The Effect of Mandatory Carbon Disclosure Along Global Supply Chains

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Abstract

We examine whether and how mandatory carbon disclosure affects the transmission of carbon emissions through a firm's global supply chain. Our analysis uses the 2013 UK carbon disclosure regulation that requires the reporting of Scopes 1 and 2 emissions (from firms' own activities and purchased energy) but not Scope 3 emissions (from purchased goods and services). We find that affected UK firms exhibit a decrease in reported Scopes 1 and 2 emissions, but an increase in estimated Scope 3 emissions and a shift of emissions from Scope 1 to 3 following the disclosure mandate. Investigation of Scope 1 emissions of suppliers further supports the finding that affected UK firms outsource emissions to foreign suppliers. Additionally, this increase in Scope 1 emissions is more pronounced among foreign suppliers with stronger and longer relationships with affected UK firms and in industries with fewer customers. Our findings highlight the importance of considering corporate supply chains when implementing mandatory carbon disclosures.

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1. Introduction

Climate change is a pressing global issue with far-reaching societal implications. To enhance investors' ability to assess climate-related risks, the US SEC recently proposed mandating climate-related disclosures by large US public companies (Gensler 2022). The inclusion of Scope 3 emissions, also referred to as value chain emissions, is a particularly contentious issue relating to the SEC's proposal (Rosenbaum 2021; Vanderford 2023).[1] Proponents argue that the disclosure of Scope 3 emissions is necessary to fully reveal companies' climate risks and address their full carbon footprints. Critics, however, argue that measuring and disclosing Scope 3 emissions is burdensome and costly and could expose proprietary information about companies' supply chains. Using the 2013 carbon disclosure mandate in the United Kingdom, we examine whether and how carbon disclosure regulation that does not mandate reporting of Scope 3 emissions affects the carbon footprints throughout firms' global supply chains.

In 2013, the United Kingdom enacted The Companies Act 2006 (Strategic Report and Directors' Report) Regulations 2013. This act requires publicly listed UK companies to disclose the annual quantity of Scopes 1 and 2 emissions in their annual reports. The disclosure mandate increases the availability and salience of the information on a firm's carbon emissions and is commonly used in research to test the real effects of carbon disclosure regulations. Consistent with the notion that increased public scrutiny incentivizes firms to reduce reported emissions, studies find that affected firms decrease Scopes 1 and 2 emissions following the disclosure mandate

[1] We use the terms "carbon emissions" and "GHG emissions" interchangeably. The SEC proposed mandating disclosures of Scope 1 emissions (direct emissions from production) and Scope 2 emissions (indirect emissions from consumption of purchased energy). The proposal only requires disclosure of Scope 3 emissions (indirect emissions from upstream and downstream activities of a company's value chain) if these emissions are "material." This has sparked debate because Scope 3 emissions represent most of the carbon footprints for most companies. According to a 2021 report by the Carbon Disclosure Project (CDP), Scope 3 emissions are on average 11.4 times higher than the sum of Scopes 1 and 2 emissions (CDP 2021).

(Downar et al. 2021; Jouvenot and Krueger 2021). However, there is little evidence on how the disclosure mandate affects Scope 3 emissions and the transmission of emissions along firms' supply chains.

Decarbonization measures can be costly (McKinsey & Company 2009). In response, firms may resort to shifting emissions to suppliers as a quicker and cheaper way of reducing the mandatorily reported direct emissions.[2] Thus, we hypothesize that Scope 3 emissions of affected UK firms increase following the UK carbon disclosure mandate. As the volumes of Scopes 1 and 3 emissions are positively correlated due to firm size, we further hypothesize that shifting emissions from Scope 1 to 3, which causes a decrease in Scope 1 emissions but an increase in Scope 3 emissions, will reduce the positive correlation between Scopes 1 and 3 emissions following the disclosure mandate.[3]

There are also arguments against our predictions. First, the increased monitoring of a firm's emissions following the disclosure mandate may transmit a positive effect along a firm's supply chain. Bolton and Kacperczyk (2021a) find that the UK carbon disclosure mandate improves disclosure practices of peer firms in countries with geographic and economic proximity to the United Kingdom. Second, the disclosure mandate may enhance firms' awareness of climate-related risks. Heightened awareness may encourage firms to strive to reduce emissions across various dimensions, such as discontinuing emissions-intensive production and monitoring suppliers to improve environmental practices (Dai, Liang, and Ng 2021). Third, emission shifting is more difficult across different firms than within the same firm (Ben-David et al. 2021). Suppliers may

[2] For example, firms may outsource production and services rather than discontinue these activities, which are more harmful to profits. They may also sell gas power plants to suppliers, rather than retrofit these plants. Even if firms choose to switch to energy efficient equipment, the switch can increase emissions upstream if they use low-cost suppliers with a carbon intensive production. We focus on emission shifting to a firm's foreign suppliers rather than subsidiaries, because the reported Scope 1 emissions encompass a firm's global operations.

[3] Following Dai et al. (2022), we examine only upstream Scope 3 emissions, which are associated with purchased materials. Throughout the paper, Scope 3 emissions refer to *upstream* Scope 3 emissions.

resist an increase in their emissions to avoid jeopardizing support from other stakeholders (e.g., regulators, employees, and investors).

We test our predictions using a difference-in-differences research design that covers five years before and five years after the enactment of the UK carbon disclosure mandate. To ensure that our results are not driven by changes in firm characteristics, we use a balanced sample that requires affected UK firms to have at least one year of observation in both the pre- and post-mandate periods. For the benchmark sample, we choose firms that are incorporated in the European Economic Area (EEA) countries and listed in the same set of stock exchanges as the affected UK firms, because these firms are likely subject to potential confounding regulations and economic shocks as UK firms. Our sample consists of 843 firms (7,729 firm-years) from 2008 to 2018, including 321 treatment firms (2,978 treatment firm-years) and 522 benchmark firms (4,751 benchmark firm-years).

Our carbon emissions data come from S&P Trucost, which provides broad coverage and is widely used by international organizations (e.g., United Nations Environment Program Finance Initiative) and prior studies (e.g., Azar et al. 2021; Bolton and Kacperczyk 2021b). Trucost collects carbon emissions from firms' public disclosures in annual reports, corporate websites, CDP surveys, or estimates the emissions when firms do not publicly disclose. Unlike Scopes 1 and 2 emissions, which are straightforward to measure and commonly disclosed, Scope 3 emissions are hard to measure and rarely disclosed by firms.[4] Aswani et al. (2023) argue that the vendor-estimated emissions appear rather naïve because most of the variation is associated with firm size,

[4] Busch, Johnson, and Pioch (2020) find that Scope 1 data are highly consistent between data providers with an average correlation coefficient of 0.97. In contrast, Scope 3 data are less frequently provided by data providers and less consistently estimated.

growth, industry membership, and time. To address this concern, we include firm and year fixed effects that control for time-invariant firm characteristics and time-varying macro conditions.

We find that, relative to benchmark firms, treatment firms reduce their Scopes 1 and 2 emissions following the UK carbon disclosure mandate. We further find that treatment firms exhibit an increase in Scope 3 emissions and a shift of emissions from Scope 1 to 3. Our assessment of the parallel trends assumption indicates that the increase in Scope 3 emissions and the shifting of emissions occur in the years following the disclosure mandate. These results hold up to a variety of robustness checks.

The effect is also economically significant. Relative to benchmark firms, treatment firms experience a 4.3 percent increase in Scope 3 emissions following the disclosure mandate. Before the mandate, a one percent reduction in Scope 1 emissions is associated with 0.113 percent and 0.177 percent reductions in Scope 3 emissions for treatment and benchmark firms, respectively. Afterward, consistent with the emissions shifting in treatment firms, a one percent reduction of Scope 1 emissions is associated with only a 0.086 percent reduction in Scope 3 emissions for treatment firms, while the association for benchmark firms remains at 0.176 percent. We find little change in the total emissions (Scope 1 + Scope 2 + Scope 3) of treatment firms following the disclosure mandate, suggesting that the increase in Scope 3 emissions offsets the decrease in Scopes 1 and 2 emissions.

To address concerns about the validity of Trucost's estimations of Scope 3 emissions, we examine changes in suppliers' Scope 1 emissions, which are less prone to vendor-estimation errors. If our treatment firms reduce Scope 1 emissions by shifting emissions to Scope 3, we should observe an increase in their suppliers' Scope 1 emissions because suppliers' Scope 1 emissions contribute to firms' upstream Scope 3 emissions. We find that Scope 1 emissions of non-UK

suppliers for our treatment firms but not non-UK suppliers for our benchmark firms increase following the disclosure mandate.[5] Moreover, in contrast to non-UK suppliers, UK (domestic) suppliers for our treatment firms, which are also subject to the disclosure mandate, decrease Scope 1 emissions afterward.

Additionally, we investigate the impact of the disclosure mandate on financial operating performance. Since firms are likely to pay higher prices to suppliers to compensate for the outsourcing of emissions, we expect an increase in the cost of goods sold, and we find that. We also find that, compared to benchmark firms, treatment firms experience an increase in sales revenue, leading to an insignificant change in the gross profit margin following the disclosure mandate. The increases in the cost of goods sold and sales are positively associated with the increase in Scope 3 emissions, suggesting that the emission shifting is associated with both higher purchasing costs and sales revenue.

Last, we explore factors that may impact UK firms' incentives and abilities to outsource emissions and their foreign suppliers' willingness to accept those emissions. We expect that the outsourcing prevails among UK firms with higher Scope 1 emissions before the mandate, because they face greater pressure to reduce emissions. We also expect outsourcing to be greater among UK firms with fewer environmental policies and weaker shareholder monitoring or when UK firms have a smaller proportion of suppliers that are publicly listed or located in countries with strong environmental protection. Our analysis confirms these expectations.

Regarding the publicly listed foreign suppliers of our treatment firms, we find that the increase in Scope 1 emissions after the disclosure mandate is more pronounced among the foreign suppliers with stronger and longer relationships with the UK firms and in industries with fewer

[5] This analysis focuses on publicly listed suppliers due to the data availability of private firms. To the extent that firms are more likely to shift emissions to private suppliers, we underestimate the impact of the emission outsourcing.

customers. These findings suggest that firms are more likely to outsource emissions to foreign suppliers with closer relationships and weaker bargaining power.

We contribute to the literature in several ways. First, we document the effects of mandatory carbon disclosure on unreported emissions and provide policy implications. Studies suggest that firms improve environmental and social performance following sustainability disclosure regulations (e.g., Christensen et al. 2017; Chen, Hung, and Wang 2018; Fiechter, Hitz, and Lehmann 2022; Tomar 2023).[6] Unlike a broad sustainability disclosure mandate that lacks standardized reporting requirements, the UK carbon disclosure mandate requires specific emission measures to facilitate comparison and benchmarking. Exploring the effects of the disclosure mandate, Downar et al. (2021) document a decrease in firms' Scope 1 emissions but no change in their financial operating performance. Jouvenot and Krueger (2021) find a decrease in firms' Scopes 1 and 2 emissions but no change in Scope 3 emissions.[7] We complement these studies by showing that the UK carbon disclosure mandate results in an increase in unreported Scope 3 emissions, thereby neutralizing the impact on firms' overall carbon footprints.

Our findings speak to the importance of considering supply chains when designing and implementing carbon disclosure regulations. Given the urgency of climate risks, regulators worldwide are taking steps to require or encourage climate-related disclosures.[8] Our findings

[6] We use the terms "sustainability disclosure," "corporate social responsibility (CSR) disclosure," and "environmental, social and governance (ESG) disclosure" interchangeably.

[7] The treatment sample of Jouvenot and Krueger (2021) includes only UK voluntary adopters that have GHG emission data from Refinitiv (formerly Assets 4). We include both voluntary and mandatory adopters in our treatment sample and use carbon emission data from the S&P Trucost, which has a broader coverage.

[8] In June 2023, the International Sustainability Standard Board (ISSB) published an inaugural set of two standards, IFRS S1 (General Requirements for Disclosure of Sustainability-related Financial Information) and IFRS S2 (Climate-related Disclosures). On July 25 of the same year, International Organization of Securities Commissions (IOSCO) endorsed the ISSB standards and called on its 130 member jurisdictions, which regulate more than 95% of the world's financial markets, to consider ways in which they might adopt these standards.

underscore the need for global cooperation in mandating disclosure of direct emissions for all corporations (Bolton et al. 2021; Mahieux, Sapra, and Zhang 2023).

Second, our study complements the growing literature that examines the effect of sustainability information on supply-chain contracting. Darendeli et al. (2022) find that firms are less likely to contract with low-CSR suppliers after an exogenous change in CSR rating coverage that reveals their type. She (2022) documents that suppliers' human rights performance improves following the California mandate that requires firms to disclose their due diligence in ensuring suppliers' compliance with labor laws. Cho et al. (2023) show a reduction in suppliers' Scope 1 emissions after one of their major customers begins disclosing Scope 3 emissions. Lu et al. (2023) suggest that firms strategically select new suppliers from countries with opaque ESG reporting environments following the adoption of mandatory ESG disclosures worldwide. Our study differs by documenting the impact of mandating firms' carbon emission disclosures on the emission performance of their suppliers.

Finally, we add to the literature that examines carbon leakage in response to environmental regulations and policies. Most of these studies focus on within-firm carbon leakage and suggest that firms transfer emissions to unregulated facilities (Yang Muller, and Liang 2021; Bartram, Hou, and Kim 2022; Jiang 2023). The evidence on carbon leakage across firms, however, is relatively weak. Ben-David et al. (2021) find little evidence that carbon leakage occurs among firms' foreign suppliers. Using transaction-level import information for US firms, Dai et al. (2022) document a substitutional relationship between a firm's Scopes 1 and 3 emissions following exogenous shocks to regulatory stringency (e.g., inspections by the US Environmental Protection Agency). Our study extends this literature by documenting that UK firms shift emissions following the carbon disclosure mandate and by demonstrating the changes in their suppliers' Scope 1 emissions.

2. Institutional background and hypothesis development

2.1 Institutional background

The Companies Act 2006 (Strategic Report and Directors' Report) Regulations 2013 came into effect on October 1, 2013. The act requires UK-incorporated companies listed on the Main Market of the London Stock Exchange, an exchange in an EEA country, the New York Stock Exchange, or Nasdaq to report annual carbon emissions for fiscal years ending on or after September 30, 2013 in the annual report (as part of the Directors' Report).[9] The affected firms are required to report annual carbon emissions in metric tonnes of carbon dioxide equivalent, along with a ratio expressing carbon emissions in relation to the company's activities, such as sales or assets.

The disclosure requirements are formulated using the GHG Protocol Corporate Accounting and Reporting Standard (GHG Protocol), an internationally recognized framework for reporting (DEFRA 2012a). The UK government further issued guidance specifying acceptable methodologies to measure carbon emissions (e.g., Standard 14064-1 of the International Organization for Standardization), the reporting boundary (global carbon emission for the entire organization), and the covered period (the 12 months corresponding to the firm's fiscal year). In addition, as part of the Directors' Report, the disclosures of carbon emissions must be approved by the board of directors and reviewed by auditors. These procedures safeguard the carbon disclosure quality (Downar et al. 2021; Jouvenot and Krueger 2021).

[9] The disclosure mandate exempts small firms that meet at least two of the following criteria: 1) a turnover lower than GBP 6.5 million, 2) a balance sheet total lower than GBP 3.26 million, and 3) an average number of employees lower than 50. Since the companies listed on the main market of the London Stock Exchange are predominantly large and medium-sized companies, very few firms approach these thresholds.

The disclosure mandate requires affected companies to report their Scopes 1 and 2 emissions but not Scope 3 emissions. Scope 1 emissions are the direct emissions generated by a firm from owned or controlled sources, e.g., combustion of fuels in stationary buildings and equipment and vehicles. Scope 2 emissions relate to emissions generated from purchased electricity, heat, steam, or cooling that are consumed within the boundary of the firm. Scopes 1 and 2 emissions are straightforward to measure and report (Bolton and Kacperczyk 2021b; Lu, Serafeim, and Toffel 2022), because they can be determined by invoices for fuels consumed (for Scope 1) and electricity purchased (for Scope 2).[10] Appendix A presents excerpts from the annual report of one of our treatment firms, Norcros, following the adoption of the UK carbon disclosure mandate.

Scope 3 emissions cover the indirect emissions outside a firm's boundary, which mainly relate to the upstream and downstream emissions embodied in the goods and services in a firm's supply chain. According to the consultation report from the UK government (DEFRA 2012b), 86% (1,730) of the respondents support the mandatory inclusion of some Scope 3 emissions disclosure. However, more than 1,600 of the supporters are individuals, prompted by the Christian Aid campaign. Among institutions (e.g., companies, institutional investors, and trade associations), only 20% support the inclusion. The supporters note that Scope 3 disclosure is necessary to understand company activities and can prevent companies from reducing their emissions by outsourcing. Opponents of the Scope 3 disclosure, however, raise the following main concerns: 1) inconsistent methodologies, 2) collation costs, 3) inaccuracy, 4) difficulty in gathering information, and 5) double counting. In the end, the UK government decided not to require reporting of Scope 3 emissions because doing so could impose excessive costs on businesses.

[10] According to the GHG protocol, Scope 1 emissions are calculated based on the purchased quantities of commercial fuels using published emission factors, and Scope 2 primarily from metered electricity consumption and supplier-specific, local grid, or other published emission factors (GHG Protocol 2004).

Figure 1 plots the percentages of disclosed and estimated emissions for our sample firms in the year prior to (Year t-1) and following (Year t+0) the implementation of the disclosure mandate. It shows that the proportion of firms voluntarily disclosing Scope 1 emissions is about 60% for the treatment firms (Panel A) and 69% for the benchmark firms (Panel B) in Year t-1. In contrast, less than 6% of the treatment or benchmark firms disclose Scope 3 emissions. In Year t+0, while the treatment firms are mandated to disclose Scope 1 emissions, the proportion of benchmark firms disclosing Scope 1 emissions increases slightly to 71%.[11] The disclosure of Scope 3 emissions remains less than 6%.

2.2 Hypothesis development

Studies suggest that the UK carbon disclosure mandate improves transparency and enhances stakeholder monitoring, thereby leading to a reduction in the reported emissions of the affected firms (Downar et al. 2021; Jouvenot and Krueger 2021). The decrease in emissions is also economically significant, even for firms that already voluntarily report their carbon emissions to the CDP prior to 2013. These studies suggest that firms may take several measures to reduce the mandatorily reported Scopes 1 and 2 emissions, such as reducing the use of energy, investing in energy-efficient equipment or switching from fossil fuel to renewable alternatives. They conclude that the disclosure mandate leads to a real effect in reducing corporate carbon emissions.

We posit, however, the increased pressure for cutting direct emissions can also motivate firms to outsource emissions, diminishing the effect of the disclosure mandate on firms' total carbon footprints. By shifting the emissions out of a firm's own operations, i.e., Scope 1 emissions,

[11] We classify a firm into the subsample of estimated emissions if Trucost notes that the emissions are based on estimated data, except for the treatment firms in Year t+0. Despite the mandatory disclosures, there are 38 treatment firms where Trucost uses estimated data for Scope 1 emissions for the first adopting year, instead of the exact values from the annual report. This is likely because Trucost questions the validity and coverage of the reported numbers and therefore chooses to provide estimates. According to Trucost, when the disclosed emissions are lower than their estimates, it would reach out to the firms and have the volume of emissions corrected. Additional analysis (untabulated) finds that our result is robust to excluding these 38 firms.

to those of suppliers, i.e., Scope 3 emissions, firms can reduce the mandatorily reported emissions at the expense of the undisclosed emissions. While estimates of Scope 3 emissions may be available to market participants by subscribing the data from ESG data providers, the information on these estimates can be difficult to access and understand. By enhancing stakeholder monitoring of direct emissions, the carbon disclosure mandate may inadvertently incentivize firms to shift emissions to measures that are not widely monitored.

Emission shifting differs from the expense shifting documented in the literature (McVay 2006), because it involves changes in firms' operations and cooperation with other firms (i.e., suppliers). While firms have other options of cutting direct emissions, emission outsourcing is likely quicker and cheaper (Levinson 2023).[12] For example, firms may cut direct emissions by discontinuing the production of certain goods, but they will lose revenues associated with these goods. In comparison, outsourcing the production is less costly. Firms may also switch to more fuel-efficient engines or materials, but producing these new engines and materials may cause more carbon emissions among the suppliers of these products (*The Economist* 2023). Instead of compensating or selecting suppliers that use clean energy to reduce firms' total emissions, firms may choose low-cost, carbon-intensive suppliers. Consequently, our first hypothesis is as follows:

Hypothesis 1: Scope 3 emissions of customer firms increase following the UK carbon disclosure mandate.

If firms outsource emissions from Scope 1 to 3, these firms' reductions of Scope 1 emissions should be associated with their increases in Scope 3 emissions. Because the total volumes of Scope 1 and 3 emissions relate positively due to firm size, we expect a decrease in this relation following the disclosure mandate. Our second hypothesis is as follows:

[12] Also see "You've heard of Outsourced Jobs, but Outsourced Pollution? It is Real, and Tough to Tally Up" https://www.nytimes.com/2018/09/04/climate/outsourcing-carbon-emissions.html).

Hypothesis 2: The relation between Scope 1 and Scope 3 emissions is reduced following the UK carbon disclosure mandate.

Note that information about Scope 1 emissions of individual installations (e.g., power plants or steel mills) was already available prior to the 2013 mandate, and a substantial portion of UK firms already reported Scope 1 emissions to the CDP. The disclosure mandate nonetheless affects voluntary reporting firms, likely because it "pilloried" these firms to the extent that their emissions became more accessible and transparent and the emission information of non-voluntary reporting firms became available (Downar et al. 2021; Tomar 2023).

There are also reasons why we may not find an increase in Scope 3 emissions following the UK carbon disclosure mandate. To begin with, the requirement to disclose carbon emissions may enhance firms' supply chains because stakeholder monitoring becomes more intensive. Bolton and Kacperczyk (2021a) document that the disclosure mandate spills over to emission reductions among peer firms in other countries. Additionally, the requirement may improve firms' awareness of climate-related risks and incentivize them to monitor their suppliers. Dai et al. (2021) suggest that socially responsible customers motivate comparable behaviors among their suppliers. Suppliers may also be mindful about accepting the outsourcing of environmentally detrimental production that significantly increases their own emissions because they desire the support of their other stakeholders, such as regulators and employees.

3. Sample and descriptive statistics

3.1 Sample

The UK carbon disclosure mandate requires UK-incorporated companies whose equity shares are listed on the Main Market of the London Stock Exchange, an exchange in an EEA country, the New York Stock Exchange, or Nasdaq to disclose their Scopes 1 and 2 emissions for

fiscal years ending on or after September 30, 2013. We include UK-incorporated firms listed in the affected stock exchanges as our treatment sample. We use other European companies incorporated in the 30 EEA countries and listed in the same set of affected stock exchanges of the treatment sample as our benchmark sample.[13] Note that the implementation of the disclosure mandate happened in the same year as the transition of the EU Emissions Trading Scheme (ETS) to its third period from 2013 to 2020 (Downar et al. 2021). Using other EU firms as the benchmark sample mitigates the potential confounding effect of the EU ETS transition. Our event window covers 2008 and 2018 fiscal years, five fiscal years before and five fiscal years after the effective year of the disclosure mandate.[14]

Table 1 Panel A describes sample selection. We start from the population of companies in S&P's Global Vantage that meet the above requirements of stock exchange listing status and sample period. We then remove firms in financial industries (i.e., SIC codes between 6000 and 6999), and firms without required control variables for regression analysis. Next we merge the data with Trucost to obtain emissions data (where Scope 3 emissions are limited to the upstream emissions). Our full sample comprises 1,853 firms (10,484 firm-years) during fiscal years 2008 and 2018, including 494 firms (3,427 firm-years) for the treatment sample and 1,359 firms (7,012 firm-years) for the benchmark sample. To ensure that the changes in carbon emissions of treatment firms around the disclosure mandate are not due to changes in the sample composition over time, we require a sample firm to have at least one year of carbon emission data both before and after the mandate. This procedure yields a balanced sample of 843 firms (7,729 firm-years). Among

[13] The EEA countries include 27 EU countries and Iceland, Liechtenstein, and Norway (see https://www.gov.uk/eu-eea#:~:text=The%20European%20Economic%20Area%20(%20EEA,part%20of%20the%20single%20market).

[14] For firms with fiscal years ending between September 30 and December 31, 2013, the first adopting fiscal year is 2013, and the event window covers fiscal years 2008 to 2017. For firms with fiscal years ending between January 1 and September 29, 2014, the first adopting fiscal year is 2014, and the event window covers fiscal years 2009 to 2018.

them, 321 and 522 firms (2,978 and 4,751 firm-years) are in the treatment and benchmark samples, respectively. We use the balanced sample to test our hypotheses and conduct a robustness check for the full sample.

Table 1 Panel B reports the sample distribution by country. It shows that France and Germany have the most observations in the benchmark sample. Panel C reports the sample distribution by event years. By construction, the balanced sample displays a comparable number of observations between pre- and post-mandate periods for both treatment and benchmark samples. In contrast, the full sample shows a significant surge in the number of benchmark firms during Years 3 and 4 (largely corresponding to fiscal years 2016 and 2017). This is likely due to increased coverage by Trucost following the Paris Agreement on climate change, which entered into force in November 2016. Panel D presents the sample distribution by industry (based on NAICS two-digit industry code). It shows that manufacturing (NAICS2=31, 32, 33), information (NAICS2=51), and energy and utilities (NIACS2=21, 22) account for about 44%, 11%, and 9% in both treatment and benchmark samples, representing the top three industry segments in our study.

3.2 Descriptive statistics

Table 2 presents the descriptive statistics for the variables used in our main analysis. We find that treatment firms have less carbon emissions than benchmark firms. In addition, they have a lower percentage of Scope 1 emissions but a higher percentage of Scope 3 emissions, relative to benchmark firms. Concerning operating performance, treatment firms have higher gross profit margin (*GrossMargin*) but lower cost of goods sold (*Ln(COGS)*) and sales revenue (*Ln(SALES)*) than benchmark firms. With respect to other firm characteristics, we observe that treatment firms are smaller (*Ln(Assets)*) and less leveraged (*Leverage*) but more profitable (*ROA*). They also have lower growth opportunities (*TobinQ*) and tangible assets (*Tangibility*) but a higher sales growth

(*Growth*) than benchmark firms. Appendix B provides variable definitions. In our regression analysis, in addition to controlling for these characteristics, we use entropy balancing in a robustness test to address the concern that systematic differences may drive our findings between treatment and benchmark samples.

4. Hypothesis tests

4.1 Mandatory carbon disclosure and firm emissions

We test our first hypothesis regarding the changes in Scope 3 emissions using the following difference-in-differences regression model:

$$Scope3_{i,t} = \beta_0 + \beta_1 Post_{i,t} \times Treat_i + \beta_2 Post_{i,t} + \sum \beta_i Control\ Variables + Firm\ FE + Year\ FE + \varepsilon_{it}, \quad (1)$$

where $Scope3$ is either *Ln(Scope3)*, the natural logarithm of Scope 3 emissions volume or *Propn(Scope3)*, the proportion of Scope 3 emissions out of total emissions (i.e., Scope 1 + Scope 2 + Scope 3 emissions). Each of these measures has its advantages and limitations, so we use both to provide corroborating evidence for our hypotheses. Emissions volume captures a firm's environmental impact but is heavily influenced by firm size and concurrent environmental policies (e.g., the 2015 Paris Agreement). While the proportion of emissions reflects the relative importance of the specific scope of emissions and is immune from the firm size effect, proportions of Scopes 1 and 3 are mechanically and negatively related. *Post* is a dummy variable indicating the post-mandate period. *Treat* is a dummy variable indicating treatment firms. Our first hypothesis predicts a positive coefficient on the interaction term *Post*×*Treat*. We suppress the coefficient on *Treat* because we include firm fixed effects and there is no within-firm variation of *Treat*. We include both *Post* and fiscal-year fixed effects, because *Post* can be set to either one or zero for fiscal year 2013 (i.e., one if a sample firm's fiscal year ends between September 30, 2013, and

December 31, 2013, and zero if a sample firm's fiscal year ends between January 1, 2014, and September 29, 2014). We control firm characteristics reported in Table 2 and adjust standard errors by country and fiscal-year cluster.

We test our second hypothesis regarding the shift of emissions from Scope 1 to Scope 3 using the following regression model:

$$\begin{aligned} Scope3_{i,t} = & \beta_0 + \beta_1 Post_{i,t} \times Treat_i + \beta_2 Scope1_{i,t} + \beta_3 Post_{i,t} \times Treat_i \times Scope1_{i,t} \\ & + \beta_4 Post_{i,t} + \beta_5 Post_{i,t} \times Scope1_{i,t} + \beta_6 Treat_i \times Scope\ 1_{i,t} \\ & + \sum \beta_i Control\ Variables + Firm\ FE + Year\ FE + \varepsilon_{it}, \end{aligned} \quad (2)$$

where $Scope3$ and $Scope1$ are measured as the natural logarithm of Scope 3 and Scope 1 emission volume or the proportion of Scope 3 and Scope 1 emissions out of the total emissions.[15] Our variable of interest is the coefficient on the interaction term $Post_{i,t} \times Treat_i \times Scope1_{i,t}$, β_3. A negative coefficient on β_3 indicates a shifting of emissions from Scope 1 to 3 following the disclosure mandate.

Table 3 presents the regression estimates for our hypothesis tests. Columns (1)–(5) present changes in the volumes of carbon emissions following the disclosure mandate. Columns (1)–(2), where the dependent variables are the volume of Scopes 1 and 2 emissions, show significantly negative coefficients on *Post×Treat*. These results, consistent with the findings in Downar et al. (2021) and Jouvenot and Krueger (2021), indicate that, relative to the benchmark sample, the treatment sample experiences a greater decrease in Scopes 1 and 2 emissions after the disclosure mandate. Importantly, Column (3), where the dependent variable is Scope 3 emissions, shows a significantly positive coefficient on *Post×Treat*. This finding is consistent with our first hypothesis and suggests that, relative to benchmark firms, treatment firms experience a greater increase in

[15] We focus on the substitutional relationship between Scopes 1 and 3 emissions rather than Scopes 2 and 3 emissions, because outsourcing production directly impacts Scopes 1 and 3 emissions. During our sample period, the reduction in Scope 2 emissions could also be driven by the emission charges of the upstream electricity producers (Downar et al. 2021).

Scope 3 emissions after the disclosure mandate. Column (4) uses the total volume of carbon emissions as the dependent variable and reports that the coefficient on *Post*×*Treat* is insignificant at conventional levels, suggesting that the decrease in Scopes 1 and 2 emissions is offset by the increase in Scope 3 emissions.

Column (5) presents the test for our second hypothesis on emission shifting from Scope 1 to Scope 3 after the mandate. Beforehand, the volume of Scope 3 emissions is significantly and positively associated with the volume of Scope 1 emissions, as indicated by the coefficient on *Ln(Scope1)*. This is likely driven by the firm size. Moreover, the coefficient on *Treat*×*Ln(Scope1)* is insignificant at conventional levels, suggesting that treatment and benchmark firms share a comparable association between Scopes 1 and 3 emissions before the disclosure mandate. The coefficient on *Post*×*Ln(Scope1)* is also insignificant at conventional levels, indicating that the association does not change significantly for the benchmark sample following the disclosure mandate. Most importantly, the coefficient on *Post*×*Treat*×*Ln(Scope1)* is significantly negative, suggesting that relative to benchmark firms the association reduces among treatment firms after the disclosure mandate.

The effect is also economically significant. Using coefficient estimates in Column (5) as an example, before the mandate, a one percent reduction of Scope 1 emissions in the treatment sample is associated with a 0.113 percent reduction in Scope 3 emissions.[16] In contrast, after the mandate, a one percent reduction of Scope 1 emissions in the treatment sample is associated with only a 0.086 percent reduction in Scope 3 emissions.[17] Descriptive statistics in Table 2 show that the mean values of the annual volume of Scopes 1 and 3 emissions in the treatment sample are 24,222

[16] 0.113=0.177-0.064, the sum of the coefficients on *Ln(Scope1*) and *Treat*×*Ln(Scope1).*
[17] 0.086=0.177-0.064-0.001-0.026, the sum of the coefficients on *Ln(Scope1)*, *Treat*×*Ln(Scope1)*, *Post*×*Ln(Scope1)*, and *Post*×*Treat*×*Ln(Scope1)*.

(i.e., exp(10.095)) and 157,472 (i.e., exp (11.967)) metric tonnes, respectively. Therefore, before the mandate, every 100 metric tonnes reduction in Scope 1 emissions is associated with 73 metric tonnes reduction in Scope 3 emissions (i.e., 100/24,222×0.113×157,472). In contrast, afterward, every 100 metric tonnes reduction in Scope 1 emissions is associated with only 56 metric tonnes reduction in Scope 3 emissions (i.e., 100/24,222×0.086×157,472). This is consistent with the notion that UK firms attempt to shift their Scope 1 emissions to their suppliers, causing an increase in Scope 3 emissions and weakening the positive association between Scopes 1 and 3 emissions.

Columns (6)–(9) of Table 3 present changes in the proportion of each scope of emissions out of the total emissions. Like Columns (1)–(2), Columns (6)-(7) report significantly negative coefficients on *Post*×*Treat*, indicating a greater reduction in the proportion of Scopes 1 and 2 emissions for the treatment sample than the benchmark sample after the disclosure mandate. Column (8) shows a significantly positive coefficient on *Post*×*Treat*, suggesting that the proportion of Scope 3 emissions increases more for the treatment sample than the benchmark sample after the mandate. Finally, Column (9) presents the shift of emissions from Scope 1 to Scope 3 after the mandate. The negative coefficient on *Propn(Scope1)*, which indicates a negative relation with *Propn(Scope3)*, is expected because both are measured as the proportion of total emissions. The insignificant coefficients on *Treat*×*Propn(Scope1)* and *Post*×*Propn(Scope1)* suggest the relation does not differ between treatment and benchmark samples before the mandate and does not differ between pre- and post-mandate periods for the benchmark sample. The significantly negative coefficient on *Post*×*Treat*×*Propn(Scope1)* suggests that, compared to the benchmark sample, a reduction in the proportion of Scope 1 emissions for the treatment sample is associated with a greater increase in the proportion of Scope 3 emissions afterward. For example, beforehand, a one percent reduction of Scope 1 emissions in the treatment sample is associated

with a 0.827 (=0.782+0.045) percent increase in Scope 3 emissions. In contrast, afterward, a one percent reduction of Scope 1 emissions in the treatment sample is associated with a 0.854 (=0.782+0.045-0.004+0.031) percent increase in Scope 3 emissions.

In sum, consistent with our hypotheses, we find that, compared to benchmark firms in the same economic zone, UK firms subject to the disclosure mandate increase their Scope 3 emissions and shift emissions from Scope 1 to Scope 3. These results are consistent with the notion that UK firms shift emissions to suppliers.

4.2 Parallel trends assumption and robustness checks

We first assess the parallel trends assumption underlying our difference-in-differences regression estimation; i.e., without the treatment effects, the average change in the response variable should have been the same for the treatment and benchmark groups. Following Bertrand and Mullainathan (2003), we replace the *Post* indicator with nine year indicators for Year -*5* to Year -*2* and Year *0* (the effective year) to Year *4*, with Year -*1* being the benchmark year. Columns (1)–(2) and (3)–(4) examine the parallel trends assumption for the level of Scope 3 emissions and the emission shifting between Scopes 1 and 3, respectively. Columns (1) and (2) show that the coefficients on the interaction terms *Year Indicator*×*Treat* are mostly insignificant but sometimes significantly negative during the pre-mandate period. This result indicates that there is no increasing trend with respect to Scope 3 emissions before the mandate. In contrast, the coefficients become significantly positive from Year *1* and Year *0* and afterward in Columns (1) and (2), respectively, suggesting that treatment firms experience larger increases in Scope 3 emissions than benchmark firms after the disclosure mandate.[18] Columns (3)–(4) show that the coefficients on the

[18] In an untabulated analysis, we also examine the parallel trends assumption for Scope 1 emissions. For both the volume and the proportion of Scope 1 emissions, we find that the coefficients on the interaction terms are all insignificant at conventional levels during the pre-mandate period and the coefficients become significantly negative

interaction terms *Scope1×Year Indicator×Treat* are significantly positive when dependent variable is the volume of Scope 3 emissions or mostly insignificant when dependent variable is the proportion of Scope 3 emissions during the pre-mandated period. This suggests that treatment firms do not display stronger emission shifting from Scope 1 to Scope 3 than benchmark firms before the mandate. In contrast, the coefficients become significantly negative from Year *1* and Year *0* and afterward, respectively, suggesting that treatment firms experience stronger emission shifting than benchmark firms after the disclosure mandate. The results are largely consistent with the parallel trends assumption.

We also conduct a set of robustness tests. We re-run the regression model testing our first hypothesis (Columns (3) and (8)) and second hypothesis (Columns (5) and (9)) in Table 3. First, to assess whether our results are robust to narrowing the difference in firm characteristics between treatment and benchmark samples, we re-run the regression using an entropy balanced sample, where we perform the entropy balancing on the first, second, and third moments of the full set of control variables and set the tolerance level at 0.01. Second, we exclude firms that voluntarily disclose Scope 1 emissions from the treatment sample.[19] Third, we exclude Ireland from the benchmark sample, as it had mandated a carbon tax since 2012, which may confound firms' emission incentives during our sample period. Fourth, we expand the analysis to the full sample where a sample firm may have carbon emissions data during either pre- or post-mandate period but not both. Last, we conduct a placebo test by setting fiscal year 2010 as the pseudo carbon disclosure mandating year and 2007–2012 as the six-year pseudo-event window. Panel B of Table

from Year *0*, indicating that there are no increasing or decreasing trends with respect to Scope 1 emissions before the mandate and treatment firms experience greater reductions in Scope 1 emissions afterward.

[19] There are 144 and 279 voluntary reporting firms in our treatment and benchmark samples, respectively.

4 reports the results for these robustness checks. It shows that our findings in Table 3 continue to hold in all the alternative specifications and sample compositions, except for the placebo test.

4.3 Analysis of foreign suppliers

This section examines the effects of the disclosure mandate on Scope 1 emissions of global suppliers. If UK treatment firms reduce their Scope 1 emissions by outsourcing, we expect the Scope 1 emissions of their foreign (non-UK) suppliers to increase. In contrast, we do not expect Scope 1 emissions of non-UK suppliers of our benchmark to increase, because the benchmark firms are not exposed to the emission outsourcing incentives. In addition to providing direct evidence for emissions outsourcing using suppliers' emissions performance, this analysis also mitigates the concern that our results on the increase in Scope 3 emissions following the disclosure mandate may be driven by vendor-estimation errors, because Scope 1 emissions are straightforward to measure and commonly disclosed by firms. Due to the data limitation of private firms in many countries, this analysis includes only publicly listed suppliers. To the extent that firms are more likely to shift emissions to private suppliers, we underestimate the emission outsourcing following the disclosure mandate.

As an additional comparison, we also examine Scope 1 emissions of the UK suppliers of our treatment firms. Because the publicly listed local suppliers face the disclosure mandate themselves, we expect their Scope 1 emissions to decrease (due to greater scrutiny of the reported direct emissions), rather than increase (as treatment firms are unlikely to outsource emissions to their local suppliers).[20]

Table 5 Panel A presents the sample selection procedures to identify our treatment suppliers (i.e., non-UK suppliers of treatment firms) and benchmark suppliers (i.e., non-UK suppliers of

[20] The sample of publicly listed UK local suppliers is a subset of the sample UK treatment firms.

benchmark firms). We use the S&P Global Vantage and FactSet Revere Supply Chain databases to identify all UK incorporated firms that face the UK carbon disclosure mandate and benchmark firms from the EAA countries during 2008 and 2018, disregarding the availability of carbon emission data from Trucost. We first identify 6,900 unique nonfinancial firms, including 1,741 firms incorporated in the United Kingdom and 5,519 firms incorporated in the EAA countries.

Next we identify 9,450 unique firms (90,199 firm-years) that have been suppliers of the above firms during 2008 and 2018. We remove suppliers in the financial industry, incorporated in the United Kingdom, and with missing control variables for regression analysis. We merge the remaining 7,981 suppliers (70,722 supplier-years) with Trucost to obtain their Scope 1 emissions. This procedure excludes 3,257 suppliers (45,351 supplier-years) that do not have any carbon emission information during the sample period. As in our main tests, we develop a balanced sample that requires a supplier to have at least one year of carbon emission data in both pre- and post-mandate periods. This step eliminates 2,702 suppliers (6,867 supplier-years). Last, we remove 456 firms (4,066 firm-years) that have never served as suppliers to any sample firms (neither firms incorporated in the United Kingdom nor firms incorporated in EAA countries) during the post-mandate period. Our final supplier sample consists of 1,566 unique suppliers (14,438 supplier-years), including 891 treatment suppliers (8,303 supplier-years), and 675 benchmark suppliers (6,135 supplier-years).

Table 5 Panel B presents the sample distribution by economy for treatment suppliers and benchmark suppliers. Out of the 37 economies that have at least five suppliers, the United States and Japan are the most popular supplier destinations for both treatment and benchmark samples, followed by France, Germany, and Australia for the treatment sample, and South Korea, China, and Taiwan for the benchmark sample.

Table 5 Panel C reports the regression results. Column (1) reports a significantly positive coefficient on *Post*, while Column (2) reports a significantly negative coefficient on *Post*, suggesting that foreign suppliers to UK firms increase Scope 1 emissions following the disclosure mandate while those not serving UK firms reduce Scope 1 emissions during the same period. Column (3) reports a significantly negative coefficient on *Post*, indicating that UK local suppliers reduce Scope 1 emissions after the disclosure mandate, like the overall UK treatment firms. Taken together, these findings support the inference that UK firms shift their carbon emissions to foreign suppliers after the disclosure mandate.

4.4 The effect of carbon disclosure mandate on financial operating performance

Outsourcing carbon emissions likely involves nontrivial operational adjustments, as firms may pay higher prices to suppliers to compensate for the shifting of emissions. We thus expect UK firms to have a higher cost of goods sold after the disclosure mandate. Correspondingly, UK firms are likely to pass the rising cost of goods sold on to their own clients by charging higher prices, leading to an increase in sales revenue but an insignificant change in gross profit margin after the disclosure mandate. In addition to profit concerns, UK firms' capacities to raise prices are also consistent with consumers' increasing preferences for ethical products (i.e., products manufactured by following labor practices or environmental standards) (Hainmueller, Hiscox, and Sequeria 2015).

Table 6 reports the estimation results for changes in financial operating performance. Columns (1)–(2) report the results for changes in gross profit margin. The coefficient on *Post*×*Treat* differs insignificantly from zero, suggesting that, relative to the benchmark firms, treatment firms experience little change in operating performance after the disclosure mandate. Columns (3)–(4) report the results for changes in the cost of goods sold. Column (3) shows a

significantly positive coefficient on *Post*×*Treat*. This result suggests that, after accounting for Scope 1 emissions, treatment firms experience a significant increase in the cost of goods sold relative to benchmark firms after the disclosure mandate.[21] In contrast, Column (4) shows that, once we further control for Scope 3 emissions, the coefficient on *Post*×*Treat* differs insignificantly from zero and the magnitude of the coefficient is around half of that in Column (3). This suggests that the increase in Scope 3 emissions in treatment firms drives the increase in the cost of goods sold after the disclosure mandate.

Columns (5)–(6) report the results for changes in sales revenue. Similarly, Column (5) reports a significantly positive coefficient on *Post*×*Treat* after controlling for Scope 1 emissions. Once we further control for Scope 3 emissions in Column (6), the coefficient on *Post*×*Treat* differs insignificantly from zero, and the magnitude of the coefficient is less than half of that in Column (5). These findings echo the message that the increase in Scope 3 emissions in treatment firms drives the increase in revenues after the disclosure mandate.[22]

Taken together, the findings in Table 6 indicate that emission outsourcing is associated with an increase in both the cost of goods sold and sales revenues, leading to a minimal impact on gross profit margins.

[21] As a robustness test, we control for the sum of Scopes 1 and 2 emissions in the regressions. The results are qualitatively similar.

[22] We focus on the emissions volume as our primary measure because it captures a firm's impact on the environment. In an additional analysis (untabulated), we find that the carbon intensity, measured as the ratio of carbon emissions volume to total sales, decreases for Scopes 1 and 2 but remains similar for Scope 3. These results are likely an outcome of the decrease (increase) in the volumes of Scopes 1 and 2 emissions (Scope 3 emissions), as documented in Table 3, combined with the increase in sales, as documented in Table 6.

5. Cross-sectional analyses

5.1 Cross-sectional analysis for UK firms' carbon emissions

In this section, we explore four sets of factors that may affect UK firms' incentives and capacities to shift their emissions from Scope 1 to 3. First, since the disclosure mandate improves information transparency and enhances market participants' ability to benchmark and discipline firms, we expect that firms or industries with more Scope 1 emissions beforehand have greater incentives to reduce the emissions afterward. Second, we expect that firms with fewer environmental policies are more likely to outsource emissions, because they have weaker governance to constrain such actions. Third, shareholders that prefer social norms may play different roles in monitoring corporate carbon emissions. Pension funds and independent institutions (e.g., mutual funds) pay more attention to social norms and cater more to the social preferences of their clients (Hong and Kacperczyk 2009; Dyck et al. 2019) than do hedge funds, which focus more on earning short-term financial returns (Brav et al. 2010). So we expect firms with a lower ownership by pension funds and independent institutions face less pressure and monitoring to reduce carbon emissions and thus to be more likely to shift emissions from Scope 1 to 3. In contrast, hedge funds may have minimal impact on firms' carbon emissions. Fourth, we expect that UK firms are more likely to outsource emissions when they have a smaller proportion of suppliers publicly listed or located in countries with strong environment regulations and enforcement, because these suppliers face more scrutiny and therefore are less likely to accept the outsourcing of emissions-intensive production.

To measure firms' Scope 1 emissions before the disclosure mandate, we first collect the Scope 1 emissions during the most recent fiscal year immediately before the effective year for each sample firm. We then partition sample firms within each country-industry based on the two-

digit NAICS industry code provided by the Global Vantage. We classify firms with an emission volume above the country-industry median value as high polluters. Alternatively, we calculate the mean value of Scope 1 emissions of all sample firms within each country-industry. Next we partition all industries within each sample country into two groups. We classify industries with average Scope 1 emissions above the country median value as high polluting industries.

Table 7 Panel A reports the results for the analysis, conditional on firms' Scope 1 emissions. Columns (1)–(4) show that, when we partition sample firms based on firms' Scope 1 emissions, the coefficients on *Post*×*Treat*×*Scope1* are significantly negative among high polluters. Moreover, the chi-squared test reported at the bottom of the panel shows that differences in the coefficients on *Post*×*Treat*×*Scope1* between the two subgroups are significant at the 1% level for both the volume and proportion of Scope 3 emissions. The results based on industry-level Scope 1 emissions are similar (Columns (5)–(8)).

To capture the intensity of a firm's policies to deal with environmental problems and to monitor supply chains for environmental concerns, we collect 33 items related to firm's environmental policies from Refinitiv (formerly Asset4) during the five years before the UK carbon disclosure mandate. Appendix C presents these items, including policies related to reducing toxic emissions in production and operational process (Emission), developing new environmental technologies and processes or eco-designed products (Innovation), and reducing the use of materials, energy or water or improving supply chain management (Resource use). We obtain the environment policies from Refinitiv for 560 sample firms before the disclosure mandate. We count the total number of items for which a firm indicates the presence of a specific environmental policy, with more indicating more intensive environmental protection policies. In addition, we identify five out of the 33 items that relate directly to supply chain management and count the number of

a firm's policies for monitoring supply chains. We then partition the sample firms within each country-industry into high and low environmental protection policy groups, based on the country-industry median value of the number of environmental protection policies or the number of supply chain management policies.

Table 7 Panel B presents the results, conditional on the intensity of a firm's environmental policies and supply chain management policies. Consistent with our expectation that firms with fewer environmental policies have greater incentives to shift carbon emissions, Columns (1)–(4) show that the coefficients on *Post*×*Treat*×*Scope1* are significantly more negative among firms with less intensive environmental policies. The results based on the intensity of supply chain management policies are similar (Columns (5)–(8)).

To capture the intensity of the monitoring by different investors, we calculate the sum of the ownership by pension funds and independent institutions and the ownership by hedge funds, respectively, during the most recent fiscal year immediately before the effective year for each sample firm. We then partition the sample firms within each country-industry into high and low holdings, based on the country-industry median value of these two groups of institutional ownership.

Table 7 Panel C presents the results, conditional on the types of institutional investors. Consistent with our expectation that weaker scrutiny from pension funds and independent institutions offers firms a greater opportunity to shift carbon emissions, Columns (1)–(4) show that the coefficients on *Post*×*Treat*×*Scope1* are significantly more negative among firms with lower ownership by pension funds and independent institutions. In contrast, Columns (5)–(8) suggest that the different levels of ownership by hedge funds make little difference in firms' decisions to shift emissions from Scope 1 to 3.

To measure the visibility of suppliers in a firm's supply chain, for each sample firm, we collect the information on its suppliers during the two fiscal years immediately before the effective year. We can identify suppliers from FactSet database during these two years for 676 sample firms. We count the total number of unique suppliers and the number of publicly listed suppliers and calculate the ratio of the number of public suppliers to the total number of suppliers. Unreported statistics show that the mean ratio of public suppliers to total suppliers is 68% and 71% in the treatment and benchmark sample, respectively. We then partition the sample firms within each country-industry into high and low visibility groups, based on the country-industry median value of the ratio.

To gauge the stringency of supplier countries' environmental regulation and enforcement, for each sample firm, we collect the unique suppliers during the two fiscal years immediately before the effective year and their countries of incorporation. We identify 85 unique supplier countries for our sample firms. Following Ben-David et al. (2021) and Dai et al. (2022), for each supplier country, we obtain the stringency of environmental regulation score (SER score) and enforcement of environmental regulation score (EER score) from World Economic Forum's Travel & Tourism Competitive reports from 2011–2015 (i.e., five years surrounding the effective year). Both scores range between 1 and 7, with a higher value indicating more stringent regulation or enforcement. Because the scores are highly correlated, we follow Ben-David et al. (2021) and combine them into a single variable SEER, which equals (SER×EER)/7. We calculate the mean value of SEER from 2011–2015 for each of the 85 supplier countries, partition these countries into terciles and define countries in the bottom two terciles as those with poor environmental protection.[23] Next, for each sample firm, we calculate the percentage of suppliers from poor

[23] We do not partition the supplier countries based on the median value of the SEER, because about 45% of suppliers of our sample firms are located in the United States. Using median value of SEER to partition supplier countries leads

environmental protection countries. We then classify firms with the percentage above the country-industry median value as having more suppliers from weak environmental protection countries.

Table 7 Panel D presents the results, conditional on the proportion of suppliers that are publicly listed or in countries with weak environmental protection. As predicted, we find that the coefficients on *Post*×*Treat*×*Scope1* are significantly negative only among the low visibility subample, and they are significantly more negative than the coefficients among the high visibility subsample, as indicated by the chi-squared tests. Thus UK firms with a lower proportion of public suppliers are more likely to shift emissions from Scope 1 to 3 after the disclosure mandate. Also consistent with our expectation, the coefficients on *Post*×*Treat*×*Scope1* are more negative among firms with a greater proportion of suppliers from countries with poor environmental protection.

Taken together, the results in Table 7 suggest that environmental pressure, environmental protection policies, shareholders' preferences for social norms, visibility of suppliers, and home-country environmental protection applied to foreign suppliers play an important role in UK firms' incentives and capabilities to outsource emissions.

5.2 Cross-sectional analysis for carbon emissions of UK firms' foreign suppliers

We further examine the cross-sectional differences in the effects of UK carbon disclosure mandate on UK firms' foreign suppliers. We expect that 1) a supplier with a greater proportion of UK customers in its customer portfolios has greater exposure to receiving outsourced emissions from these UK customers; 2) a supplier with a longer relationship with UK customers than other customers in its customer portfolio likely relies more on the UK customers, which weakens its ability to resist UK customers' emissions outsourcing; and 3) a supplier in industries with fewer

to a disproportionally large number of sample firms having suppliers from countries with strong environmental protection.

customers has limited exit options and relatively weak bargaining power, increasing its risk of receiving outsourced emissions from its UK customers.

To measure the proportion of UK customers of a supplier, we identify its unique customers and the respective customer countries during the first three years since the supplier is exposed to the UK disclosure mandate, i.e., [0, 2] period. The proportion is calculated as the ratio of the number of UK customers to the number of all customers. We partition suppliers in each country-industry into high and low subsamples, based on the country-industry median value. To measure the duration of the relationship with UK customers, relative to that with other customers, we identify the duration with each customer until Year 2 after the disclosure mandate, then we calculate the ratio of the sum of durations with all UK customers to the sum of duration with all customers. Again we partition suppliers in each country-industry into high and low subsamples, based on whether the ratio is above the country-industry median value. We count the total number of customers from the global market that belong to an industry (based on the two-digit NAICS code) during 2013 and 2015 and then partition industries based on whether the number of total customers is below the median value.

Table 8 reports the results. Consistent with our expectations, we find that suppliers with a greater proportion of UK customers, a longer relationship with UK customers, or in industries with fewer customers, have a greater increase in Scope 1 emissions after they are exposed to the disclosure mandate. These results suggest that emission outsourcing following the disclosure mandate is more likely to occur among foreign suppliers with closer relationships and weaker bargaining power with UK firms.[24]

[24] By using the same set of suppliers present in both pre- and post-mandate periods, we ensure that changes in the coverage of our databases do not drive the results. Additional analysis (untabulated) finds that, while the numbers of new suppliers for both treatment and benchmark firms increase following the disclosure mandate, there is no evidence

6. Conclusion

We examine the effect of the UK mandatory carbon disclosure on firms' emissions along their global supply chains. The mandate requires firms to disclose carbon emissions from the activities they are responsible for (Scopes 1 and 2) but not other carbon emissions (Scope 3). Using a difference-in-differences design, we find that firms affected by the disclosure mandate reduce their Scopes 1 and 2 emissions but increase their Scope 3 emissions. The decrease in Scope 1 emissions is associated with the increase in Scope 3 emissions following the mandate. Moreover, the reduction in Scopes 1 and 2 emissions is offset by the increase in Scope 3 emissions, leading to an insignificant change in total carbon emissions.

Consistent with the notion of emissions outsourcing, we find that foreign suppliers of the affected UK firms increase their Scope 1 emissions after the disclosure mandate. Our analysis of operating performance reveals that the affected UK firms experience little change in gross profit margin, likely because the rising cost of goods sold induced by the increasing Scope 3 emissions is compensated for with higher sales revenue. We also find that the shift of emissions from Scope 1 to 3 prevails among firms with greater Scope 1 emissions prior to the mandate, fewer environmental policies, lower ownership by pension funds and independent institutions, and a smaller proportion of suppliers that are publicly listed or located in countries with strong environmental protection. Finally, we find that UK firms are more likely to shift emissions to

that the increase is greater for the treatment firms. Thus our result is more consistent with the notion that firms' relationship with their suppliers facilitates emission outsourcing, rather than firms' migration to new suppliers.

foreign suppliers with stronger and longer relationships and in industries with fewer customers are more likely to suffer from UK firms' carbon emission shifting.

Overall our study suggests that customers shift their emissions to their global suppliers following the carbon disclosure regulation that excludes reporting of Scope 3 emissions. These findings highlight the importance of considering corporate supply chains when implementing mandatory carbon disclosures and provide potential policy implications for the formation and design of global carbon disclosure standards. We caution, however, that Scope 3 emissions are relatively noisy and costly to measure. Other mechanisms, such as improving supply chain transparency and coordination among global regulators on climate-related policies, may be worth considering.

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Appendix A
Examples of Emission Disclosures Following the UK Carbon Disclosure Mandate

Norcros Plc Annual Report and Accounts 2014

Greenhouse gas emissions

The Board presents this report in order to meet the Company's obligation under the Companies Act 2006 (Strategic Report and Directors' Reports) Regulations 2013 to disclose the Group's worldwide emissions of the six Kyoto gases attributable to human activity measured in tonnes of carbon dioxide equivalent. As stated in the Corporate Responsibility Report on pages 26 and 27, the Company is committed to reducing and minimising its impact on the environment.

Global GHG emissions data for the year ended 31 March 2014	Tonnes of CO_2e 2014
Emissions from:	
Combustion of fuel and operation of facilities (Scope 1)	64,062
Electricity, heat, steam and cooling purchased for own use (Scope 2)	27,387
Total	**91,449**
Company's chosen intensity measurement[1]	**418.1**

[1] Emissions per £m of revenue.

We have reported on all of the emission sources, being Scope 1 and Scope 2 emissions. These are emissions from activities for which the Group is responsible, plus emissions resulting from the purchase of electricity, heat, steam or cooling by a business in the Group for its own use. This is the first year for which reporting is required. These sources use the same reporting boundary as for our consolidated financial statements. We do not have responsibility for any emission sources that are not included in our consolidated statement.

We have used the GHG Protocol Corporate Accounting and Reporting Standard (revised edition), data gathered to fulfil our requirements under the CRC Energy Efficiency scheme, and emission factors from the UK Government's GHG Conversion Factors for Company Reporting 2014. Where no more suitable data sources are available, we have used, where practicable, estimates based on the appropriate information that is available to the Group.

Appendix B
Variable Definitions

Post	An indicator variable equal to one for fiscal years after September 30, 2013 (post-period for UK carbon disclosure mandate), and zero otherwise.
Treat	An indicator variable equal to one for UK incorporated firms subject to the UK carbon disclosure mandate, and zero otherwise.
Ln(Scope1)	The natural logarithm of Scope 1 emissions, where Scope 1 emissions are direct carbon emissions (in metric tons) that arise from sources controlled or owned by the firm.
Ln(Scope2)	The natural logarithm of Scope 2 emissions, where Scope 2 emissions are indirect emissions (in metric tons) from the generation of purchased electricity, steam, heating and cooling consumed by the firm.
Ln(Scope3)	The natural logarithm of upstream Scope 3 emissions, where upstream Scope 3 emissions are indirect carbon emissions (in metric tons) that mainly occur from the firm's suppliers.
Ln(Total)	The natural logarithm of the sum of Scope 1, 2, and 3 emissions.
Propn(Scope1)	The proportion of Scope 1 emissions out of total emissions (i.e., Scope 1 + Scope 2 + Upstream Scope 3).
Propn(Scope2)	The proportion of Scope 2 emissions out of total emissions (i.e., Scope 1 + Scope 2 + Upstream Scope 3).
Propn(Scope3)	The proportion of upstream Scope 3 emissions out of total emissions (i.e., Scope 1 + Scope 2 + Upstream Scope 3).
GrossMargin	Total revenue minus cost of goods sold, divided by total revenue of a firm-year.
Ln(COGS)	The natural logarithm of cost of goods sold in millions of US dollars of a firm-year.
Ln(SALES)	The natural logarithm of total revenue in millions of US dollars of a firm- year.
Ln(Assets)	The natural logarithm of book value of assets in millions of US dollars at the end of a fiscal year.
TobinQ	Total assets plus the market value of equity minus deferred taxes minus the book value of equity divided by total assets at the end of a fiscal year.
Leverage	Sum of long-term debt and short-term debt, divided by total assets at the end of a fiscal year.
ROA	Earnings before extraordinary items divided by the average total assets at the beginning and the end of a fiscal year.
Growth	Annual percentage change in sales.
Tangibility	Net book value of property, plant, and equipment divided by total assets at the end of a fiscal year.
R&D	Annual R&D expenditure scaled by total assets at the end of a fiscal year, where missing values for R&D expenditure are replaced by zero.

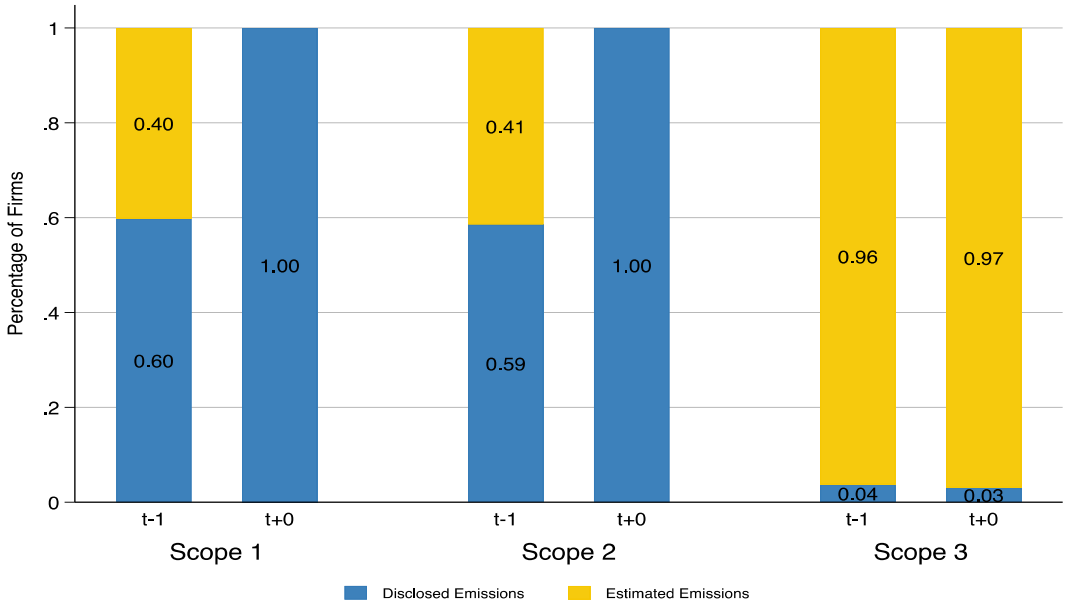
Appendix C
Measures of Environmental Policies

Item	Category	Title
1	Emissions	Biodiversity Impact Reduction
2	Emissions	Climate Change Commercial Risks Opportunities
3	Emissions	Emissions Trading
4	Emissions	Environmental Expenditures Investments
5	Emissions	Environmental Partnerships
6	Emissions	Environmental Restoration Initiatives
7	Emissions	e-Waste Reduction
8	Emissions	NOx and SOx Emissions Reduction
9	Emissions	Policy Emissions
10	Emissions	Staff Transportation Impact Reduction
11	Emissions	Targets Emissions
12	Emissions	VOC or Particulate Matter Emissions Reduction
13	Innovation	Environmental Assets Under Management
14	Innovation	Environmental Products
15	Innovation	Hybrid Vehicles
16	Innovation	Noise Reduction
17	Innovation	Renewable/Clean Energy Products
18	Innovation	Sustainable Building Products
19	Innovation	Water Technologies
20	**Resource Use**	**Environmental Materials Sourcing**
21	**Resource Use**	**Environmental Supply Chain Management**
22	**Resource Use**	**Environmental Supply Chain Monitoring**
23	**Resource Use**	**Env Supply Chain Partnership Termination**
24	Resource Use	Environment Management Team
25	Resource Use	Green Buildings
26	Resource Use	Land Environmental Impact Reduction
27	Resource Use	Policy Energy Efficiency
28	**Resource Use**	**Policy Environmental Supply Chain**
29	Resource Use	Policy Sustainable Packaging
30	Resource Use	Policy Water Efficiency
31	Resource Use	Targets Energy Efficiency
32	Resource Use	Targets Water Efficiency
33	Resource Use	Toxic Chemicals Reduction

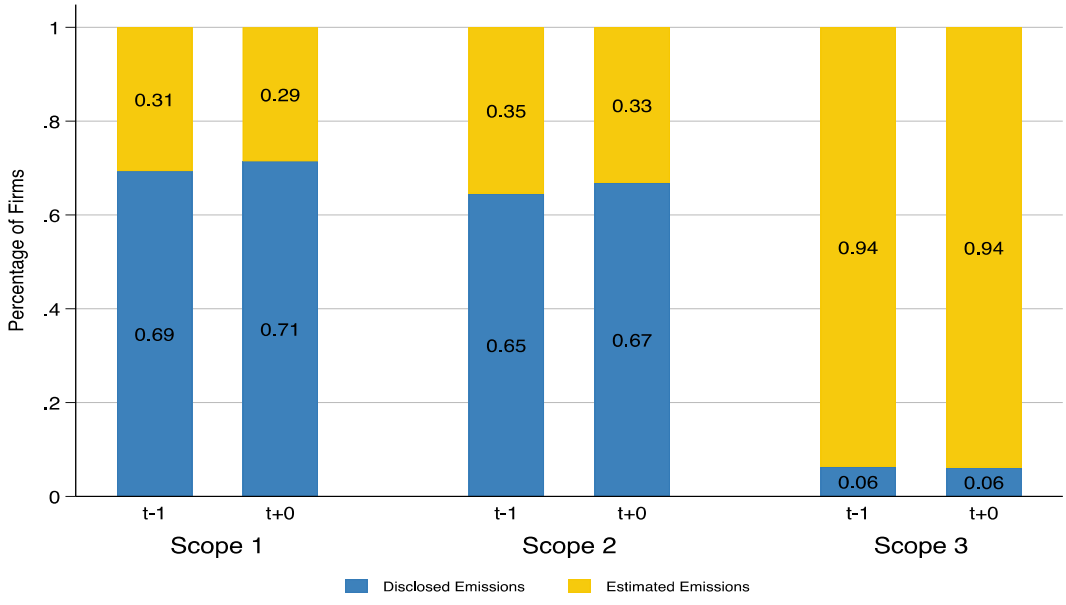
Items in bold relate to supply chain management. Source: Refinitiv (Formerly Asset 4).

Figure 1
Percentages of Disclosed and Estimated Carbon Emissions

Panel A: Treatment firms (321 firms)



Panel B: Benchmark firmsms (522 firms)



This figure plots the percentages of disclosed versus estimated carbon emissions in the year immediately before (Year t-1) and after (Year t+0) the enactment of the carbon disclosure mandate. Panels A and B show the percentages for the treatment firms and benchmark firms, respectively. Source: S&P Trucost and company annual reports.

Table 1
Sample Distribution

Panel A: Sample selection procedure

	Treatment sample		Benchmark sample	
	# Firms	#Firm-years	# Firms	#Firm-years
Global Vantage population for sample countries during 2008-2018 fiscal years	**2,528**	**19,508**	**7,284**	**57,826**
-Financial firms (6000≤SIC≤6999)	(710)	(5,771)	(1,381)	(11,455)
-Missing control variables for firm characteristics	(262)	(3,491)	(748)	(9,326)
-Missing emissions data during the event window	(1,062)	(6,774)	(3,796)	(30,033)
Full sample	**494**	**3,472**	**1,359**	**7,012**
-Missing emissions data during both pre- and post-periods	(173)	(494)	(837)	(2,261)
Balanced sample	**321**	**2,978**	**522**	**4,751**

Panel B: Sample distribution by economy

	Balanced sample		Full sample	
	#Firms	#Firm-years	#Firms	#Firm-years
Treatment sample				
UK	**321**	**2,978**	**494**	**3,472**
Benchmark sample				
Austria	15	140	29	177
Belgium	19	180	52	256
Bulgaria	0	0	3	14
Croatia	0	0	3	13
Cyprus	0	0	5	11
Czech Republic	2	20	4	24
Denmark	21	194	46	254
Estonia	0	0	3	15
Finland	28	261	55	314
France	106	907	254	1,403
Germany	73	687	203	1,007
Greece	8	67	21	110
Hungary	3	30	3	30
Ireland	28	251	50	311
Italy	34	305	112	509
Lithuania	0	0	2	9
Luxembourg	10	93	27	139
Malta	1	10	4	15
Netherlands	43	388	90	505
Norway	20	183	69	298
Poland	23	211	51	278
Portugal	7	65	18	94
Romania	0	0	5	20
Slovenia	0	0	3	15
Spain	38	357	82	472
Sweden	43	402	165	719
Sub-Total	**522**	**4,751**	**1,359**	**7,012**
Total	**843**	**7,729**	**1,853**	**10,484**

Table 1, Continued

Panel C: Sample distribution by event year

Event Year	Balanced sample			Full sample		
	Treatment sample	Benchmark sample	Total	Treatment sample	Benchmark sample	Total
-5	291	422	713	363	466	829
-4	302	434	736	366	472	838
-3	307	452	759	357	482	839
-2	309	472	781	336	489	825
-1	317	508	825	330	514	844
Pre-Period	**1,526**	**2,288**	**3,814**	**1,752**	**2,423**	**4,175**
0	318	513	831	336	694	1030
1	305	501	806	339	730	1069
2	289	491	780	340	785	1125
3	274	483	757	353	1156	1509
4	266	475	741	352	1224	1576
Post-Period	**1,452**	**2,463**	**3,915**	**1,720**	**4,589**	**6,309**
Total	**2,978**	**4,751**	**7,729**	**3,472**	**7,012**	**10,484**

Table 1, Continued

Panel D: Sample distribution by industry

NAICS2 - industry description	Balanced sample				Full sample			
	Treatment sample	Benchmark sample	Total	%	Treatment sample	Benchmark sample	Total	%
11 - agriculture, forestry, fishing & hunting	30	12	42	0.5%	33	17	50	0.5%
21 - mining, quarrying, and oil land gas extraction	233	134	367	4.7%	272	164	436	4.2%
22 - utilities	78	320	398	5.1%	87	425	512	4.9%
23 - construction	158	256	414	5.4%	178	334	512	4.9%
31 - manufacturing-food, textile, apparel	177	346	523	6.8%	202	494	696	6.6%
32 - manufacturing-wood, paper, printing, petroleum, chemicals, plastics	334	814	1,148	14.9%	385	1,201	1,586	15.1%
33 - manufacturing-metals, machinery, computers, electrical, furniture	500	1,253	1,753	22.7%	549	1,823	2,372	22.6%
42 - wholesale trade	119	94	213	2.8%	138	178	316	3.0%
44 - retail trade-motor vehicles, furniture, electronics, food, gas	192	132	324	4.2%	218	224	442	4.2%
45 - retail trade-sporting goods, books, florists, office supplies, mail-order, vending	83	59	142	1.8%	103	109	212	2.0%
48 - transportation & warehousing-air transport, water transport, trucks, pipelines	88	156	244	3.2%	94	231	325	3.1%
49 - transportation & warehousing-post service, courier & express delivery service, local messengers, warehousing & storage	8	43	51	0.7%	13	45	58	0.6%
51 - information	296	574	870	11.3%	362	808	1170	11.2%
53 - real estate & rental & leasing	66	7	73	0.9%	78	31	109	1.0%
54 - professional, scientific & technical services	253	267	520	6.7%	316	466	782	7.5%
56 - admin/support waste management/remediation services	141	87	228	2.9%	154	152	306	2.9%
61 - educational services	10	0	10	0.1%	15	3	18	0.2%
62 - health care and social assistance	12	36	48	0.6%	29	52	81	0.8%
71 - arts, entertainment & recreation	43	40	83	1.1%	66	87	153	1.5%
72 - accommodation & food services	128	68	196	2.5%	144	90	234	2.2%
81 - other services (except public administration)	19	6	25	0.3%	23	6	29	0.3%
99 - public administration	10	47	57	0.7%	13	72	85	0.8%
Total	**2,978**	**4,751**	**7,729**	**100.0%**	**3,472**	**7,012**	**10,484**	**100.0%**

Panel A presents sample selection procedures. Panels B, C, and D present the sample distribution by economy, event year, and industry, respectively.

Table 2
Descriptive Data for Carbon Emissions and Firm Characteristics

	Treatment sample (N=2,978)			Benchmark sample (N=4,751)		
	Mean	Median	Std Dev	Mean	Median	Std Dev
	(1)	(2)	(3)	(4)	(5)	(6)
Post	0.488	0.000	0.500	0.518	1.000	0.500
Ln(Scope1)	10.095	9.907	2.680	11.717	11.401	2.758
Ln(Scope2)	10.081	9.974	2.154	11.349	11.312	2.069
Ln(Scope3)	11.967	11.887	1.933	13.413	13.404	1.848
Ln(Total)	12.474	12.462	2.036	13.967	13.880	2.000
Propn(Scope1)	17.9%	10.5%	20.9%	21.3%	10.5%	25.0%
Propn(Scope2)	14.7%	11.3%	13.3%	12.7%	8.4%	13.2%
Propn(Scope3)	67.4%	72.8%	23.5%	65.9%	74.3%	25.9%
GrossMargin	0.428	0.407	0.228	0.409	0.378	0.214
Ln(COGS)	6.461	6.396	1.934	7.746	7.833	1.800
Ln(SALES)	7.174	7.085	1.662	8.397	8.366	1.497
Ln(Assets)	7.312	7.152	1.688	8.697	8.669	1.526
TobinQ	2.482	1.751	2.210	2.927	2.115	2.548
Leverage	0.210	0.194	0.172	0.251	0.241	0.154
ROA	0.050	0.052	0.091	0.043	0.040	0.073
Growth	0.069	0.048	0.215	0.041	0.036	0.179
Tangibility	0.254	0.192	0.228	0.265	0.226	0.198
R&D	0.018	0.000	0.045	0.017	0.002	0.035

This table presents carbon emissions and firm characteristics of treatment and benchmark firms for the balanced sample. See Appendix B for variable definitions.

Table 3
Mandatory Carbon Disclosure and Firm Emissions

Dep Var=	***Ln(Scope1)***	***Ln(Scope2)***	***Ln(Scope3)***	***Ln(Total)***	***Ln (Scope3)***	***Propn (Scope1)***	***Propn (Scope2)***	***Propn (Scope3)***	***Propn (Scope3)***
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Post×Treat	**-0.310*** **	**-0.126** **	**0.043***	0.006	**0.326*** **	**-0.020*** **	**-0.010***	**0.031*** **	**0.019*** **
	(0.039)	**(0.046)**	**(0.022)**	(0.021)	**(0.071)**	**(0.004)**	**(0.005)**	**(0.006)**	**(0.006)**
Scope1					0.177***				-0.782***
					(0.051)				(0.048)
Post×Treat×Scope1					**-0.026*** **				**-0.031*** **
					(0.006)				**(0.008)**
Post	0.014	-0.025	-0.051**	-0.033	-0.037	-0.000	0.010**	-0.010	-0.012
	(0.029)	(0.033)	(0.018)	(0.019)	(0.085)	(0.008)	(0.004)	(0.011)	(0.006)
Post×Scope1					-0.001				0.004
					(0.007)				(0.007)
Treat×Scope1					-0.064				-0.045
					(0.050)				(0.056)
Ln(Asset)	0.618***	0.589***	0.752***	0.737***	0.665***	0.005	-0.017***	0.012*	0.016***
	(0.042)	(0.030)	(0.022)	(0.016)	(0.024)	(0.007)	(0.003)	(0.006)	(0.003)
TobinQ	-0.002	0.008	0.023***	0.019***	0.023***	-0.001	-0.001	0.002*	0.002
	(0.013)	(0.005)	(0.005)	(0.006)	(0.004)	(0.001)	(0.001)	(0.001)	(0.001)
Leverage	0.219	0.182	-0.126	0.057	-0.146	0.027	0.026*	-0.053*	-0.031**
	(0.180)	(0.240)	(0.111)	(0.150)	(0.112)	(0.024)	(0.012)	(0.024)	(0.012)
ROA	0.088	-0.296*	0.114	0.000	0.102	-0.023	-0.045***	0.068**	0.050***
	(0.236)	(0.159)	(0.214)	(0.176)	(0.213)	(0.025)	(0.011)	(0.028)	(0.015)
Growth	0.100	0.088	0.170***	0.125*	0.142**	-0.009	-0.002	0.010	0.002
	(0.092)	(0.087)	(0.047)	(0.059)	(0.049)	(0.011)	(0.004)	(0.011)	(0.005)
Tangibility	0.965***	1.166***	0.405*	0.712**	0.302*	0.078**	0.035	-0.113**	-0.048**
	(0.287)	(0.256)	(0.193)	(0.225)	(0.159)	(0.030)	(0.020)	(0.038)	(0.020)
R&D	-2.340	-0.844	1.295***	0.775***	1.433***	-0.251**	-0.151	0.402***	0.184**
	(1.595)	(0.678)	(0.282)	(0.242)	(0.267)	(0.103)	(0.084)	(0.075)	(0.073)
Firm FE, Fiscal Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
#Firm-years	7,729	7,729	7,729	7,729	7,729	7,729	7,729	7,729	7,729
Adj. R^2	0.95	0.93	0.98	0.98	0.99	0.93	0.85	0.92	0.96

This table presents the regression estimates for changes in carbon emission for Scopes 1 to 3 following the UK carbon disclosure mandate. Columns (1)-(5) and Columns (6)-(9) report changes in the volume and changes in the proportion of carbon emissions, respectively. *Post* is an indicator variable set to one for fiscal years after September 30, 2013 (post-period for the UK carbon disclosure mandate), and zero otherwise. *Treat* is an indicator variable set to one for UK incorporated firms subjecting to the disclosure mandate, and zero otherwise. *Scope1* equals *Ln(Scope1)* in Columns (1)-(5) and *Propn(Scope1)* in Columns (6)-(9). See Appendix B for definitions of other variables. Robust standard errors, in parentheses, are clustered at the country- and fiscal-year- levels. ***, **, * represent the significance at 1%, 5% and 10% two-tailed level, respectively.

Table 4
Assessment of Parallel Trends Assumption and Robustness Checks

Panel A: Diagnostic test of the parallel trends assumption

Dep Var=	***Ln(Scope3)***	***Propn(Scope3)***		***Ln(Scope3)***	***Propn(Scope3)***
	(1)	(2)		(3)	(4)
Year -5×Treat	-0.052***	-0.005	*Scope1×Year -5×Treat*	0.020**	-0.035**
	(0.016)	(0.004)		(0.008)	(0.014)
Year -4×Treat	-0.015	-0.003	*Scope1×Year -4×Treat*	0.019**	-0.005
	(0.017)	(0.003)		(0.007)	(0.011)
Year -3×Treat	-0.005	-0.004*	*Scope1×Year -3×Treat*	0.014**	0.013
	(0.014)	(0.002)		(0.005)	(0.010)
Year -2×Treat	-0.064***	-0.002	*Scope1×Year -2×Treat*	0.012***	0.012
	(0.015)	(0.002)		(0.003)	(0.010)
Year 0×Treat	0.017	**0.004***	*Scope1×Year 0×Treat*	-0.003	**-0.018***
	(0.012)	**(0.002)**		(0.002)	**(0.009)**
Year 1×Treat	**0.034****	0.002	*Scope1×Year 1×Treat*	**-0.013*****	-0.009
	(0.013)	(0.002)		**(0.003)**	(0.009)
Year 2×Treat	**0.114*****	**0.010****	*Scope1×Year 2×Treat*	**-0.015*****	**-0.039*****
	(0.012)	**(0.003)**		**(0.004)**	**(0.009)**
Year 3×Treat	**0.087*****	**0.017*****	*Scope1×Year 3×Treat*	**-0.021*****	**-0.046*****
	(0.020)	**(0.004)**		**(0.005)**	**(0.009)**
Year 4×Treat	**0.037***	**0.024*****	*Scope1×Year 4×Treat*	**-0.019*****	**-0.048*****
	(0.017)	**(0.004)**		**(0.005)**	**(0.010)**
Year indicators	Yes	Yes		Yes	Yes
Scope1×Year Indicators	No	No		Yes	Yes
Firm Characteristics	Yes	Yes		Yes	Yes
Firm FE, Fiscal Year FE	Yes	Yes		Yes	Yes
#Firm-years	7,729	7,729		7,729	7,729
Adj. R^2	0.99	0.96		0.99	0.96

Table 4, Continued

Panel B: Robustness tests for alternative specifications

Dep Var=	*Ln(Scope3)*			*Propn(Scope3)*				
Indp Var=	***Post×Treat***	***Ln(Scope1)***	***Post×Treat ×Ln(Scope1)***	***Post×Treat***	***Propn (Scope1)***	***Post×Treat ×Propn(Scope1)***	Firm Char.	#Firm -years
	(1)	(2)	(3)	(4)	(5)	(6)		
1. Use entropy balancing	**0.082****			**0.028*****			Yes	7,729
	(0.033)			**(0.006)**				
	0.265***	0.171***	**-0.020****	**0.020****	-0.691***	**-0.032*****	Yes	7,729
	(0.075)	(0.039)	**(0.006)**	**(0.007)**	(0.110)	**(0.007)**		
2. Exclude voluntary reporting firms from the treatment sample	**0.045***			**0.036*****			Yes	6,362
	(0.022)			**(0.007)**				
	0.435***	0.177***	**-0.037*****	**0.011***	-0.783***	**-0.026****	Yes	6,362
	(0.085)	(0.052)	**(0.007)**	**(0.006)**	(0.047)	**(0.010)**		
3. Exclude Ireland from the benchmark sample	**0.042***			**0.032*****			Yes	7,478
	(0.022)			**(0.006)**				
	0.329***	0.177***	**-0.026*****	**0.020****	-0.776***	**-0.031*****	Yes	7,478
	(0.073)	(0.053)	**(0.006)**	**(0.006)**	(0.049)	**(0.008)**		
4. Use the full sample	**0.045***			**0.031*****			Yes	7,478
	(0.022)			**(0.006)**				
	0.308***	0.179***	**-0.024*****	**0.020*****	-0.784***	**-0.035*****	Yes	10,484
	(0.078)	(0.047)	**(0.006)**	**(0.006)**	(0.041)	**(0.008)**		
5. Perform placebo test, fiscal years 2007-2012	0.018			0.003			Yes	4,672
	(0.027)			(0.004)				
	0.066	0.212**	-0.005	0.000	-0.857***	0.015	Yes	4,672
	(0.104)	(0.076)	(0.008)	(0.004)	(0.059)	(0.009)		

This table reports the diagnostic test of the parallel trends assumption (Panel A) and the robustness tests for alternative specifications (Panel B). *Post* is an indicator variable set to one for fiscal years after September 30, 2013 (post-period for the UK carbon disclosure mandate), and zero otherwise. *Treat* is an indicator variable set to one for UK firms, and zero otherwise. See Appendix B for definitions of other variables. All the regressions control for firm- and fiscal-year- fixed effects. Robust standard errors, in parentheses, are clustered at the country- and fiscal-year- levels. ***, **, * represent the significance at 1%, 5% and 10% two-tailed level, respectively.

Table 5
The Effects of the Carbon Disclosure Mandate on UK Firms' Suppliers

Panel A: Sample selection for non-UK suppliers

	# Firms	#Firm-years
Unique non-financial customers of sample countries during 2008-2018 from Global Vantage and FactSet Supply Chain	**6,900**	
Unique suppliers of the above customers during 2008-2018	**9,450**	**90,199**
-Suppliers in financial industries (6000<=sic<=6999)	(720)	(7,353)
-Suppliers incorporated in the UK	(620)	(5,929)
-Suppliers missing control variables for firm characteristics	(129)	(6,195)
Initial supplier sample after merging Global Vantage and FactSet Supply Chain	**7,981**	**70,722**
-Suppliers without carbon emission from Trucost	(3,257)	(45,351)
-Suppliers without carbon emission data during both pre- and post- mandate periods	(2,702)	(6,867)
-Suppliers without any customers from sample countries during the post-mandate period	(456)	(4,066)
Non-UK supplier sample, including	**1,566**	**14,438**
Treatment firms' non-UK suppliers (Treatment suppliers)	891	8,303
Benchmark firms' non-UK suppliers (Benchmark suppliers)	675	6,135

Table 5, Continued

Panel B: Non-UK suppliers by economy

	Treatment suppliers		Benchmark suppliers			Treatment suppliers		Benchmark suppliers	
	#Firms	#Firm-years	#Firms	#Firm-years		#Firms	#Firm-years	#Firms	#Firm-years
	(1)	(2)	(3)	(4)		(5)	(6)	(7)	(8)
Australia	38	340	19	162	Luxembourg	4	36	2	17
Austria	3	26	5	46	Malaysia	10	88	9	80
Belgium	4	40	8	71	Mexico	7	64	2	20
Bermuda	6	55	1	10	Netherlands	16	157	13	104
Brazil	12	111	16	147	Norway	9	85	6	50
Canada	15	147	10	94	Poland	8	73	13	118
Chile	8	76	4	40	Russia	10	92	8	75
China	15	124	34	296	Singapore	10	95	11	93
Denmark	7	69	3	24	South Africa	19	167	7	67
Finland	7	65	12	111	South Korea	29	275	65	569
France	56	506	22	191	Spain	12	116	11	102
Germany	38	372	23	215	Sweden	18	166	8	78
Greece	1	9	5	39	Switzerland	27	248	12	115
Hong Kong	8	74	13	110	Taiwan	13	129	32	307
India	28	261	19	185	Thailand	5	48	6	59
Indonesia	5	47	11	101	Turkey	6	54	2	20
Ireland	15	135	3	30	US	318	2,980	124	1,110
Israel	6	53	4	34	Others	13	115	22	206
Italy	7	62	16	151					
Japan	78	743	94	888	**Total**	**891**	**8,303**	**675**	**6,135**

Table 5, Continued

Panel C: Changes in suppliers' Scope 1 emissions following the disclosure mandate

Dep Var=	***Ln(Scope1)***		
Sample=	**Treatment firms' non-UK suppliers (Treatment suppliers)**	**Benchmark firms' non-UK suppliers (Benchmark suppliers)**	**Treatment firms' UK suppliers**
	(1)	(2)	(3)
Post	**0.051****	**-0.081*****	**-0.172*****
	(0.023)	**(0.020)**	**(0.035)**
Ln(Asset)	0.611***	0.713***	0.509***
	(0.053)	(0.085)	(0.114)
TobinQ	0.018	-0.027*	0.011
	(0.015)	(0.015)	(0.018)
Leverage	0.091	-0.059	0.261
	(0.256)	(0.259)	(0.305)
ROA	0.143	0.111	0.107
	(0.170)	(0.315)	(0.491)
Growth	0.220***	0.323***	0.126
	(0.049)	(0.088)	(0.080)
Tangibility	0.817	0.817**	0.013
	(0.510)	(0.321)	(0.526)
R&D	2.557*	0.760	-5.107**
	(1.216)	(1.452)	(1.991)
Firm FE, Fiscal Year FE	Yes	Yes	Yes
#Firm-years	8,303	6,135	2,324
Adj. R^2	0.96	0.95	0.95

This table presents changes in Scope 1 emissions of non-UK suppliers of UK firms or benchmark firms after the UK carbon disclosure mandate. Panel A presents the sample selection procedures. Panel B shows the distribution of non-UK suppliers by economy. Panel C reports the regression estimates for changes in Scope 1 emissions for 1) non-UK suppliers of UK firms, 2) non-UK suppliers of benchmark firms, and 3) UK local suppliers. *Post* is an indicator variable set to one for fiscal years after September 30, 2013 (post-period for the UK carbon disclosure mandate), and zero otherwise. See Appendix B for definitions of other variables. Robust standard errors, in parentheses, are clustered at the supplier-country- and fiscal-year- levels. ***, **, * represent the significance at 1%, 5% and 10% two-tailed level, respectively.

Table 6
The Effect of the Carbon Disclosure Mandate on Financial Operating Performance

Dep Var=	***Gross Margin***		***Ln(COGS)***		***Ln(SALES)***	
	(1)	(2)	(3)	(4)	(5)	(6)
Post×Treat	**-0.009**	**-0.006**	**0.103****	**0.055**	**0.063*****	**0.024**
	(0.005)	**(0.005)**	**(0.038)**	**(0.034)**	**(0.018)**	**(0.016)**
Ln(Scope3)		**-0.042*****		**0.566*****		**0.465*****
		(0.012)		**(0.135)**		**(0.104)**
Ln(Scope1)	-0.014***	-0.009***	0.127***	0.053*	0.069***	0.007
	(0.003)	(0.002)	(0.028)	(0.026)	(0.010)	(0.011)
Post	-0.009*	-0.011**	-0.011	0.019	-0.043**	-0.019
	(0.004)	(0.005)	(0.023)	(0.016)	(0.017)	(0.013)
Ln(Asset)	0.010	0.038***	0.710***	0.330***	0.725***	0.414***
	(0.007)	(0.008)	(0.030)	(0.091)	(0.016)	(0.065)
TobinQ	0.001	0.002	0.021***	0.007	0.020***	0.009**
	(0.001)	(0.001)	(0.006)	(0.007)	(0.003)	(0.003)
Leverage	0.024	0.018	-0.327	-0.239	-0.149	-0.076
	(0.047)	(0.044)	(0.206)	(0.175)	(0.106)	(0.073)
ROA	0.297***	0.301***	-0.464***	-0.521***	0.190	0.142
	(0.047)	(0.051)	(0.134)	(0.119)	(0.187)	(0.116)
Growth	0.006	0.013*	0.237***	0.149**	0.243***	0.170***
	(0.005)	(0.007)	(0.048)	(0.056)	(0.047)	(0.046)
Tangibility	0.013	0.025	0.436	0.279	0.242*	0.113
	(0.035)	(0.033)	(0.287)	(0.254)	(0.115)	(0.109)
R&D	-0.001	0.066	2.400***	1.491	1.654***	0.909***
	(0.126)	(0.122)	(0.666)	(0.826)	(0.314)	(0.283)
Firm FE, Fiscal Year FE	Yes	Yes	Yes	Yes	Yes	Yes
#Firm-years	7,729	7,729	7,729	7,729	7,729	7,729
Adj. R^2	0.91	0.91	0.96	0.97	0.99	0.99

This table presents the effect of carbon disclosure mandate on financial operating performance. *Post* is an indicator variable set to one for fiscal years after September 30, 2013 (post-period for the UK carbon disclosure mandate), and zero otherwise. *Treat* is an indicator variable set to one for UK firms, and zero otherwise. See Appendix B for definitions of other variables. Robust standard errors, in parentheses, are clustered at the country- and fiscal-year- levels. ***, **, * represent the significance at 1%, 5% and 10% two-tailed level, respectively.

Table 7
Cross-Sectional Analysis for the Emission Shifting

Panel A: Analysis conditional on firms' Scope 1 emissions

Partition Var =	**Firm-level Scope 1 emission before the mandate**				**Industry-level Scope 1 emission before the mandate**			
Dep Var=	***Ln(Scope3)***		***Propn(Scope3)***		***Ln(Scope3)***		***Propn(Scope3)***	
	High	**Low**	**High**	**Low**	**High**	**Low**	**High**	**Low**
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Post×Treat×Scope1	**-0.040*** **	**-0.008** **	**-0.054*** **	-0.015	**-0.035*** **	-0.002	**-0.025** **	0.043*
	(0.007)	**(0.003)**	**(0.011)**	(0.014)	**(0.008)**	(0.008)	**(0.009)**	(0.022)
Scope1	0.045	0.231***	-0.869***	-0.693***	0.138***	0.219**	-0.749***	-0.886***
	(0.031)	(0.066)	(0.040)	(0.080)	(0.036)	(0.091)	(0.039)	(0.109)
Post×Treat	0.533***	0.142**	0.032***	0.008	0.467***	0.063	0.012*	0.021***
	(0.095)	(0.046)	(0.007)	(0.006)	(0.103)	(0.099)	(0.006)	(0.006)
Post×Scope1	0.018**	-0.006	0.021**	-0.016	0.008	-0.020	0.006	0.020
	(0.008)	(0.005)	(0.008)	(0.011)	(0.009)	(0.011)	(0.008)	(0.028)
Treat×Scope1	0.091**	-0.150**	0.040	-0.127	0.027	-0.188*	-0.021	-0.176
	(0.035)	(0.065)	(0.046)	(0.091)	(0.036)	(0.087)	(0.044)	(0.118)
Post	-0.292**	0.018	-0.012	-0.008	-0.190	0.166	-0.024**	0.000
	(0.102)	(0.068)	(0.007)	(0.007)	(0.118)	(0.121)	(0.010)	(0.004)
Diff.,								
Post×Treat×Scope1	***-0.032******		***-0.039******		***-0.033****		***-0.068****	
(Chi-Square)	***(13.37)***		***(15.03)***		***(5.26)***		***(4.37)***	
Firm Characteristics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE, Fiscal Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
# of firm-years	3,856	3,873	3,856	3,873	4,739	2,990	4,739	2,990
Adj. R^2	0.99	0.98	0.97	0.95	0.99	0.98	0.97	0.92

Table 7, Continued

Panel B: Analysis conditional on firm's environmental policies

Partition Var =	**Intensity of firms' environmental policies**				**Intensity of firms' supply chain management policies**			
Dep Var=	***Ln(Scope3)***		***Propn(Scope3)***		***Ln(Scope3)***		***Propn(Scope3)***	
	High	**Low**	**High**	**Low**	**High**	**Low**	**High**	**Low**
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Post×Treat×Scope1	-0.009	**-0.035*** **	0.022	**-0.033***	**-0.015***	**-0.033*** **	0.013	**-0.055** **
	(0.007)	**(0.009)**	(0.020)	**(0.015)**	**(0.008)**	**(0.004)**	(0.015)	**(0.017)**
Scope1	0.215**	0.119**	-0.732***	-0.894***	0.244**	0.082***	-0.738***	-0.836***
	(0.093)	(0.039)	(0.066)	(0.057)	(0.092)	(0.022)	(0.077)	(0.090)
Post×Treat	0.106	0.445***	0.018	0.026**	0.187*	0.413***	0.020**	0.025**
	(0.099)	(0.091)	(0.010)	(0.009)	(0.098)	(0.039)	(0.008)	(0.008)
Post×Scope1	-0.005	0.005	0.005	0.009	-0.006	0.009	0.003	0.009
	(0.009)	(0.008)	(0.009)	(0.014)	(0.009)	(0.006)	(0.010)	(0.015)
Treat×Scope1	-0.093	-0.053	-0.004	0.070	-0.143	-0.018	0.163*	-0.089
	(0.083)	(0.037)	(0.075)	(0.059)	(0.085)	(0.017)	(0.083)	(0.078)
Post	-0.001	-0.071	-0.017**	-0.034**	0.015	-0.090*	-0.038***	-0.003
	(0.108)	(0.066)	(0.007)	(0.012)	(0.106)	(0.043)	(0.008)	(0.006)
Diff.,								
Post×Treat×Scope1	***0.026****		***0.055*****		***0.018****		***0.068*****	
(Chi-Square)	***(4.71)***		***(9.16)***		***(3.65)***		***(13.52)***	
Firm Characteristics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE, Fiscal Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
# of firm-years	3,070	2,042	3,070	2,042	3,154	1,958	3,154	1,958
Adj. R^2	0.98	0.99	0.97	0.95	0.98	0.99	0.97	0.95

Table 7, Continued

Panel C: Analysis conditional on type of institutional investors

Partition Var =	% ownership of pension funds and independent institutions				% ownership of hedge funds			
Dep Var=	***Ln(Scope3)***		***Propn(Scope3)***		***Ln(Scope3)***		***Propn(Scope3)***	
	High	**Low**	**High**	**Low**	**High**	**Low**	**High**	**Low**
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Post×Treat×Scope1	**-0.011****	**-0.049*****	-0.014	**-0.046****	**-0.020****	**-0.031*****	**-0.037*****	**-0.035*****
	(0.004)	**(0.014)**	(0.011)	**(0.016)**	**(0.007)**	**(0.005)**	**(0.009)**	**(0.008)**
Scope1	0.190**	0.144***	-0.771***	-0.798***	0.226***	0.070***	-0.765***	-0.821***
	(0.065)	(0.035)	(0.070)	(0.055)	(0.061)	(0.016)	(0.045)	(0.105)
*Post*Treat*	0.137*	0.629***	0.011*	0.026**	0.251**	0.395***	0.020***	0.019**
	(0.071)	(0.172)	(0.005)	(0.009)	(0.088)	(0.059)	(0.005)	(0.008)
*Post*Scope1*	-0.012	0.016	-0.007	0.020	-0.000	0.001	0.001	0.010
	(0.008)	(0.011)	(0.006)	(0.017)	(0.008)	(0.006)	(0.008)	(0.009)
*Treat*Scope1*	-0.116*	0.002	-0.255***	0.081	-0.172**	0.057***	-0.219***	0.034
	(0.063)	(0.037)	(0.071)	(0.060)	(0.059)	(0.015)	(0.048)	(0.116)
Post	0.107	-0.268	0.001	-0.028**	-0.039	-0.068	-0.001	-0.016*
	(0.094)	(0.156)	(0.006)	(0.010)	(0.109)	(0.083)	(0.007)	(0.008)
Diff.,								
Post×Treat×Scope1	***0.038******		***0.032****		*0.011*		*-0.002*	
(Chi-Square)	***(6.51)***		***(3.87)***		*(1.79)*		*(0.05)*	
Firm Characteristics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE, Fiscal Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
# of firm-years	4,502	3,227	4,502	3,227	3,577	4,152	3,577	4,152
Adj. R^2	0.99	0.99	0.96	0.96	0.98	0.99	0.96	0.95

Table 7, Continued

Panel D: Analysis conditional on suppliers' visibility and home-country environmental protection

Partition Var =	**%Public suppliers**				**%Foreign suppliers in countries with lax environmental regulation and enforcement**			
Dep Var=	***Ln(Scope3)***		***Propn(Scope3)***		***Ln(Scope3)***		***Propn(Scope3)***	
	High	**Low**	**High**	**Low**	**Strong protection**	**Weak protection**	**Strong protection**	**Weak protection**
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Post×Treat×Scope1	-0.009	**-0.024*** **	0.010	**-0.066*** **	-0.001	**-0.029** **	0.014	**-0.068*** **
	(0.009)	**(0.005)**	(0.015)	**(0.011)**	(0.009)	**(0.010)**	(0.014)	**(0.013)**
Scope1	0.092***	0.229*	-0.803***	-0.750***	0.238*	0.092***	-0.812***	-0.742***
	(0.026)	(0.117)	(0.074)	(0.047)	(0.120)	(0.027)	(0.063)	(0.042)
*Post*Treat*	0.150	0.309***	0.015*	0.032***	0.048	0.376***	0.015	0.034***
	(0.101)	(0.085)	(0.007)	(0.007)	(0.140)	(0.118)	(0.009)	(0.006)
*Post*Scope1*	0.007	-0.003	-0.003	0.012	-0.017	0.016	0.001	0.009
	(0.009)	(0.009)	(0.014)	(0.009)	(0.013)	(0.010)	(0.012)	(0.013)
*Treat*Scope1*	-0.049	-0.127	-0.056	0.141**	-0.169	-0.024	-0.018	0.108**
	(0.027)	(0.108)	(0.091)	(0.045)	(0.111)	(0.031)	(0.073)	(0.042)
Post	-0.134	0.004	-0.024**	-0.009*	0.169	-0.217*	-0.016	-0.014**
	(0.098)	(0.123)	(0.008)	(0.005)	(0.181)	(0.108)	(0.009)	(0.006)
Diff., *Post×Treat×Scope1*	***0.015****		***0.076*****		***0.028****		***0.080*****	
(Chi-Square)	***(3.03)***		***(17.62)***		***(4.06)***		***(17.41)***	
Firm Characteristics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE, Fiscal Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
# of firm-years	3,188	3,069	3,188	3,069	3,480	2,777	3,480	2,777
Adj. R^2	0.99	0.99	0.95	0.97	0.98	0.99	0.96	0.96

This table compares the cross-sectional differences in the shift of emissions from Scope 1 to 3 following the UK carbon disclosure mandate. Panels A-D present analyses conditional on firms' Scope 1 emissions before the disclosure mandate, firm's environmental protection policies, type of institutional investors, and suppliers' visibility and home-country environmental protection, respectively. *Post* is an indicator variable set to one for fiscal years after September 30, 2013 (post-period for the UK carbon disclosure mandate), and zero otherwise. *Treat* is an indicator variable set to one for UK firms, and zero otherwise. See Appendix B for definitions of other variables. Robust standard errors, in parentheses, are clustered at the country- and fiscal-year- levels. ***, **, * represent the significance at 1%, 5% and 10% two-tailed level, respectively.

Table 8
Cross-Sectional Analysis of Changes in Scope 1 Emissions of Foreign Suppliers

Dep Var=	***Ln(Scope1)***					
Partition Var=	**Proportion of UK customers**		**Duration of UK customer relationship**		**# Customer in an industry**	
	High	**Low**	**Long**	**Short**	**Low**	**High**
	(1)	(2)	(3)	(4)	(5)	(6)
Post	**0.141*** **	**-0.095** **	**0.096** **	-0.039	**0.135** **	-0.011
	(0.038)	**(0.033)**	**(0.035)**	(0.039)	**(0.045)**	(0.037)
Ln(Asset)	0.621***	0.594***	0.636***	0.571***	0.562***	0.685***
	(0.047)	(0.087)	(0.049)	(0.074)	(0.061)	(0.068)
TobinQ	0.008	0.032**	0.014	0.021	0.003	0.030*
	(0.019)	(0.012)	(0.023)	(0.016)	(0.021)	(0.015)
Leverage	0.067	0.123	0.127	0.068	0.272	-0.074
	(0.260)	(0.394)	(0.254)	(0.397)	(0.454)	(0.248)
ROA	0.098	0.178	0.131	0.178	0.057	0.236
	(0.244)	(0.229)	(0.244)	(0.136)	(0.313)	(0.145)
Growth	0.280***	0.145*	0.253***	0.193***	0.151*	0.305***
	(0.083)	(0.070)	(0.074)	(0.058)	(0.083)	(0.092)
Tangibility	1.188	0.137	1.220	0.123	1.105	0.395
	(0.775)	(0.426)	(0.771)	(0.405)	(0.812)	(0.330)
R&D	1.065	4.532***	1.129	4.607***	1.817	3.470**
	(1.748)	(0.911)	(1.565)	(0.742)	(1.600)	(1.231)
Difference in *Post*	***0.236*** **		***0.135*** **		***0.146*** **	
(Chi-square)	***(8.91)***		***(4.53)***		***(4.90)***	
Firm FE, Fiscal Year FE	Yes	Yes	Yes	Yes	Yes	Yes
#Firm-years	4,850	3,453	4,869	3,434	4,055	4,248
Adj.R^2	0.95	0.97	0.95	0.96	0.95	0.97

This table presents cross-sectional differences in the changes in Scope 1 emissions of treatment firms' foreign suppliers. *Post* is an indicator variable set to one for fiscal years after September 30, 2013 (post-period for the UK carbon disclosure mandate), and zero otherwise. See Appendix B for definitions of other variables. Robust standard errors, in parentheses, are clustered at the supplier-country- and fiscal-year- levels. ***, **, * represent the significance at 1%, 5% and 10% two-tailed level, respectively.