.031) | (0.046) | (0.046) | (0.046) |
| ROE | 0.011*** | 0.011*** | 0.011*** | 0.012*** | 0.012*** | 0.011*** | 0.012*** | 0.012*** | 0.011*** |
| | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.002) | (0.002) | (0.002) |
| Invest/A | -4.077*** | -3.911*** | -4.069*** | -5.309*** | -5.233*** | -5.427*** | -5.309*** | -5.233*** | -5.427*** |
| | (0.784) | (0.784) | (0.784) | (0.948) | (0.948) | (0.949) | (1.664) | (1.660) | (1.609) |
| Constant | 1.192*** | 1.180*** | 1.176*** | 1.602*** | 1.610*** | 1.604*** | 1.602*** | 1.610*** | 1.604*** |
| | (0.141) | (0.141) | (0.141) | (0.184) | (0.184) | (0.184) | (0.461) | (0.458) | (0.460) |
| Observations | 167,964 | 167,964 | 167,964 | 167,964 | 167,964 | 167,964 | 167,964 | 167,964 | 167,964 |
| R-squared | 0.193 | 0.193 | 0.193 | 0.194 | 0.194 | 0.194 | 0.194 | 0.194 | 0.194 |
| Industry | No | No | No | Yes | Yes | Yes | Yes | Yes | Yes |
| Month-Year | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Clustering | No | No | No | No | No | No | Yes | Yes | Yes |

*Panel F: Change in Carbon Intensity*

This panel provides results from regressions of monthly stock returns on the year-over-year change in scope 1, 2, and 3 carbon emissions intensity and including the full set of control variables. In Columns (1), (2), and (3) we estimate regressions using month-year fixed effects but neither industry fixed effects nor clustering of standard errors; in Columns (4), (5), and (6) we add industry fixed effects (but not clustering of standard errors); and in Columns (7)-(9) we include industry fixed effects, month-year fixed effects, as well as clustering of standard errors by both industry and month-year. Please refer to Appendix A for variable definitions.

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
|---|---|---|---|---|---|---|---|---|---|
| VARIABLES | Ret | Ret | Ret | Ret | Ret | Ret | Ret | Ret | Ret |
| Change in Scope 1 Intensity | 0.032 | | | 0.045 | | | 0.045 | | |
| | (0.039) | | | (0.040) | | | (0.056) | | |
| Change in Scope 2 Intensity | | 0.183 | | | 0.173 | | | 0.173 | |
| | | (0.251) | | | (0.252) | | | (0.288) | |
| Change in Scope 3 Intensity | | | -0.315*** | | | -0.332*** | | | -0.332 |
| | | | (0.106) | | | (0.107) | | | (0.210) |
| Log Sales | -0.007 | -0.005 | -0.007 | -0.058 | -0.058 | -0.061* | -0.058 | -0.058 | -0.061 |
| | (0.028) | (0.028) | (0.028) | (0.035) | (0.035) | (0.035) | (0.053) | (0.053) | (0.053) |
| HHI | -0.239 | -0.233 | -0.219 | -1.552*** | -1.549*** | -1.539*** | -1.552*** | -1.549*** | -1.539*** |
| | (0.194) | (0.194) | (0.194) | (0.468) | (0.468) | (0.468) | (0.580) | (0.580) | (0.578) |
| SaleGR | 0.957*** | 0.956*** | 0.943*** | 0.896*** | 0.895*** | 0.879*** | 0.896*** | 0.895*** | 0.879*** |
| | (0.069) | (0.069) | (0.069) | (0.072) | (0.072) | (0.072) | (0.258) | (0.259) | (0.254) |
| EPSGR | 0.017** | 0.017** | 0.017** | 0.014* | 0.014* | 0.014* | 0.014 | 0.014 | 0.014 |
| | (0.007) | (0.007) | (0.007) | (0.007) | (0.007) | (0.007) | (0.012) | (0.012) | (0.012) |
| Leverage | -0.162 | -0.162 | -0.163 | -0.536*** | -0.536*** | -0.531*** | -0.536 | -0.536 | -0.531 |
| | (0.142) | (0.142) | (0.142) | (0.160) | (0.160) | (0.160) | (0.334) | (0.334) | (0.335) |
| Log PPE | -0.022 | -0.024 | -0.025 | 0.030 | 0.030 | 0.031 | 0.030 | 0.030 | 0.031 |
| | (0.025) | (0.025) | (0.025) | (0.031) | (0.031) | (0.031) | (0.046) | (0.046) | (0.046) |
| ROE | 0.011*** | 0.011*** | 0.011*** | 0.012*** | 0.012*** | 0.012*** | 0.012*** | 0.012*** | 0.012*** |
| | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.002) | (0.002) | (0.002) |
| Invest/A | -3.886*** | -3.883*** | -3.922*** | -5.191*** | -5.194*** | -5.207*** | -5.191*** | -5.194*** | -5.207*** |
| | (0.783) | (0.783) | (0.784) | (0.948) | (0.948) | (0.948) | (1.666) | (1.668) | (1.665) |
| Constant | 1.196*** | 1.193*** | 1.200*** | 1.622*** | 1.620*** | 1.625*** | 1.622*** | 1.620*** | 1.625*** |
| | (0.141) | (0.141) | (0.141) | (0.184) | (0.184) | (0.184) | (0.460) | (0.459) | (0.460) |
| Observations | 167,964 | 167,964 | 167,964 | 167,964 | 167,964 | 167,964 | 167,964 | 167,964 | 167,964 |
| R-squared | 0.193 | 0.193 | 0.193 | 0.194 | 0.194 | 0.194 | 0.194 | 0.194 | 0.194 |
| Industry | No | No | No | Yes | Yes | Yes | Yes | Yes | Yes |
| Month-Year | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Clustering | No | No | No | No | No | No | Yes | Yes | Yes |

## Table 10: Returns and Disclosed vs. Vendor-Estimated Emissions

This table replicates the specifications provided in Panels C – F of Table 9, regressing monthly stock returns on four different measures of carbon emissions (for each of scope 1, 2, and 3 emissions). In each panel, we partition the sample according to whether an observation has estimated scope 1 emissions or firm-disclosed emissions; we then run analyses separately for these two subsamples. Please refer to Appendix A for variable definitions. We report standard errors in parentheses beneath coefficient estimates. In all panels, *, **, and *** indicate statistical significance at 10% ,5%, and 1% levels, respectively.

### *Panel A: Log Carbon Emissions*

This panel provides results from regressions of monthly stock returns on the natural logarithm of scope 1, 2, and 3 emissions and including the full set of control variables. In Columns (1), (2), and (3) we estimate this relation on the set of observations with firm-disclosed emissions values; in Columns (4), (5), and (6) we estimate this relation on the set of observations with vendor-estimated emissions values. All specifications include month-year fixed effects.

| | Disclosed | | | Estimated | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| VARIABLES | Ret | Ret | Ret | Ret | Ret | Ret |
| Log Scope 1 | 0.034 | | | 0.069*** | | |
| | (0.021) | | | (0.019) | | |
| Log Scope 2 | | -0.026 | | | 0.118*** | |
| | | (0.024) | | | (0.027) | |
| Log Scope 3 | | | 0.002 | | | 0.068** |
| | | | (0.040) | | | (0.030) |
| Log Sales | -0.094** | -0.087* | -0.111* | -0.106*** | -0.179*** | -0.117** |
| | (0.048) | (0.051) | (0.058) | (0.037) | (0.044) | (0.046) |
| HHI | -0.101 | -0.153 | -0.156 | -0.407* | -0.387 | -0.374 |
| | (0.257) | (0.254) | (0.254) | (0.238) | (0.238) | (0.238) |
| SaleGR | 1.176*** | 1.142*** | 1.151*** | 0.937*** | 0.934*** | 0.940*** |
| | (0.185) | (0.184) | (0.185) | (0.070) | (0.070) | (0.070) |
| EPSGR | 0.020* | 0.019 | 0.019* | 0.010 | 0.011 | 0.010 |
| | (0.012) | (0.012) | (0.012) | (0.008) | (0.008) | (0.008) |
| Leverage | -0.406 | -0.322 | -0.342 | -0.470*** | -0.549*** | -0.416*** |
| | (0.262) | (0.259) | (0.262) | (0.159) | (0.161) | (0.158) |
| Log PPE | -0.013 | 0.042 | 0.038 | -0.049* | -0.029 | -0.039 |
| | (0.050) | (0.039) | (0.039) | (0.029) | (0.029) | (0.029) |
| ROE | 0.007*** | 0.007*** | 0.007*** | 0.012*** | 0.012*** | 0.012*** |
| | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) |
| Invest/A | -5.800*** | -5.471*** | -5.587*** | -3.537*** | -3.806*** | -2.872*** |
| | (1.193) | (1.190) | (1.186) | (0.930) | (0.934) | (0.901) |
| Constant | 1.692*** | 1.912*** | 1.841*** | 1.626*** | 1.571*** | 1.478*** |
| | (0.325) | (0.316) | (0.361) | (0.161) | (0.162) | (0.188) |
| Observations | 51,915 | 51,915 | 51,915 | 145,433 | 145,433 | 145,433 |
| R-squared | 0.252 | 0.252 | 0.252 | 0.174 | 0.174 | 0.174 |
| Month-Year | Yes | Yes | Yes | Yes | Yes | Yes |

*Panel B: Carbon Intensity*

This panel provides results from regressions of monthly stock returns on the scope 1, 2, and 3 emissions intensity and including the full set of control variables. In Columns (1), (2), and (3) we estimate this relation on the set of observations with firm-disclosed emissions values; in Columns (4), (5), and (6) we estimate this relation on the set of observations with vendor-estimated emissions values. All specifications include month-year fixed effects.

| | Disclosed | | | Estimated | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| VARIABLES | Ret | Ret | Ret | Ret | Ret | Ret |
| Carbon Intensity Scope 1 | 0.011 | | | 0.019 | | |
| | (0.007) | | | (0.014) | | |
| Carbon Intensity Scope 2 | | -0.039 | | | 0.335*** | |
| | | (0.077) | | | (0.117) | |
| Carbon Intensity Scope 3 | | | -0.005 | | | 0.019 |
| | | | (0.024) | | | (0.023) |
| Log Sales | -0.069 | -0.115** | -0.112** | -0.036 | -0.037 | -0.043 |
| | (0.053) | (0.047) | (0.047) | (0.033) | (0.032) | (0.032) |
| HHI | -0.090 | -0.170 | -0.164 | -0.379 | -0.321 | -0.368 |
| | (0.258) | (0.256) | (0.257) | (0.238) | (0.239) | (0.239) |
| SaleGR | 1.163*** | 1.149*** | 1.147*** | 0.940*** | 0.944*** | 0.942*** |
| | (0.184) | (0.184) | (0.185) | (0.070) | (0.070) | (0.070) |
| EPSGR | 0.019* | 0.019* | 0.019* | 0.010 | 0.010 | 0.010 |
| | (0.012) | (0.012) | (0.012) | (0.008) | (0.008) | (0.008) |
| Leverage | -0.360 | -0.330 | -0.331 | -0.393** | -0.446*** | -0.394** |
| | (0.259) | (0.259) | (0.262) | (0.157) | (0.159) | (0.157) |
| Log PPE | 0.000 | 0.042 | 0.039 | -0.043 | -0.043 | -0.037 |
| | (0.045) | (0.039) | (0.039) | (0.030) | (0.029) | (0.029) |
| ROE | 0.007*** | 0.007*** | 0.007*** | 0.012*** | 0.012*** | 0.012*** |
| | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) |
| Invest/A | -5.445*** | -5.556*** | -5.597*** | -2.573*** | -2.965*** | -2.556*** |
| | (1.189) | (1.187) | (1.187) | (0.887) | (0.900) | (0.888) |
| Constant | 1.723*** | 1.874*** | 1.860*** | 1.686*** | 1.637*** | 1.686*** |
| | (0.320) | (0.314) | (0.315) | (0.160) | (0.161) | (0.161) |
| Observations | 51,915 | 51,915 | 51,915 | 145,433 | 145,433 | 145,433 |
| R-squared | 0.252 | 0.252 | 0.252 | 0.174 | 0.174 | 0.174 |
| Month-Year | Yes | Yes | Yes | Yes | Yes | Yes |

*Panel C: Growth in Carbon Emissions*

This panel provides results from regressions of monthly stock returns on the year-over-year growth in scope 1, 2, and 3 emissions and including the full set of control variables. In Columns (1), (2), and (3) we estimate this relation on the set of observations with firm-disclosed emissions values; in Columns (4), (5), and (6) we estimate this relation on the set of observations with vendor-estimated emissions values. All specifications include month-year fixed effects.

| | Disclosed | | | Estimated | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| VARIABLES | Ret | Ret | Ret | Ret | Ret | Ret |
| Scope 1 Growth | -0.008 | | | 1.247*** | | |
| | (0.114) | | | (0.169) | | |
| Scope 2 Growth | | -0.099 | | | 0.891*** | |
| | | (0.094) | | | (0.177) | |
| Scope 3 Growth | | | -1.076*** | | | 1.573*** |
| | | | (0.283) | | | (0.216) |
| Log Sales | -0.095** | -0.099** | -0.096** | -0.001 | 0.008 | 0.003 |
| | (0.048) | (0.048) | (0.048) | (0.036) | (0.036) | (0.036) |
| HHI | -0.172 | -0.172 | -0.150 | -0.339 | -0.219 | -0.254 |
| | (0.258) | (0.258) | (0.258) | (0.259) | (0.258) | (0.259) |
| SaleGR | 1.142*** | 1.188*** | 1.741*** | 0.336*** | 0.456*** | 0.342*** |
| | (0.193) | (0.193) | (0.245) | (0.115) | (0.126) | (0.115) |
| EPSGR | 0.020* | 0.020* | 0.021* | 0.017* | 0.017* | 0.016* |
| | (0.012) | (0.012) | (0.012) | (0.009) | (0.009) | (0.009) |
| Leverage | -0.336 | -0.342 | -0.380 | -0.171 | -0.131 | -0.137 |
| | (0.264) | (0.264) | (0.264) | (0.172) | (0.172) | (0.172) |
| Log PPE | 0.049 | 0.051 | 0.045 | -0.041 | -0.049 | -0.043 |
| | (0.039) | (0.039) | (0.039) | (0.032) | (0.032) | (0.032) |
| ROE | 0.006*** | 0.006*** | 0.007*** | 0.012*** | 0.012*** | 0.012*** |
| | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) |
| Invest/A | -6.301*** | -6.293*** | -6.294*** | -3.629*** | -3.359*** | -3.579*** |
| | (1.221) | (1.221) | (1.221) | (0.984) | (0.983) | (0.984) |
| Constant | 1.646*** | 1.676*** | 1.699*** | 1.216*** | 1.169*** | 1.172*** |
| | (0.319) | (0.320) | (0.319) | (0.180) | (0.179) | (0.179) |
| Observations | 50,014 | 50,014 | 50,014 | 117,950 | 117,950 | 117,950 |
| R-squared | 0.255 | 0.255 | 0.255 | 0.182 | 0.182 | 0.182 |
| Month-Year | Yes | Yes | Yes | Yes | Yes | Yes |

*Panel D: Change in Carbon Intensity*

This panel provides results from regressions of monthly stock returns on the year-over-year change in scope 1, 2, and 3 emissions and including the full set of control variables. In Columns (1), (2), and (3) we estimate this relation on the set of observations with firm-disclosed emissions values; in Columns (4), (5), and (6) we estimate this relation on the set of observations with vendor-estimated emissions values. All specifications include month-year fixed effects.

| | Disclosed | | | Estimated | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| VARIABLES | Ret | Ret | Ret | Ret | Ret | Ret |
| Change in Scope 1 Intensity | 0.026 | | | 0.097 | | |
| | (0.034) | | | (0.095) | | |
| Change in Scope 2 Intensity | | 0.200 | | | 0.419 | |
| | | (0.213) | | | (0.716) | |
| Change in Scope 3 Intensity | | | -0.352*** | | | -0.272* |
| | | | (0.124) | | | (0.155) |
| Log Sales | -0.099** | -0.094** | -0.095** | 0.009 | 0.010 | 0.008 |
| | (0.048) | (0.048) | (0.048) | (0.036) | (0.036) | (0.036) |
| HHI | -0.181 | -0.166 | -0.153 | -0.210 | -0.209 | -0.195 |
| | (0.258) | (0.258) | (0.258) | (0.258) | (0.258) | (0.259) |
| SaleGR | 1.152*** | 1.151*** | 1.090*** | 0.955*** | 0.954*** | 0.946*** |
| | (0.188) | (0.188) | (0.188) | (0.078) | (0.078) | (0.079) |
| EPSGR | 0.020* | 0.020* | 0.020* | 0.017* | 0.017* | 0.017* |
| | (0.012) | (0.012) | (0.012) | (0.009) | (0.009) | (0.009) |
| Leverage | -0.334 | -0.340 | -0.347 | -0.133 | -0.130 | -0.131 |
| | (0.264) | (0.264) | (0.264) | (0.172) | (0.172) | (0.172) |
| Log PPE | 0.053 | 0.049 | 0.046 | -0.049 | -0.050 | -0.050 |
| | (0.040) | (0.039) | (0.039) | (0.032) | (0.032) | (0.032) |
| ROE | 0.006*** | 0.006*** | 0.006*** | 0.013*** | 0.013*** | 0.013*** |
| | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) |
| Invest/A | -6.352*** | -6.348*** | -6.357*** | -3.197*** | -3.214*** | -3.266*** |
| | (1.222) | (1.222) | (1.221) | (0.983) | (0.983) | (0.983) |
| Constant | 1.655*** | 1.636*** | 1.661*** | 1.179*** | 1.179*** | 1.179*** |
| | (0.319) | (0.319) | (0.319) | (0.179) | (0.179) | (0.179) |
| Observations | 50,014 | 50,014 | 50,014 | 117,950 | 117,950 | 117,950 |
| R-squared | 0.255 | 0.255 | 0.255 | 0.182 | 0.182 | 0.182 |
| Month-Year | Yes | Yes | Yes | Yes | Yes | Yes |

## Table 11: Profitability and Carbon Emissions

This table provides results from regressions of five measures of operating performance and profitability – EBIT margin (the ratio of EBIT to assets), EBITDA margin (the ratio of EBITDA to assets), ROA (return on assets), ROS (return on sales), and Tobin's *q* – on the four measures of carbon emissions that we use throughout the paper. For brevity we only tabulate results using scope 1 emissions. Panel A considers the relation between operating performance and the natural logarithm of total carbon emissions; Panel B instead considers carbon intensity; Panel C considers the year-over-year emissions growth rate; and Panel D considers the year-over-year change in emissions. Please refer to Appendix A for variable definitions. We report standard errors in parentheses beneath coefficient estimates. In all panels, *, **, and *** indicate statistical significance at 10% ,5%, and 1% levels, respectively.

### *Panel A: Log Scope 1 Emissions*

This panel provides results from regressions of operating performance on the natural logarithm of scope 1 emissions. In Column (1) the dependent variable is EBIT margin, in Column (2) the dependent variable is EBITDA margin; in Column (3) the dependent variable is ROA; in Column (4) the dependent variable is ROS; and in Column (5) the dependent variable is Tobin's *q*. All specifications include industry and month-year fixed effects. Standard errors are two-way clustered by industry and month-year.

| | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| VARIABLES | EBIT Margin | EBITDA Margin | ROA | ROS | Tobin's *q* |
| Log Scope 1 | 0.368* | 0.405* | 0.008 | 0.368* | -0.055** |
| | (0.194) | (0.218) | (0.005) | (0.194) | (0.025) |
| Log Sales | 0.034 | 0.002 | 0.031*** | 0.034 | 0.136** |
| | (0.040) | (0.044) | (0.006) | (0.040) | (0.064) |
| HHI | 0.798 | 0.843 | 0.032 | 0.798 | -0.413 |
| | (0.534) | (0.572) | (0.040) | (0.534) | (0.286) |
| SaleGR | 0.144 | 0.169 | -0.001 | 0.144 | 0.309*** |
| | (0.128) | (0.133) | (0.007) | (0.128) | (0.107) |
| EPSGR | -0.006** | -0.006** | -0.000 | -0.006** | 0.013*** |
| | (0.003) | (0.003) | (0.000) | (0.003) | (0.003) |
| Leverage | 0.247 | 0.308 | -0.009 | 0.247 | -0.295 |
| | (0.238) | (0.263) | (0.026) | (0.238) | (0.245) |
| Log PPE | -0.189* | -0.187 | -0.020*** | -0.189* | -0.201*** |
| | (0.111) | (0.128) | (0.005) | (0.111) | (0.058) |
| ROE | 0.008*** | 0.008*** | 0.001*** | 0.008*** | 0.004*** |
| | (0.002) | (0.003) | (0.000) | (0.002) | (0.001) |
| Invest/A | 2.478* | 2.751* | 0.432*** | 2.478* | 7.729*** |
| | (1.391) | (1.481) | (0.113) | (1.391) | (1.622) |
| Constant | -3.345** | -3.494** | -0.167** | -3.345** | 2.583*** |
| | (1.523) | (1.659) | (0.063) | (1.523) | (0.239) |
| Observations | 197,348 | 195,865 | 197,348 | 197,348 | 197,187 |
| R-squared | 0.427 | 0.412 | 0.495 | 0.427 | 0.327 |
| Industry | Yes | Yes | Yes | Yes | Yes |
| Month-Year | Yes | Yes | Yes | Yes | Yes |
| Clustering | Yes | Yes | Yes | Yes | Yes |

*Panel B: Scope 1 Carbon Intensity*

This panel provides results from regressions of operating performance on scope 1 emissions intensity. In Column (1) the dependent variable is EBIT margin, in Column (2) the dependent variable is EBITDA margin; in Column (3) the dependent variable is ROA; in Column (4) the dependent variable is ROS; and in Column (5) the dependent variable is Tobin's *q*. All specifications include industry and month-year fixed effects. Standard errors are two-way clustered by industry and month-year.

| | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| VARIABLES | EBIT Margin | EBITDA Margin | ROA | ROS | Tobin's Q |
| Scope 1 Intensity | 0.009 | 0.009 | -0.000 | 0.009 | -0.004 |
| | (0.006) | (0.006) | (0.000) | (0.006) | (0.005) |
| Log Sales | 0.313* | 0.301* | 0.037*** | 0.313* | 0.093 |
| | (0.157) | (0.170) | (0.008) | (0.157) | (0.059) |
| HHI | 0.900 | 0.949 | 0.034 | 0.900 | -0.428 |
| | (0.624) | (0.668) | (0.041) | (0.624) | (0.281) |
| SaleGR | 0.161 | 0.189 | -0.001 | 0.161 | 0.306*** |
| | (0.161) | (0.172) | (0.008) | (0.161) | (0.110) |
| EPSGR | -0.007** | -0.008** | -0.000 | -0.007** | 0.013*** |
| | (0.004) | (0.004) | (0.000) | (0.004) | (0.003) |
| Leverage | 0.264 | 0.322 | -0.009 | 0.264 | -0.297 |
| | (0.260) | (0.284) | (0.025) | (0.260) | (0.246) |
| Log PPE | -0.107 | -0.087 | -0.018*** | -0.107 | -0.212*** |
| | (0.072) | (0.081) | (0.005) | (0.072) | (0.059) |
| ROE | 0.008*** | 0.009*** | 0.001*** | 0.008*** | 0.004*** |
| | (0.003) | (0.003) | (0.000) | (0.003) | (0.001) |
| Invest/A | 2.354* | 2.556* | 0.428*** | 2.354* | 7.732*** |
| | (1.388) | (1.448) | (0.115) | (1.388) | (1.612) |
| Constant | -2.219** | -2.238** | -0.143*** | -2.219** | 2.423*** |
| | (1.003) | (1.069) | (0.052) | (1.003) | (0.230) |
| Observations | 197,348 | 195,865 | 197,348 | 197,348 | 197,187 |
| R-squared | 0.374 | 0.356 | 0.492 | 0.374 | 0.325 |
| Industry | Yes | Yes | Yes | Yes | Yes |
| Month-Year | Yes | Yes | Yes | Yes | Yes |
| Clustering | Yes | Yes | Yes | Yes | Yes |

*Panel C: Growth in Scope 1 Emissions*

This panel provides results from regressions of operating performance on the year-over-year growth in scope 1 emissions. In Column (1) the dependent variable is EBIT margin, in Column (2) the dependent variable is EBITDA margin; in Column (3) the dependent variable is ROA; in Column (4) the dependent variable is ROS; and in Column (5) the dependent variable is Tobin's *q*. All specifications include industry and month-year fixed effects. Standard errors are two-way clustered by industry and month-year.

| | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| VARIABLES | EBIT Margin | EBITDA Margin | ROA | ROS | Tobin's Q |
| Scope 1 Growth | 0.185 | 0.205 | 0.001 | 0.185 | 0.251*** |
| | (0.147) | (0.161) | (0.006) | (0.147) | (0.083) |
| Log Sales | 0.283* | 0.267* | 0.037*** | 0.283* | 0.094 |
| | (0.144) | (0.155) | (0.008) | (0.144) | (0.060) |
| HHI | 0.888 | 0.921 | 0.036 | 0.888 | -0.412 |
| | (0.616) | (0.647) | (0.042) | (0.616) | (0.277) |
| SaleGR | 0.089 | 0.111 | -0.002 | 0.089 | 0.186 |
| | (0.144) | (0.150) | (0.009) | (0.144) | (0.118) |
| EPSGR | -0.007* | -0.008** | -0.000 | -0.007* | 0.012*** |
| | (0.004) | (0.004) | (0.000) | (0.004) | (0.004) |
| Leverage | 0.297 | 0.351 | -0.006 | 0.297 | -0.287 |
| | (0.265) | (0.282) | (0.023) | (0.265) | (0.232) |
| Log PPE | -0.088 | -0.065 | -0.018*** | -0.088 | -0.210*** |
| | (0.062) | (0.070) | (0.005) | (0.062) | (0.060) |
| ROE | 0.008*** | 0.008*** | 0.001*** | 0.008*** | 0.004*** |
| | (0.003) | (0.003) | (0.000) | (0.003) | (0.001) |
| Invest/A | 2.054* | 2.243* | 0.444*** | 2.054* | 7.655*** |
| | (1.170) | (1.194) | (0.131) | (1.170) | (1.671) |
| Constant | -2.077** | -2.073** | -0.143*** | -2.077** | 2.387*** |
| | (0.967) | (1.023) | (0.053) | (0.967) | (0.234) |
| Observations | 167,964 | 166,733 | 167,964 | 167,964 | 167,868 |
| R-squared | 0.354 | 0.337 | 0.477 | 0.354 | 0.325 |
| Industry | Yes | Yes | Yes | Yes | Yes |
| Month-Year | Yes | Yes | Yes | Yes | Yes |
| Clustering | Yes | Yes | Yes | Yes | Yes |

*Panel D: Change in Scope 1 Intensity*

This panel provides results from regressions of operating performance on the year-over-year change in carbon intensity. In Column (1) the dependent variable is EBIT margin, in Column (2) the dependent variable is EBITDA margin; in Column (3) the dependent variable is ROA; in Column (4) the dependent variable is ROS; and in Column (5) the dependent variable is Tobin's *q*. All specifications include industry and month-year fixed effects. Standard errors are two-way clustered by industry and month-year.

| | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| VARIABLES | EBIT Margin | EBITDA Margin | ROA | ROS | Tobin's Q |
| Change in Scope 1 Intensity | 0.004 | 0.010 | -0.003 | 0.004 | 0.002 |
| | (0.009) | (0.009) | (0.002) | (0.009) | (0.012) |
| Log Sales | 0.282* | 0.265* | 0.037*** | 0.282* | 0.092 |
| | (0.143) | (0.154) | (0.008) | (0.143) | (0.060) |
| HHI | 0.881 | 0.913 | 0.036 | 0.881 | -0.422 |
| | (0.612) | (0.643) | (0.042) | (0.612) | (0.277) |
| SaleGR | 0.180 | 0.212 | -0.002 | 0.180 | 0.310*** |
| | (0.168) | (0.178) | (0.008) | (0.168) | (0.110) |
| EPSGR | -0.007* | -0.008** | -0.000 | -0.007* | 0.012*** |
| | (0.004) | (0.004) | (0.000) | (0.004) | (0.004) |
| Leverage | 0.302 | 0.357 | -0.006 | 0.302 | -0.280 |
| | (0.269) | (0.287) | (0.023) | (0.269) | (0.231) |
| Log PPE | -0.087 | -0.064 | -0.018*** | -0.087 | -0.209*** |
| | (0.062) | (0.069) | (0.005) | (0.062) | (0.060) |
| ROE | 0.008*** | 0.008*** | 0.001*** | 0.008*** | 0.004*** |
| | (0.003) | (0.003) | (0.000) | (0.003) | (0.001) |
| Invest/A | 2.097* | 2.291* | 0.444*** | 2.097* | 7.713*** |
| | (1.207) | (1.235) | (0.131) | (1.207) | (1.682) |
| Constant | -2.070** | -2.065** | -0.143*** | -2.070** | 2.397*** |
| | (0.962) | (1.017) | (0.053) | (0.962) | (0.236) |
| Observations | 167,964 | 166,733 | 167,964 | 167,964 | 167,868 |
| R-squared | 0.353 | 0.336 | 0.477 | 0.353 | 0.323 |
| Industry | Yes | Yes | Yes | Yes | Yes |
| Month-Year | Yes | Yes | Yes | Yes | Yes |
| Clustering | Yes | Yes | Yes | Yes | Yes |

## Table 12: Operating Performance and Emissions for Disclosed Values

This table is analogous to Table 11 but considers only the subset of firm-month observations with firm-disclosed (rather than vendor-estimated) emissions figures. We provide results from regressions of five measures of operating performance and profitability – EBIT margin (the ratio of EBIT to assets), EBITDA margin (the ratio of EBITDA to assets), ROA (return on assets), ROS (return on sales), and Tobin's *q* – on the four measures of carbon emissions that we use throughout the paper. For brevity we only tabulate results using scope 1 emissions. Panel A considers the relation between operating performance and the natural logarithm of total carbon emissions; Panel B instead considers carbon intensity; Panel C considers the year-over-year emissions growth rate; and Panel D considers the year-over-year change in emissions. Please refer to Appendix A for variable definitions. We report standard errors in parentheses beneath coefficient estimates. In all panels, *, **, and *** indicate statistical significance at 10% ,5%, and 1% levels, respectively.

### *Panel A: Log Scope 1 Emissions*

This panel provides results from regressions of operating performance on the natural logarithm of scope 1 emissions, only for the subsample of observations with disclosed (rather than vendor-estimated) scope 1 emissions figures. In Column (1) the dependent variable is EBIT margin, in Column (2) the dependent variable is EBITDA margin; in Column (3) the dependent variable is ROA; in Column (4) the dependent variable is ROS; and in Column (5) the dependent variable is Tobin's *q*. All specifications include industry and month-year fixed effects. Standard errors are two-way clustered by industry and month-year.

| | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| VARIABLES | EBIT Margin | EBITDA Margin | ROA | ROS | Tobin's Q |
| Log Scope 1 | -0.001 | -0.004 | -0.004 | -0.001 | -0.089*** |
| | (0.008) | (0.008) | (0.003) | (0.008) | (0.033) |
| Log Sales | 0.033 | -0.010 | 0.027*** | 0.033 | 0.197* |
| | (0.027) | (0.029) | (0.006) | (0.027) | (0.099) |
| HHI | -0.050 | -0.089 | -0.000 | -0.050 | -0.578 |
| | (0.089) | (0.089) | (0.024) | (0.089) | (0.390) |
| SaleGR | 0.173*** | 0.149*** | 0.048*** | 0.173*** | 0.314* |
| | (0.051) | (0.042) | (0.013) | (0.051) | (0.182) |
| EPSGR | 0.006 | 0.006 | 0.001* | 0.006 | 0.009* |
| | (0.004) | (0.004) | (0.001) | (0.004) | (0.005) |
| Leverage | -0.022 | -0.000 | -0.025 | -0.022 | 0.115 |
| | (0.053) | (0.058) | (0.031) | (0.053) | (0.361) |
| Log PPE | -0.009 | 0.031 | -0.018*** | -0.009 | -0.182** |
| | (0.029) | (0.032) | (0.005) | (0.029) | (0.077) |
| ROE | 0.001*** | 0.001*** | 0.001*** | 0.001*** | 0.005*** |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.001) |
| Invest/A | -0.047 | 0.166 | 0.359** | -0.047 | 5.774*** |
| | (0.313) | (0.284) | (0.144) | (0.313) | (2.078) |
| Constant | -0.082 | 0.088 | 0.023 | -0.082 | 2.372*** |
| | (0.147) | (0.149) | (0.034) | (0.147) | (0.372) |
| Observations | 51,915 | 51,867 | 51,915 | 51,915 | 51,914 |
| R-squared | 0.219 | 0.236 | 0.373 | 0.219 | 0.426 |
| Industry | Yes | Yes | Yes | Yes | Yes |
| Month-Year | Yes | Yes | Yes | Yes | Yes |
| Clustering | Yes | Yes | Yes | Yes | Yes |

*Panel B: Scope 1 Emissions Intensity*

This panel provides results from regressions of operating performance on scope 1 emissions intensity, only for the subsample of observations with disclosed (rather than vendor-estimated) scope 1 emissions figures. In Column (1) the dependent variable is EBIT margin, in Column (2) the dependent variable is EBITDA margin; in Column (3) the dependent variable is ROA; in Column (4) the dependent variable is ROS; and in Column (5) the dependent variable is Tobin's *q*. All specifications include industry and month-year fixed effects. Standard errors are two-way clustered by industry and month-year.

| | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| VARIABLES | EBIT Margin | EBITDA Margin | ROA | ROS | Tobin's Q |
| Scope 1 Intensity | 0.001 | 0.001 | -0.001 | 0.001 | -0.005 |
| | (0.002) | (0.002) | (0.000) | (0.002) | (0.006) |
| Log Sales | 0.034 | -0.009 | 0.024*** | 0.034 | 0.159* |
| | (0.031) | (0.033) | (0.006) | (0.031) | (0.094) |
| HHI | -0.047 | -0.084 | 0.002 | -0.047 | -0.518 |
| | (0.092) | (0.091) | (0.023) | (0.092) | (0.372) |
| SaleGR | 0.174*** | 0.151*** | 0.049*** | 0.174*** | 0.345* |
| | (0.051) | (0.042) | (0.012) | (0.051) | (0.187) |
| EPSGR | 0.006 | 0.006 | 0.001* | 0.006 | 0.010* |
| | (0.004) | (0.004) | (0.001) | (0.004) | (0.005) |
| Leverage | -0.024 | -0.003 | -0.025 | -0.024 | 0.110 |
| | (0.054) | (0.060) | (0.031) | (0.054) | (0.374) |
| Log PPE | -0.011 | 0.026 | -0.020*** | -0.011 | -0.241*** |
| | (0.027) | (0.030) | (0.005) | (0.027) | (0.085) |
| ROE | 0.001*** | 0.001*** | 0.001*** | 0.001*** | 0.005*** |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.001) |
| Invest/A | -0.035 | 0.185 | 0.357** | -0.035 | 5.818*** |
| | (0.319) | (0.292) | (0.144) | (0.319) | (2.043) |
| Constant | -0.093 | 0.067 | 0.012 | -0.093 | 2.083*** |
| | (0.130) | (0.130) | (0.033) | (0.130) | (0.393) |
| Observations | 51,915 | 51,867 | 51,915 | 51,915 | 51,914 |
| R-squared | 0.219 | 0.236 | 0.370 | 0.219 | 0.419 |
| Industry | Yes | Yes | Yes | Yes | Yes |
| Month-Year | Yes | Yes | Yes | Yes | Yes |
| Clustering | Yes | Yes | Yes | Yes | Yes |

*Panel C: Growth in Scope 1 Emissions*

This panel provides results from regressions of operating performance on the year-over-year growth in scope 1 emissions, only for the subsample of observations with disclosed (rather than vendor-estimated) scope 1 emissions figures. In Column (1) the dependent variable is EBIT margin, in Column (2) the dependent variable is EBITDA margin; in Column (3) the dependent variable is ROA; in Column (4) the dependent variable is ROS; and in Column (5) the dependent variable is Tobin's *q*. All specifications include industry and month-year fixed effects. Standard errors are two-way clustered by industry and month-year.

| | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| VARIABLES | EBIT Margin | EBITDA Margin | ROA | ROS | Tobin's Q |
| Scope 1 Growth | -0.014 | -0.009 | -0.005 | -0.014 | -0.093* |
| | (0.014) | (0.014) | (0.003) | (0.014) | (0.050) |
| Log Sales | 0.026 | -0.017 | 0.024*** | 0.026 | 0.166* |
| | (0.029) | (0.032) | (0.006) | (0.029) | (0.095) |
| HHI | -0.034 | -0.068 | 0.000 | -0.034 | -0.541 |
| | (0.069) | (0.069) | (0.023) | (0.069) | (0.399) |
| SaleGR | 0.188*** | 0.164*** | 0.053*** | 0.188*** | 0.391* |
| | (0.039) | (0.033) | (0.011) | (0.039) | (0.206) |
| EPSGR | 0.006 | 0.006 | 0.001* | 0.006 | 0.009* |
| | (0.004) | (0.004) | (0.001) | (0.004) | (0.005) |
| Leverage | -0.017 | 0.002 | -0.021 | -0.017 | 0.160 |
| | (0.044) | (0.048) | (0.030) | (0.044) | (0.380) |
| Log PPE | -0.009 | 0.028 | -0.020*** | -0.009 | -0.248*** |
| | (0.027) | (0.030) | (0.005) | (0.027) | (0.086) |
| ROE | 0.001*** | 0.001** | 0.001*** | 0.001*** | 0.005*** |
| | (0.001) | (0.000) | (0.000) | (0.001) | (0.001) |
| Invest/A | -0.123 | 0.096 | 0.346** | -0.123 | 5.821*** |
| | (0.318) | (0.284) | (0.158) | (0.318) | (2.093) |
| Constant | -0.029 | 0.132 | 0.014 | -0.029 | 2.051*** |
| | (0.100) | (0.108) | (0.033) | (0.100) | (0.404) |
| Observations | 50,014 | 49,966 | 50,014 | 50,014 | 50,014 |
| R-squared | 0.228 | 0.249 | 0.378 | 0.228 | 0.419 |
| Industry | Yes | Yes | Yes | Yes | Yes |
| Month-Year | Yes | Yes | Yes | Yes | Yes |
| Clustering | Yes | Yes | Yes | Yes | Yes |

*Panel D: Change in Carbon Intensity*

This panel provides results from regressions of operating performance on the year-over-year change in scope 1 emissions intensity, only for the subsample of observations with disclosed (rather than vendor-estimated) scope 1 emissions figures. In Column (1) the dependent variable is EBIT margin, in Column (2) the dependent variable is EBITDA margin; in Column (3) the dependent variable is ROA; in Column (4) the dependent variable is ROS; and in Column (5) the dependent variable is Tobin's *q*. All specifications include industry and month-year fixed effects. Standard errors are two-way clustered by industry and month-year.

| | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| VARIABLES | EBIT Margin | EBITDA Margin | ROA | ROS | Tobin's Q |
| Change in Carbon Intensity | -0.006 | -0.004 | -0.001 | -0.006 | 0.004 |
| | (0.006) | (0.005) | (0.002) | (0.006) | (0.006) |
| Log Sales | 0.026 | -0.017 | 0.024*** | 0.026 | 0.168* |
| | (0.029) | (0.032) | (0.006) | (0.029) | (0.095) |
| HHI | -0.031 | -0.066 | 0.001 | -0.031 | -0.531 |
| | (0.068) | (0.067) | (0.023) | (0.068) | (0.399) |
| SaleGR | 0.179*** | 0.158*** | 0.050*** | 0.179*** | 0.356* |
| | (0.039) | (0.035) | (0.011) | (0.039) | (0.192) |
| EPSGR | 0.006 | 0.006 | 0.001* | 0.006 | 0.009* |
| | (0.004) | (0.004) | (0.001) | (0.004) | (0.005) |
| Leverage | -0.018 | 0.002 | -0.022 | -0.018 | 0.156 |
| | (0.044) | (0.047) | (0.030) | (0.044) | (0.382) |
| Log PPE | -0.009 | 0.028 | -0.021*** | -0.009 | -0.250*** |
| | (0.027) | (0.029) | (0.005) | (0.027) | (0.086) |
| ROE | 0.001*** | 0.001*** | 0.001*** | 0.001*** | 0.005*** |
| | (0.001) | (0.000) | (0.000) | (0.001) | (0.001) |
| Invest/A | -0.122 | 0.097 | 0.345** | -0.122 | 5.788*** |
| | (0.318) | (0.285) | (0.157) | (0.318) | (2.081) |
| Constant | -0.029 | 0.132 | 0.014 | -0.029 | 2.048*** |
| | (0.101) | (0.108) | (0.033) | (0.101) | (0.405) |
| Observations | 50,014 | 49,966 | 50,014 | 50,014 | 50,014 |
| R-squared | 0.228 | 0.249 | 0.378 | 0.228 | 0.418 |
| Industry | Yes | Yes | Yes | Yes | Yes |
| Month-Year | Yes | Yes | Yes | Yes | Yes |
| Clustering | Yes | Yes | Yes | Yes | Yes |

# INTERNET APPENDIX

## Table IA1: Industries by Percentage of Vendor-Estimated Emissions Figures

This table presents the full list of industries in our sample, along with the percentage of observations that are Trucost-estimated (rather than firm-disclosed). The table is sorted from highest to lowest according to the percentage of emissions observations that are estimated rather than disclosed. We define a firm to have estimated emissions if its scope 1 emissions are estimated by Trucost.

| GICS | Industry | Distinct Firms | Firm-Month Observations | % Obs. with Estimated Emissions |
|---|---|---|---|---|
| 401020 | Thrifts & Mortgage Finance | 42 | 2,414 | 100 |
| 253020 | Diversified Consumer Services | 23 | 1,998 | 100 |
| 402040 | Mortgage Real Estate Investment Trusts | 34 | 1,674 | 100 |
| 351030 | Health Care Technology | 19 | 1,023 | 100 |
| 255010 | Distributors | 6 | 541 | 100 |
| 203050 | Transportation Infrastructure | 1 | 60 | 100 |
| 551020 | Gas Utilities | 11 | 937 | 99 |
| 501020 | Wireless Telecommunication Services | 7 | 691 | 97 |
| 352010 | Biotechnology | 179 | 8,087 | 93 |
| 151020 | Construction Materials | 7 | 689 | 93 |
| 402010 | Diversified Financial Services | 5 | 349 | 93 |
| 502010 | Media | 47 | 4,787 | 91 |
| 201030 | Construction & Engineering | 27 | 2,059 | 91 |
| 401010 | Banks | 230 | 14,427 | 90 |
| 201070 | Trading Companies & Distributors | 33 | 2,400 | 90 |
| 502020 | Entertainment | 20 | 1,579 | 90 |
| 255020 | Internet & Direct Marketing Retail | 25 | 1,864 | 89 |
| 202020 | Professional Services | 35 | 2,520 | 88 |
| 303020 | Personal Products | 12 | 874 | 86 |
| 601010 | Equity Real Estate Investment Trusts | 168 | 13,429 | 85 |
| 255040 | Specialty Retail | 84 | 7,492 | 85 |
| 252010 | Household Durables | 43 | 3,686 | 85 |
| 101010 | Energy Equipment & Services | 52 | 4,028 | 84 |
| 402020 | Consumer Finance | 25 | 1,641 | 83 |
| 451030 | Software | 118 | 6,880 | 82 |
| 452030 | Electronic Equipment, Instruments & Components | 53 | 4,294 | 82 |
| 201040 | Electrical Equipment | 29 | 2,532 | 82 |
| 601020 | Real Estate Management & Development | 18 | 1,151 | 81 |
| 551040 | Water Utilities | 9 | 836 | 80 |
| 351010 | Health Care Equipment & Supplies | 92 | 6,277 | 79 |
| 403010 | Insurance | 70 | 7,621 | 78 |
| 402030 | Capital Markets | 65 | 6,199 | 78 |
| 351020 | Health Care Providers & Services | 60 | 5,053 | 78 |
| 502030 | Interactive Media & Services | 17 | 1,173 | 78 |
| 252020 | Leisure Products | 17 | 1,214 | 77 |
| 451020 | IT Services | 71 | 5,419 | 76 |
| 202010 | Commercial Services & Supplies | 51 | 4,455 | 76 |
| 252030 | Textiles, Apparel & Luxury Goods | 26 | 2,136 | 76 |
| 251010 | Auto Components | 24 | 1,737 | 73 |
| 201060 | Machinery | 93 | 8,395 | 72 |
| 253010 | Hotels, Restaurants & Leisure | 72 | 6,012 | 72 |
| 151040 | Metals & Mining | 33 | 3,242 | 71 |
| 352020 | Pharmaceuticals | 59 | 2,920 | 71 |
| 501010 | Diversified Telecommunication Services | 18 | 1,364 | 71 |
| 201020 | Building Products | 25 | 1,858 | 70 |
| 201010 | Aerospace & Defense | 33 | 2,818 | 68 |
| 452010 | Communications Equipment | 34 | 2,419 | 68 |
| 453010 | Semiconductors & Semiconductor Equipment | 64 | 5,739 | 66 |
| 352030 | Life Sciences Tools & Services | 24 | 2,159 | 65 |

| | | | | |
|---|---|---|---|---|
| 203040 | Road & Rail | 28 | 2,346 | 64 |
| 255030 | Multiline Retail | 12 | 1,785 | 64 |
| 201050 | Industrial Conglomerates | 6 | 793 | 64 |
| 101020 | Oil, Gas & Consumable Fuels | 98 | 8,355 | 61 |
| 203010 | Air Freight & Logistics | 11 | 1,008 | 61 |
| 301010 | Food & Staples Retailing | 20 | 1,885 | 59 |
| 151050 | Paper & Forest Products | 7 | 435 | 54 |
| 302020 | Food Products | 38 | 3,761 | 49 |
| 151010 | Chemicals | 59 | 4,967 | 47 |
| 302030 | Tobacco | 6 | 477 | 47 |
| 151030 | Containers & Packaging | 16 | 2,376 | 44 |
| 251020 | Automobiles | 6 | 810 | 44 |
| 203030 | Marine | 3 | 276 | 43 |
| 452020 | Technology Hardware, Storage & Peripherals | 19 | 1,871 | 40 |
| 302010 | Beverages | 11 | 1,860 | 39 |
| 303010 | Household Products | 9 | 1,049 | 28 |
| 551050 | Independent Power and Renewable Electricity Producers | 5 | 469 | 19 |
| 551030 | Multi-Utilities | 15 | 2,114 | 7 |
| 203020 | Airlines | 11 | 872 | 7 |
| 551010 | Electric Utilities | 27 | 3,568 | 5 |

## Table IA2: Replication of Garvey et al. (2018)

This table replicates the main specification in Garvey et al. (2018), regressing future ROA on current ROA, firm fundamentals, and the change in scope 1 carbon emissions. We introduce the following variables not used in the main text: sales/assets, which is the ratio of a firm's net sales to total assets, and sales growth, which is the dollar change in annual firm sales normalized by prior-yearsales. All variables are winsorized at the 1% level. In columns (1)-(4), we include month-year fixed effects; in column (5), we include both industry and month-year fixed effects. Please refer to Appendix A for variable definitions. We report standard errors in parentheses beneath coefficient estimates. *, **, and *** indicate statistical significance at 10% ,5%, and 1% levels, respectively.

| | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| | Future | Future | Future | Future | Future |
| VARIABLES | ROA | ROA | ROA | ROA | ROA |
| ROA | 0.843*** | 0.880*** | 0.851*** | 0.851*** | 0.817*** |
| | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) |
| Sales / Assets | 1.093*** | 1.052*** | 0.790*** | 0.764*** | 1.388*** |
| | (0.023) | (0.022) | (0.022) | (0.022) | (0.031) |
| Change in Scope 1 | | | | | |
| Carbon Intensity | -0.280*** | -0.198*** | -0.142*** | -0.119*** | -0.128*** |
| | (0.023) | (0.023) | (0.022) | (0.022) | (0.023) |
| Sales Growth | | 0.044*** | 0.050*** | 0.045*** | 0.048*** |
| | | (0.000) | (0.000) | (0.000) | (0.000) |
| Log Sales | | | | 0.571*** | 0.627*** |
| | | | | (0.010) | (0.011) |
| Constant | 0.017 | -0.682*** | -4.665*** | -4.650*** | -5.376*** |
| | (0.022) | (0.023) | (0.067) | (0.073) | (0.083) |
| Observations | 181,283 | 181,271 | 181,223 | 181,211 | 181,211 |
| R-squared | 0.769 | 0.784 | 0.789 | 0.791 | 0.797 |
| Month-year | No | No | No | Yes | Yes |
| Industry | No | No | No | No | Yes |

## Table IA3: Are Future Returns Associated with Emissions?

This table provides results from estimating regressions of future stock returns on the natural logarithm of scope 1, 2, and 3 emissions and including the full set of control variables. The dependent variable in all columns is monthly stock returns for month *t*+1, expressed as a percentage. Please refer to Appendix A for variable definitions. All specifications include industry and month-year fixed effects, and standard errors are clustered by industry and month-year. We report standard errors in parentheses. *, **, and *** indicate statistical significance at 10%, 5%, and 1% levels, respectively.

| | (1) | (2) | (3) |
|---|---|---|---|
| VARIABLES | Ret(t+1) | Ret(t+1) | Ret(t+1) |
| | | | |
| Log Scope 1 | -0.022 | | |
| | (0.035) | | |
| Log Scope 2 | | -0.029 | |
| | | (0.049) | |
| Log Scope 3 | | | 0.032 |
| | | | (0.095) |
| Log Sales | 0.019 | 0.030 | -0.030 |
| | (0.077) | (0.087) | (0.107) |
| HHI | -0.512 | -0.501 | -0.522 |
| | (1.109) | (1.114) | (1.114) |
| SaleGR | -0.251* | -0.251* | -0.252* |
| | (0.129) | (0.130) | (0.129) |
| EPSGR | -0.002 | -0.002 | -0.002 |
| | (0.012) | (0.012) | (0.012) |
| Leverage | 0.278 | 0.279 | 0.281 |
| | (0.352) | (0.351) | (0.351) |
| Log PPE | -0.046 | -0.049 | -0.054 |
| | (0.055) | (0.053) | (0.055) |
| ROE | 0.000 | 0.000 | 0.000 |
| | (0.002) | (0.002) | (0.002) |
| Invest/A | 1.173 | 1.229 | 1.208 |
| | (1.619) | (1.600) | (1.615) |
| Constant | 1.345*** | 1.335*** | 1.141* |
| | (0.474) | (0.503) | (0.645) |
| Observations | 166,923 | 166,923 | 166,923 |
| R-squared | 0.193 | 0.193 | 0.193 |
| Industry | Yes | Yes | Yes |
| Month-Year | Yes | Yes | Yes |
| Clustering | Yes | Yes | Yes |