

Are carbon emissions associated with stock returns?*

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March 8, 2021

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 CO₂), 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 CO₂ 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 Kacperczyk (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 CO₂ (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 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:

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

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 θ_i and γ_t denote firm and year fixed effects, respectively.

The presence of the firm fixed effect θ_i means that the coefficient α_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 α_1 to be statistically insignificant. Conversely, if Trucost estimates are systematically biased upward (downward), we would expect α_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 of 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:

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

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 γ_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 as 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 Margin_{it}, which is the ratio of earnings before interest and taxes by sales for firm *i* in year *t*; (ii) EBITDA Margin_{it}, which is the ratio of earnings before interest, taxes, depreciation, and amortization by sales for firm *i* in year *t*; (iii) 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) 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 (γ_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 CO₂ 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 CO₂ 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.

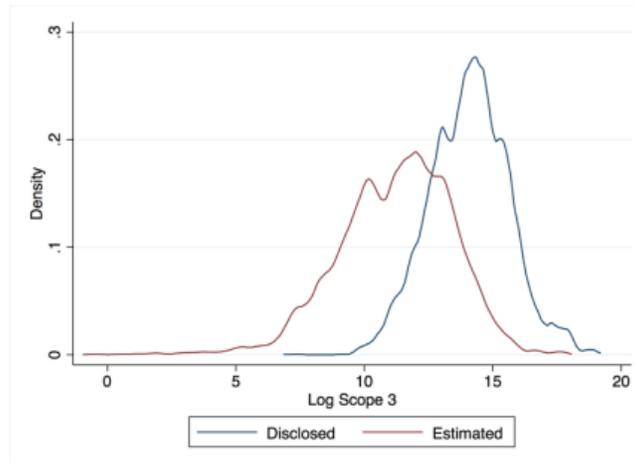
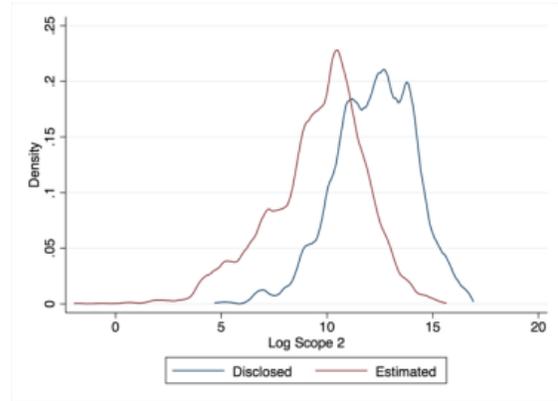
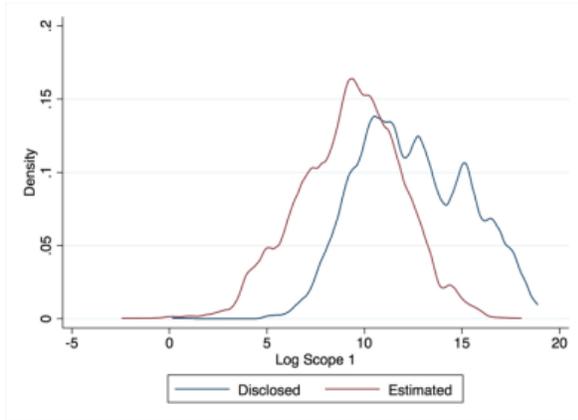


Table 1: Sample Selection

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	Thriffs & 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.

Year	Carbon Emissions			Carbon Intensity		
	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	Thriffs & 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	Thriffs & 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

Year	Full Sample		Disclosed Values		Estimated Values		% Observations with Estimated Values
	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	Thriffs & 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 10
452020	Technology Hardware, Storage & Peripherals	19	1,871	40	
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.

VARIABLES	(1) Log Scope 1	(2) Log Scope 2	(3) Log Scope 3	(4) Log Scope 1	(5) Log Scope 2	(6) Log Scope 3
Scope 1 Estimated Indicator	0.379*** (0.069)			0.485*** (0.068)		
Scope 2 Estimated Indicator		-0.242*** (0.064)			-0.141** (0.061)	
Scope 3 Estimated Indicator			-0.141*** (0.031)			-0.040*** (0.013)
Log Sales				0.877*** (0.044)	0.876*** (0.045)	1.011*** (0.032)
HHI				-0.008 (0.209)	0.092 (0.168)	-0.102 (0.116)
Book to Market				0.017 (0.032)	0.048 (0.035)	0.002 (0.020)
SaleGR				0.139*** (0.027)	0.119*** (0.025)	0.113*** (0.024)
EPSGR				-0.000 (0.001)	-0.003*** (0.001)	0.000 (0.001)
Leverage				0.020 (0.096)	-0.056 (0.094)	-0.021 (0.058)
Log PPE				0.057** (0.027)	0.106*** (0.028)	0.039** (0.019)
ROE				0.000 (0.000)	-0.000 (0.000)	0.000 (0.000)
Invest/A				-0.353 (0.325)	0.284 (0.378)	-0.473*** (0.170)
Constant				3.381*** (0.280)	2.939*** (0.275)	4.255*** (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.

<i>Returns by:</i>		Sales Quintile				
		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
<i>t</i> -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.

<i>Number of firm-month obs. in:</i>		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)	
Scope 1 Emissions Quintile	1=Low	2,093	938	60	240	23,574	6,800	1,344	4,985	161	2,582	138	42,915
	2	3,700	3,747	436	771	7,135	7,489	4,466	9,026	167	5,851	70	42,858
	3	2,122	9,630	1,466	1,281	2,701	4,924	8,660	6,544	777	4,152	578	42,835
	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)	
Scope 1 Emissions Quintile	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
	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
	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
	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
<i>t</i> -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	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
Weighted Returns	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.

VARIABLES	(1) Ret	(2) Ret	(3) Ret	(4) Ret	(5) Ret	(6) Ret
Log Scope1	-0.027*** (0.008)			-0.008 (0.011)		
Log Scope2		-0.035*** (0.010)			-0.001 (0.017)	
Log Scope3			-0.035*** (0.010)			0.018 (0.022)
Log Sale				-0.052*** (0.019)	-0.060** (0.024)	-0.083*** (0.030)
Constant	1.372*** (0.085)	1.453*** (0.105)	1.515*** (0.126)	1.566*** (0.108)	1.556*** (0.111)	1.498*** (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.

VARIABLES	(1) Ret	(2) Ret	(3) Ret	(4) Ret	(5) Ret	(6) Ret
Log Scope 1	-0.038*** (0.008)	-0.027*** (0.008)	-0.008 (0.011)	0.006 (0.011)	0.030** (0.013)	0.024* (0.012)
Log Sale			-0.052*** (0.019)	-0.057*** (0.019)	0.024 (0.024)	-0.081*** (0.020)
Leverage				-0.681*** (0.122)		
Log PPE					-0.127*** (0.021)	
Invest / A						-3.641*** (0.643)
Constant	1.484*** (0.088)	1.372*** (0.085)	1.566*** (0.108)	1.625*** (0.109)	1.384*** (0.120)	1.595*** (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.

VARIABLES	(1) Ret	(2) Ret	(3) Ret	(4) Ret	(5) Ret	(6) Ret	(7) Ret	(8) Ret	(9) Ret
Log Scope 1	0.052*** (0.014)			-0.015 (0.023)			-0.015 (0.026)		
Log Scope 2		0.066*** (0.020)			-0.014 (0.029)			-0.014 (0.039)	
Log Scope 3			0.056** (0.025)			-0.025 (0.043)			-0.025 (0.064)
Log Sales	-0.081*** (0.028)	-0.124*** (0.034)	-0.108*** (0.037)	-0.086** (0.037)	-0.083* (0.043)	-0.072 (0.054)	-0.086 (0.068)	-0.083 (0.081)	-0.072 (0.088)
HHI	-0.309* (0.185)	-0.339* (0.185)	-0.327* (0.185)	-1.472*** (0.446)	-1.471*** (0.446)	-1.474*** (0.446)	-1.472** (0.587)	-1.471** (0.587)	-1.474** (0.586)
SaleGR	0.946*** (0.063)	0.943*** (0.063)	0.947*** (0.063)	0.943*** (0.065)	0.943*** (0.065)	0.944*** (0.065)	0.943*** (0.223)	0.943*** (0.224)	0.944*** (0.224)
EPSGR	0.011 (0.007)	0.011 (0.007)	0.011 (0.007)	0.010 (0.007)	0.010 (0.007)	0.010 (0.007)	0.010 (0.011)	0.010 (0.011)	0.010 (0.011)
Leverage	-0.450*** (0.134)	-0.463*** (0.135)	-0.410*** (0.134)	-0.646*** (0.149)	-0.646*** (0.149)	-0.649*** (0.150)	-0.646* (0.340)	-0.646* (0.340)	-0.649* (0.338)
Log PPE	-0.045* (0.024)	-0.017 (0.023)	-0.024 (0.023)	0.021 (0.029)	0.019 (0.029)	0.019 (0.029)	0.021 (0.045)	0.019 (0.044)	0.019 (0.045)
ROE	0.011*** (0.001)	0.011*** (0.001)	0.011*** (0.001)	0.011*** (0.001)	0.011*** (0.001)	0.011*** (0.001)	0.011*** (0.002)	0.011*** (0.002)	0.011*** (0.002)
Invest/A	-3.817*** (0.749)	-3.755*** (0.750)	-3.364*** (0.734)	-5.017*** (0.877)	-4.991*** (0.878)	-5.022*** (0.877)	-5.017*** (1.577)	-4.991*** (1.595)	-5.022*** (1.582)
Constant	1.565*** (0.130)	1.580*** (0.130)	1.471*** (0.152)	2.169*** (0.184)	2.155*** (0.181)	2.225*** (0.243)	2.169*** (0.374)	2.155*** (0.389)	2.225*** (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								
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.

VARIABLES	(1) Ret	(2) Ret	(3)	(4) Ret	(5) Ret	(6)	(7) Ret	(8) Ret	(9)
Carbon Intensity Scope 1	0.012* (0.006)			0.007 (0.009)			0.007 (0.010)		
Carbon Intensity Scope 2		0.142* (0.073)			-0.023 (0.095)			-0.023 (0.140)	
Carbon Intensity Scope 3			0.012 (0.017)			-0.027 (0.031)			-0.027 (0.030)
Log Sales	-0.037 (0.027)	-0.045* (0.026)	-0.049* (0.026)	-0.094*** (0.033)	-0.098*** (0.033)	-0.098*** (0.033)	-0.094 (0.057)	-0.098* (0.057)	-0.098 (0.059)
HHI	-0.304 (0.186)	-0.300 (0.186)	-0.324* (0.186)	-1.476*** (0.446)	-1.475*** (0.446)	-1.481*** (0.446)	-1.476** (0.588)	-1.475** (0.589)	-1.481** (0.587)
SaleGR	0.946*** (0.063)	0.946*** (0.063)	0.946*** (0.063)	0.943*** (0.065)	0.942*** (0.065)	0.941*** (0.065)	0.943*** (0.224)	0.942*** (0.224)	0.941*** (0.223)
EPSGR	0.011 (0.007)	0.011 (0.007)	0.011 (0.007)	0.010 (0.007)	0.010 (0.007)	0.010 (0.007)	0.010 (0.011)	0.010 (0.011)	0.010 (0.011)
Leverage	-0.386*** (0.133)	-0.405*** (0.134)	-0.385*** (0.133)	-0.648*** (0.149)	-0.648*** (0.150)	-0.651*** (0.150)	-0.648* (0.340)	-0.648* (0.340)	-0.651* (0.339)
Log PPE	-0.033 (0.025)	-0.025 (0.023)	-0.020 (0.023)	0.015 (0.029)	0.019 (0.029)	0.019 (0.029)	0.015 (0.043)	0.019 (0.043)	0.019 (0.045)
ROE	0.011*** (0.001)	0.011*** (0.001)	0.011*** (0.001)	0.011*** (0.001)	0.011*** (0.001)	0.011*** (0.001)	0.011*** (0.002)	0.011*** (0.002)	0.011*** (0.002)
Invest/A	-3.120*** (0.727)	-3.288*** (0.731)	-3.140*** (0.727)	-4.965*** (0.879)	-5.005*** (0.877)	-5.059*** (0.879)	-4.965*** (1.560)	-5.005*** (1.593)	-5.059*** (1.580)
Constant	1.637*** (0.129)	1.632*** (0.129)	1.648*** (0.129)	2.107*** (0.171)	2.130*** (0.172)	2.163*** (0.176)	2.107*** (0.404)	2.130*** (0.399)	2.163*** (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								
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*** (0.107)			0.524*** (0.108)			0.524*** (0.170)		
Scope 2 Growth		0.216** (0.096)			0.180* (0.097)			0.180 (0.135)	
Scope 3 Growth			0.955*** (0.174)			0.870*** (0.176)			0.870* (0.473)
Log Sales	-0.007 (0.028)	-0.004 (0.028)	-0.009 (0.028)	-0.054 (0.035)	-0.057 (0.035)	-0.060* (0.035)	-0.054 (0.054)	-0.057 (0.053)	-0.060 (0.053)
HHI	-0.271 (0.194)	-0.235 (0.194)	-0.259 (0.194)	-1.533*** (0.468)	-1.541*** (0.468)	-1.516*** (0.468)	-1.533** (0.585)	-1.541*** (0.580)	-1.516*** (0.574)
SaleGR	0.672*** (0.087)	0.836*** (0.087)	0.570*** (0.099)	0.636*** (0.089)	0.795*** (0.089)	0.544*** (0.101)	0.636** (0.254)	0.795*** (0.278)	0.544** (0.256)
EPSGR	0.017** (0.007)	0.017** (0.007)	0.016** (0.007)	0.014* (0.007)	0.014* (0.007)	0.014* (0.007)	0.014 (0.012)	0.014 (0.012)	0.014 (0.013)
Leverage	-0.182 (0.142)	-0.161 (0.142)	-0.162 (0.142)	-0.550*** (0.160)	-0.536*** (0.160)	-0.547*** (0.160)	-0.550 (0.334)	-0.536 (0.333)	-0.547 (0.334)
Log PPE	-0.021 (0.025)	-0.025 (0.025)	-0.018 (0.025)	0.028 (0.031)	0.029 (0.031)	0.033 (0.031)	0.028 (0.046)	0.029 (0.046)	0.033 (0.046)
ROE	0.011*** (0.001)	0.011*** (0.001)	0.011*** (0.001)	0.012*** (0.001)	0.012*** (0.001)	0.011*** (0.001)	0.012*** (0.002)	0.012*** (0.002)	0.011*** (0.002)
Invest/A	-4.077*** (0.784)	-3.911*** (0.784)	-4.069*** (0.784)	-5.309*** (0.948)	-5.233*** (0.948)	-5.427*** (0.949)	-5.309*** (1.664)	-5.233*** (1.660)	-5.427*** (1.609)
Constant	1.192*** (0.141)	1.180*** (0.141)	1.176*** (0.141)	1.602*** (0.184)	1.610*** (0.184)	1.604*** (0.184)	1.602*** (0.461)	1.610*** (0.458)	1.604*** (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								
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.

VARIABLES	(1) Ret	(2) Ret	(3) Ret	(4) Ret	(5) Ret	(6) Ret	(7) Ret	(8) Ret	(9) Ret
Change in Scope 1 Intensity	0.032 (0.039)			0.045 (0.040)			0.045 (0.056)		
Change in Scope 2 Intensity		0.183 (0.251)			0.173 (0.252)			0.173 (0.288)	
Change in Scope 3 Intensity			-0.315*** (0.106)			-0.332*** (0.107)			-0.332 (0.210)
Log Sales	-0.007 (0.028)	-0.005 (0.028)	-0.007 (0.028)	-0.058 (0.035)	-0.058 (0.035)	-0.061* (0.035)	-0.058 (0.053)	-0.058 (0.053)	-0.061 (0.053)
HHI	-0.239 (0.194)	-0.233 (0.194)	-0.219 (0.194)	-1.552*** (0.468)	-1.549*** (0.468)	-1.539*** (0.468)	-1.552*** (0.580)	-1.549*** (0.580)	-1.539*** (0.578)
SaleGR	0.957*** (0.069)	0.956*** (0.069)	0.943*** (0.069)	0.896*** (0.072)	0.895*** (0.072)	0.879*** (0.072)	0.896*** (0.258)	0.895*** (0.259)	0.879*** (0.254)
EPSGR	0.017** (0.007)	0.017** (0.007)	0.017** (0.007)	0.014* (0.007)	0.014* (0.007)	0.014* (0.007)	0.014 (0.012)	0.014 (0.012)	0.014 (0.012)
Leverage	-0.162 (0.142)	-0.162 (0.142)	-0.163 (0.142)	-0.536*** (0.160)	-0.536*** (0.160)	-0.531*** (0.160)	-0.536 (0.334)	-0.536 (0.334)	-0.531 (0.335)
Log PPE	-0.022 (0.025)	-0.024 (0.025)	-0.025 (0.025)	0.030 (0.031)	0.030 (0.031)	0.031 (0.031)	0.030 (0.046)	0.030 (0.046)	0.031 (0.046)
ROE	0.011*** (0.001)	0.011*** (0.001)	0.011*** (0.001)	0.012*** (0.001)	0.012*** (0.001)	0.012*** (0.001)	0.012*** (0.002)	0.012*** (0.002)	0.012*** (0.002)
Invest/A	-3.886*** (0.783)	-3.883*** (0.783)	-3.922*** (0.784)	-5.191*** (0.948)	-5.194*** (0.948)	-5.207*** (0.948)	-5.191*** (1.666)	-5.194*** (1.668)	-5.207*** (1.665)
Constant	1.196*** (0.141)	1.193*** (0.141)	1.200*** (0.141)	1.622*** (0.184)	1.620*** (0.184)	1.625*** (0.184)	1.622*** (0.460)	1.620*** (0.459)	1.625*** (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								
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.

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

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

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

VARIABLES	Disclosed			Estimated		
	(1) Ret	(2) Ret	(3) Ret	(4) Ret	(5) Ret	(6) Ret
Change in Scope 1 Intensity	0.026 (0.034)			0.097 (0.095)		
Change in Scope 2 Intensity		0.200 (0.213)			0.419 (0.716)	
Change in Scope 3 Intensity			-0.352*** (0.124)			-0.272* (0.155)
Log Sales	-0.099** (0.048)	-0.094** (0.048)	-0.095** (0.048)	0.009 (0.036)	0.010 (0.036)	0.008 (0.036)
HHI	-0.181 (0.258)	-0.166 (0.258)	-0.153 (0.258)	-0.210 (0.258)	-0.209 (0.258)	-0.195 (0.259)
SaleGR	1.152*** (0.188)	1.151*** (0.188)	1.090*** (0.188)	0.955*** (0.078)	0.954*** (0.078)	0.946*** (0.079)
EPSGR	0.020* (0.012)	0.020* (0.012)	0.020* (0.012)	0.017* (0.009)	0.017* (0.009)	0.017* (0.009)
Leverage	-0.334 (0.264)	-0.340 (0.264)	-0.347 (0.264)	-0.133 (0.172)	-0.130 (0.172)	-0.131 (0.172)
Log PPE	0.053 (0.040)	0.049 (0.039)	0.046 (0.039)	-0.049 (0.032)	-0.050 (0.032)	-0.050 (0.032)
ROE	0.006*** (0.001)	0.006*** (0.001)	0.006*** (0.001)	0.013*** (0.001)	0.013*** (0.001)	0.013*** (0.001)
Invest/A	-6.352*** (1.222)	-6.348*** (1.222)	-6.357*** (1.221)	-3.197*** (0.983)	-3.214*** (0.983)	-3.266*** (0.983)
Constant	1.655*** (0.319)	1.636*** (0.319)	1.661*** (0.319)	1.179*** (0.179)	1.179*** (0.179)	1.179*** (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* (0.194)	0.405* (0.218)	0.008 (0.005)	0.368* (0.194)	-0.055** (0.025)
Log Sales	0.034 (0.040)	0.002 (0.044)	0.031*** (0.006)	0.034 (0.040)	0.136** (0.064)
HHI	0.798 (0.534)	0.843 (0.572)	0.032 (0.040)	0.798 (0.534)	-0.413 (0.286)
SaleGR	0.144 (0.128)	0.169 (0.133)	-0.001 (0.007)	0.144 (0.128)	0.309*** (0.107)
EPSGR	-0.006** (0.003)	-0.006** (0.003)	-0.000 (0.000)	-0.006** (0.003)	0.013*** (0.003)
Leverage	0.247 (0.238)	0.308 (0.263)	-0.009 (0.026)	0.247 (0.238)	-0.295 (0.245)
Log PPE	-0.189* (0.111)	-0.187 (0.128)	-0.020*** (0.005)	-0.189* (0.111)	-0.201*** (0.058)
ROE	0.008*** (0.002)	0.008*** (0.003)	0.001*** (0.000)	0.008*** (0.002)	0.004*** (0.001)
Invest/A	2.478* (1.391)	2.751* (1.481)	0.432*** (0.113)	2.478* (1.391)	7.729*** (1.622)
Constant	-3.345** (1.523)	-3.494** (1.659)	-0.167** (0.063)	-3.345** (1.523)	2.583*** (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.

VARIABLES	(1) EBIT Margin	(2) EBITDA Margin	(3) ROA	(4) ROS	(5) Tobin's Q
Scope 1 Intensity	0.009 (0.006)	0.009 (0.006)	-0.000 (0.000)	0.009 (0.006)	-0.004 (0.005)
Log Sales	0.313* (0.157)	0.301* (0.170)	0.037*** (0.008)	0.313* (0.157)	0.093 (0.059)
HHI	0.900 (0.624)	0.949 (0.668)	0.034 (0.041)	0.900 (0.624)	-0.428 (0.281)
SaleGR	0.161 (0.161)	0.189 (0.172)	-0.001 (0.008)	0.161 (0.161)	0.306*** (0.110)
EPSGR	-0.007** (0.004)	-0.008** (0.004)	-0.000 (0.000)	-0.007** (0.004)	0.013*** (0.003)
Leverage	0.264 (0.260)	0.322 (0.284)	-0.009 (0.025)	0.264 (0.260)	-0.297 (0.246)
Log PPE	-0.107 (0.072)	-0.087 (0.081)	-0.018*** (0.005)	-0.107 (0.072)	-0.212*** (0.059)
ROE	0.008*** (0.003)	0.009*** (0.003)	0.001*** (0.000)	0.008*** (0.003)	0.004*** (0.001)
Invest/A	2.354* (1.388)	2.556* (1.448)	0.428*** (0.115)	2.354* (1.388)	7.732*** (1.612)
Constant	-2.219** (1.003)	-2.238** (1.069)	-0.143*** (0.052)	-2.219** (1.003)	2.423*** (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 (0.147)	0.205 (0.161)	0.001 (0.006)	0.185 (0.147)	0.251*** (0.083)
Log Sales	0.283* (0.144)	0.267* (0.155)	0.037*** (0.008)	0.283* (0.144)	0.094 (0.060)
HHI	0.888 (0.616)	0.921 (0.647)	0.036 (0.042)	0.888 (0.616)	-0.412 (0.277)
SaleGR	0.089 (0.144)	0.111 (0.150)	-0.002 (0.009)	0.089 (0.144)	0.186 (0.118)
EPSGR	-0.007* (0.004)	-0.008** (0.004)	-0.000 (0.000)	-0.007* (0.004)	0.012*** (0.004)
Leverage	0.297 (0.265)	0.351 (0.282)	-0.006 (0.023)	0.297 (0.265)	-0.287 (0.232)
Log PPE	-0.088 (0.062)	-0.065 (0.070)	-0.018*** (0.005)	-0.088 (0.062)	-0.210*** (0.060)
ROE	0.008*** (0.003)	0.008*** (0.003)	0.001*** (0.000)	0.008*** (0.003)	0.004*** (0.001)
Invest/A	2.054* (1.170)	2.243* (1.194)	0.444*** (0.131)	2.054* (1.170)	7.655*** (1.671)
Constant	-2.077** (0.967)	-2.073** (1.023)	-0.143*** (0.053)	-2.077** (0.967)	2.387*** (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.

VARIABLES	(1) EBIT Margin	(2) EBITDA Margin	(3) ROA	(4) ROS	(5) Tobin's Q
Change in Scope 1 Intensity	0.004 (0.009)	0.010 (0.009)	-0.003 (0.002)	0.004 (0.009)	0.002 (0.012)
Log Sales	0.282* (0.143)	0.265* (0.154)	0.037*** (0.008)	0.282* (0.143)	0.092 (0.060)
HHI	0.881 (0.612)	0.913 (0.643)	0.036 (0.042)	0.881 (0.612)	-0.422 (0.277)
SaleGR	0.180 (0.168)	0.212 (0.178)	-0.002 (0.008)	0.180 (0.168)	0.310*** (0.110)
EPSGR	-0.007* (0.004)	-0.008** (0.004)	-0.000 (0.000)	-0.007* (0.004)	0.012*** (0.004)
Leverage	0.302 (0.269)	0.357 (0.287)	-0.006 (0.023)	0.302 (0.269)	-0.280 (0.231)
Log PPE	-0.087 (0.062)	-0.064 (0.069)	-0.018*** (0.005)	-0.087 (0.062)	-0.209*** (0.060)
ROE	0.008*** (0.003)	0.008*** (0.003)	0.001*** (0.000)	0.008*** (0.003)	0.004*** (0.001)
Invest/A	2.097* (1.207)	2.291* (1.235)	0.444*** (0.131)	2.097* (1.207)	7.713*** (1.682)
Constant	-2.070** (0.962)	-2.065** (1.017)	-0.143*** (0.053)	-2.070** (0.962)	2.397*** (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)
	EBIT	EBITDA			
VARIABLES	Margin	Margin	ROA	ROS	Tobin's Q
Log Scope 1	-0.001 (0.008)	-0.004 (0.008)	-0.004 (0.003)	-0.001 (0.008)	-0.089*** (0.033)
Log Sales	0.033 (0.027)	-0.010 (0.029)	0.027*** (0.006)	0.033 (0.027)	0.197* (0.099)
HHI	-0.050 (0.089)	-0.089 (0.089)	-0.000 (0.024)	-0.050 (0.089)	-0.578 (0.390)
SaleGR	0.173*** (0.051)	0.149*** (0.042)	0.048*** (0.013)	0.173*** (0.051)	0.314* (0.182)
EPSGR	0.006 (0.004)	0.006 (0.004)	0.001* (0.001)	0.006 (0.004)	0.009* (0.005)
Leverage	-0.022 (0.053)	-0.000 (0.058)	-0.025 (0.031)	-0.022 (0.053)	0.115 (0.361)
Log PPE	-0.009 (0.029)	0.031 (0.032)	-0.018*** (0.005)	-0.009 (0.029)	-0.182** (0.077)
ROE	0.001*** (0.000)	0.001*** (0.000)	0.001*** (0.000)	0.001*** (0.000)	0.005*** (0.001)
Invest/A	-0.047 (0.313)	0.166 (0.284)	0.359** (0.144)	-0.047 (0.313)	5.774*** (2.078)
Constant	-0.082 (0.147)	0.088 (0.149)	0.023 (0.034)	-0.082 (0.147)	2.372*** (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 (0.002)	0.001 (0.002)	-0.001 (0.000)	0.001 (0.002)	-0.005 (0.006)
Log Sales	0.034 (0.031)	-0.009 (0.033)	0.024*** (0.006)	0.034 (0.031)	0.159* (0.094)
HHI	-0.047 (0.092)	-0.084 (0.091)	0.002 (0.023)	-0.047 (0.092)	-0.518 (0.372)
SaleGR	0.174*** (0.051)	0.151*** (0.042)	0.049*** (0.012)	0.174*** (0.051)	0.345* (0.187)
EPSGR	0.006 (0.004)	0.006 (0.004)	0.001* (0.001)	0.006 (0.004)	0.010* (0.005)
Leverage	-0.024 (0.054)	-0.003 (0.060)	-0.025 (0.031)	-0.024 (0.054)	0.110 (0.374)
Log PPE	-0.011 (0.027)	0.026 (0.030)	-0.020*** (0.005)	-0.011 (0.027)	-0.241*** (0.085)
ROE	0.001*** (0.000)	0.001*** (0.000)	0.001*** (0.000)	0.001*** (0.000)	0.005*** (0.001)
Invest/A	-0.035 (0.319)	0.185 (0.292)	0.357** (0.144)	-0.035 (0.319)	5.818*** (2.043)
Constant	-0.093 (0.130)	0.067 (0.130)	0.012 (0.033)	-0.093 (0.130)	2.083*** (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.

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

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

VARIABLES	(1) Future ROA	(2) Future ROA	(3) Future ROA	(4) Future ROA	(5) Future ROA
ROA	0.843*** (0.001)	0.880*** (0.001)	0.851*** (0.001)	0.851*** (0.001)	0.817*** (0.001)
Sales / Assets	1.093*** (0.023)	1.052*** (0.022)	0.790*** (0.022)	0.764*** (0.022)	1.388*** (0.031)
Change in Scope 1 Carbon Intensity	-0.280*** (0.023)	-0.198*** (0.023)	-0.142*** (0.022)	-0.119*** (0.022)	-0.128*** (0.023)
Sales Growth		0.044*** (0.000)	0.050*** (0.000)	0.045*** (0.000)	0.048*** (0.000)
Log Sales				0.571*** (0.010)	0.627*** (0.011)
Constant	0.017 (0.022)	-0.682*** (0.023)	-4.665*** (0.067)	-4.650*** (0.073)	-5.376*** (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.

VARIABLES	(1) Ret(t+1)	(2) Ret(t+1)	(3) 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 (0.077)	0.030 (0.087)	-0.030 (0.107)
HHI	-0.512 (1.109)	-0.501 (1.114)	-0.522 (1.114)
SaleGR	-0.251* (0.129)	-0.251* (0.130)	-0.252* (0.129)
EPSGR	-0.002 (0.012)	-0.002 (0.012)	-0.002 (0.012)
Leverage	0.278 (0.352)	0.279 (0.351)	0.281 (0.351)
Log PPE	-0.046 (0.055)	-0.049 (0.053)	-0.054 (0.055)
ROE	0.000 (0.002)	0.000 (0.002)	0.000 (0.002)
Invest/A	1.173 (1.619)	1.229 (1.600)	1.208 (1.615)
Constant	1.345*** (0.474)	1.335*** (0.503)	1.141* (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