Corporate Disclosures for Green Supply Chains:

Evidence from Scope 3 Emissions Disclosure

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Abstract

When a customer voluntarily begins to disclose its Scope 3 emissions, it can signal the firm's commitment to decarbonizing its value chain, fostering collaboration among suppliers in promoting green supply chains. Using a generalized difference-in-differences research design, we find that suppliers reduced greenhouse gas emissions after their customers initiated Scope 3 emissions disclosures. We also find that this reduction in emissions is more pronounced when the suppliers pose greater climate risks for their customers, when the suppliers have lower bargaining power, and when the suppliers have stronger economic and longer-standing ties with their customers. This effect of disclosure is incremental to the customers' sustainability endeavors and robust to excluding customer-supplier pairs likely subject to location-, industry-, and owner-wide common shocks. Overall, our results are consistent with Scope 3 emissions disclosures playing a role in promoting more sustainable supply chains.

JEL Classification: Q50; D83; G30; M41

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I. Introduction

We examine the role of Scope 3 emissions disclosures in greening supply chains. With increasing concerns about climate risks, firms have been facing pressure from various stakeholders to maintain sustainable supply chains in recent years. Research in operations and supply chain management has long discussed how customers can engage their suppliers in environmental initiatives to create sustainable supply chains given that a supplier's social or environmental misbehavior can damage the customer's operations and reputation (e.g., Villena and Gioia 2018; Kalkanci and Plambeck 2020; Dhingra and Krishnan 2021).[1] While the literature suggests that customers can play a critical role in greening supply chains by monitoring or guiding suppliers, we examine how a customer's disclosure of their emissions along the supply chain can also play an important role in this process. Consistent with the Scope 3 emissions disclosure signaling a customer's commitment to sustainability and mitigating coordination frictions in the customer-supplier relationship, we find that suppliers report lower emissions after a major customer begins to disclose emissions generated from its value chain.

Setting the world's most widely-used greenhouse gas accounting and reporting standards, the Greenhouse Gas (GHG) Protocol classifies a firm's greenhouse gas emissions into three scopes; direct emissions from the firm (Scope 1 emissions), indirect emissions, such as the generation of purchased energy (Scope 2 emissions), and indirect emissions that occur in the firm's value chain, including emissions from the production of goods and services purchased by the company (Scope 3 emissions). While it is common for firms to disclose their Scope 1 and 2 emissions in their sustainability reports, Scope 3 emissions disclosures are rare because they

[1] For example, customers can evaluate and audit suppliers' sustainability practices and renew contracts with suppliers conditional on environmental performance. Customers can also share their know-how and information with suppliers to address their environmental challenges together (e.g., Klassen and Vachon 2003; Linton, Klassen, and Jayaraman 2007; Jira and Toffel 2013; Sunar and Plambeck 2016; Kraft, Valdés, and Zheng 2020).

require significant assumptions and estimations. Yet Scope 3 emissions are arguably the most significant and relevant because they reflect the total amount of emissions generated by the firm's value chain. In the climate disclosure requirements proposed by the Securities and Exchange (SEC) in March 2022, all U.S. firms with more than $25 million in assets will be required to disclose their Scope 3 emissions if the figure is material or included in their emissions reduction target.[2] However, Scope 3 emissions disclosure is problematic because it requires public firms to seek out information from private firms who do not follow the same reporting practices and requirements, making it difficult to ensure accurate and comprehensive Scope 3 data collection. The inclusion of Scope 3 emissions disclosure in the proposed climate disclosure rule thus emerges as one of the most contentious issues, leading to a delay in the rule's final adoption. This study is thus timely and important as it provides evidence on the societal and environmental impact of a customer's Scope 3 emissions disclosure in the absence of regulation.

While disclosure is mainly demanded by investors for assessing firm risk, a customer's Scope 3 emissions disclosure can generate externalities on its suppliers, serving as a signal of the customer's commitment to decarbonized supply chains for suppliers and other stakeholders. Ferreira and Rezende (2007) show that managers' announcements of corporate strategy carry greater credibility when visible to everyone in the world, as public disclosure discourages managers from altering strategic directions, compared to when the strategy is privately communicated to partners. Consequently, partners are more inclined and better equipped to participate in investments aligned with the specific strategy as intended by managers (Ferreira and Rezende 2007). Therefore, on top of private communication with suppliers concerning the customer's commitment to advancing sustainability in supply chains, if a customer discloses Scope 3 emissions publicly, the disclosure can bolster the credibility of its commitment,

[2] https://www.sec.gov/news/press-release/2022-46

reinforcing the message already conveyed or to be conveyed privately to suppliers. Suppliers are then better positioned to collaborate with the customer in decarbonization efforts, including making essential investments to foster more sustainable supply chains. As a result, we expect to find a reduction in suppliers' greenhouse gas emissions, consistent with public disclosure resolving coordination frictions in the customer-supplier relationship (Ferreira and Rezende 2007).

However, the impact of the disclosure on suppliers' emissions may be negligible if it is merely an act of greenwashing (e.g., Laufer 2003). Although the customer may request information on supplier emissions and subsequently publicly disclose it as part of the Scope 3 emissions, suppliers may discern the authenticity of the customer's intentions behind the disclosure through their private communications. For example, while the customer emphasizes environmental responsibility in its sustainability report, suppliers may notice inconsistencies behind closed doors, where the customer's requests for emission data seem more like a procedural obligation than a sincere dedication to sustainability. In instances where suppliers fail to perceive the customer's disclosure as a genuine commitment to fostering sustainable supply chains, they may not exert sufficient efforts to mitigate greenhouse gas emissions.

To examine the impact of the customer's Scope 3 emissions disclosures on supplier emissions, we use data provided by S&P Trucost, which collects information on the amount and scope of greenhouse gas emissions disclosed by firms. Our approach is equivalent to a generalized difference-in-differences analysis, where treated firms consist of suppliers whose major customers initiated Scope 3 emissions disclosures during our sample period, while control firms are those whose major customers do not engage in such disclosure throughout the sample period. To alleviate the concern that our results are driven by customers terminating contracts

with non-cooperative suppliers and substituting them with more cooperative new suppliers when they initiate Scope 3 emissions disclosure, we require the customer to maintain the same supplier in both the pre- and post-disclosure periods, ruling out the possibility that our results are attributable to a shift in suppliers or assortative matching between customers and suppliers. We also use firm-fixed or firm-customer combination fixed effects to mitigate the possibility that time-invariant firm-specific or customer-supplier-specific unobservable factors influence the relationship between customer disclosure and supplier behavior.

Using 6,401 firm-years (i.e., supplier-years) with major customer information reported in 10-Ks between 2004 and 2019, we find a significant decrease of 6.4% in the amount of the supplier's greenhouse gas emissions after the supplier's major customer begins to disclose Scope 3 emissions.[3] However, we do not find a similar result when we examine changes in the supplier's emissions before and after the customer initiates Scope 1 or Scope 2 disclosure, suggesting that it is Scope 3, rather than omitted variables broadly associated with the customer's environmental disclosures, which are likely responsible for our finding. We also employ pseudo customers (i.e., firms reported as major customers by any suppliers in 10-K filings but outside the focal supplier's supply chain) and do not find that suppliers reduce their emissions after the pseudo customers initiate Scope 3 emissions disclosures (even when the pseudo customers operate in the same industry as true customers), suggesting that the effect we find is specific to each supply chain. This result mitigates the possibility that any market- or industry-wide common shocks correlated with overall sustainability activities prompt suppliers to reduce their emissions. We also perform a dynamic analysis and confirm that we satisfy the parallel trend

[3] In an untabulated analysis, we remove suppliers with their own Scope 3 emissions disclosures and find a consistent result, suggesting that our result is not attributable to the effect of the supplier's own disclosures.

assumption. Overall, our result is consistent with the notion that a customer's disclosure of Scope 3 emissions can contribute to a greener supply chain.

To shed additional light on our inference, we perform the following cross-sectional analyses. First, suppliers are more likely to heed a signal more strongly from the customer's decision to disclose Scope 3 emissions if they emit a greater amount of greenhouse gases and thus would end up posing a higher climate risk to the customer if they did not collaborate with the customer in decarbonization. We thus expect the customer's Scope 3 emissions disclosure to entail a greater reduction in the supplier's emissions if the supplier emitted a greater amount of greenhouse gases and took a stronger signal to alter their behavior. Accordingly, we split the sample into two groups based on the amount of the supplier's greenhouse gas emissions measured at the beginning of the year. As expected, we find that the reduction in a supplier's emissions after its major customer's Scope 3 emissions disclosure is more pronounced for a subsample of suppliers with a greater amount of emissions. This result suggests that suppliers are more responsive to the signal conveyed by the customer's Scope 3 emissions disclosures if they would pose a higher climate risk to the customer by not improving their behavior.

Second, the extent to which a supplier is willing to collaborate with its customer is likely to depend on various aspects of the customer-supplier relationship. Hence, we first split the sample into two groups based on the supplier's bargaining power, proxied by the number of firms in the customer's two-digit SIC industry, with a lower number of firms indicating weaker bargaining power (i.e., more difficult for the supplier to replace the customer with other firms in the same industry). We expect the effect of the customer's disclosure to be greater when the supplier's bargaining power is weaker, as the supplier would be more cooperative with the customer in decarbonizing the supply chain to prevent being replaced by other more

collaborative suppliers. As expected, we find that the reduction is greater for the subsample of firms where customers have stronger bargaining power. We also anticipate a supplier to exhibit a greater willingness to cooperate with its customer when the two parties share stronger ties. The closer their connection, the more information they possess about each other, mitigating a hold-up problem in relationship-specific investments in supply chains. To gauge the strength of the relationship between the customer and the supplier, we concentrate on two aspects: (1) the supplier's dependence on the customer for its sales and (2) the duration of the customer-supplier relationship. As expected, we observe that the decline in the supplier's greenhouse gas emissions following a major customer's Scope 3 emissions disclosure is more noticeable within a subset of suppliers exhibiting stronger economic ties and longer-standing relationships with their customers.

An alternative explanation for our findings could be that ESG-committed customers tend to commence Scope 3 emissions disclosures as part of their heightened sustainability efforts, concurrently exerting pressure on and monitoring their suppliers to adopt environmentally responsible practices as well (Dai, Liang, and Ng 2021). Then the customer's pressure from private communication, even in the absence of disclosure, can also contribute to our findings. To address this concern, we conduct the following additional analyses. First, we use ESG ratings as a proxy for the customer's sustainability endeavors, likely correlated with the customer's monitoring efforts, and find that our result is robust to controlling for the level of the customer's ESG commitment. Second, given that customers with a greater reduction in their own emissions are likely to exert more pressure on suppliers, we split the sample into two groups based on customers' reductions in their own Scope 1 and 2 emissions. We find no significant difference in

suppliers' emissions between the two groups, mitigating the possibility that our findings are attributed solely to the direct pressure exerted by the customer on suppliers.

We also conduct a battery of robustness tests. First, we find our results robust to excluding customer-supplier pairs within the same city and industry or those sharing common blockholders. These results alleviate the concern that our finding is driven by a location-, industry-, and owners-wide common shock affecting both the customer and the supplier, prompting them to enhance their efforts towards sustainability improvement. Second, Trucost provides estimates of the firm's carbon emissions when the emissions are not disclosed by the companies themselves, raising a concern that our results are due to a bias in Trucost's emission estimates. To address this concern, we partition the sample into two groups based on whether the emissions are disclosed or estimated and find a consistent result for the subsample with disclosed emissions (untabulated). Third, we find that our results are robust to controlling for the supplier's ESG ratings and also to using the supplier's emission intensity (i.e., natural log of emissions scaled by lagged total assets) as an alternative dependent variable (untabulated).

Our study makes the following contributions. First, our study informs regulators and policymakers currently considering whether and how to mandate climate-related disclosures. Scope 3 emissions, although not mandated to be disclosed yet, account for a substantial portion of greenhouse gases emitted by firms and hence pose critical climate risks. Our study provides novel evidence on a positive externality that a customer's Scope 3 emissions disclosure can bring about for its supply chain even in the absence of regulation. While we are unable to completely exclude the concurrent influence of the ESG-committed customer's sustainability endeavors, our results nevertheless suggest that the customer's Scope 3 emissions disclosure can play an incremental role over and above direct monitoring through private communication in fostering

sustainability within the supply chain. Second, we contribute to the environmental and social (E&S) studies in the accounting and finance literature. Research suggests that socially or environmentally responsible customers can propagate similar business behavior in suppliers through private monitoring or intervention, suggesting that corporate policies and behavior have a spillover effect along the supply chain (e.g., Schiller 2018; Dai, Liang, and Ng 2021; Darendeli et al. 2022).[4] Extending prior work, our study suggests that a customer's disclosure can also facilitate the spillover of E&S practices through a signaling channel (which is incremental to the monitoring channel), i.e., by enhancing the credibility of the customer's commitment to decarbonization, thereby mitigating potential hold-up problems for suppliers in collaborating with the customer.

In particular, our study is related to She (2022), which finds that firms increase their supply chain due diligence after they are required to disclose how they conduct their due diligence to address suppliers' human rights abuses. However, due to the voluntary nature of Scope 3 emissions disclosures and customers' possible attempts to greenwash, the findings in She (2022) cannot be directly extended to our setting. Our study therefore complements She (2022) as we suggest that public disclosures create externalities on suppliers by rendering the customer's commitment more credible. Lastly, we contribute to the literature in operations and supply chain management. Extant studies highlight the importance of the customer's monitoring of and collaboration with suppliers in diffusing green practices in firms along the supply chains. We add to this line of literature by demonstrating the role that a customer's emissions disclosure can play in greening the supply chain.

[4] Dai, Liang, and Ng (2021), in particular, suggest that customers exert influence on suppliers through an assortative matching, where they select to establish relationships with suppliers with similar E&S policies.

The remainder of the paper is organized as follows. We review the literature on green supply chain management and develop the hypotheses in section two. In section three, we describe the sample and empirical design. Sections four, five and six present the results from our analyses. Finally, section seven concludes.

II. Literature Review and Hypotheses Development

2.1 Green Supply Chain Management

Suppliers' socially or environmentally irresponsible behavior poses a significant risk to customers by inviting adverse publicity and reputational damage (e.g., Villena and Gioia 2018; Kalkanci and Plambeck 2020; Dhingra and Krishnan 2021). Research in operations and supply chain management suggests that customers can engage their suppliers in environmental initiatives through monitoring, where customers can send auditors to suppliers to evaluate the suppliers' environmental practices and renew or terminate the contracts based on the suppliers' environmental performance (e.g., Hoejmose, Grosvold, and Millington 2014; Gualandris et al. 2015; Chen, Qi, and Dawande 2020; Fang and Cho 2020; Zhang, Aydin, and Parker 2022).[5] Studies also suggest that customers can improve the sustainability of supply chains by guiding suppliers (e.g., Klassen and Vachon 2003; Lee and Klassen 2009; Karaer, Kraft, and Khawam 2017; Feng et al. 2022). For example, customers can offer environmental workshops to their suppliers, guide the suppliers to properly use and handle materials, or share know-how and experience with the suppliers to address the supplier's environmental challenges (Hoejmose, Grosvold, and Millington 2014). As cost reduction through energy efficiency would be a primary incentive for suppliers to make efforts in measuring and reducing greenhouse gas emissions,

[5] However, increased audits on suppliers could backfire, leading to suppliers to practice deception, such as hiding information from or submitting false information to customers (e.g., Jiang 2009; Plambeck and Taylor 2016).

customers can also provide capital or technical assistance to their suppliers to help them invest in energy-efficient technologies or logistics (Plambeck 2012).

Greening supply chains, however, would be challenging if suppliers are unable or unwilling to internalize the customers' environmental standards. One of the reasons for this challenge is a lack of trust between the customer and its suppliers, resulting in a hold-up problem in economic theory. Suppliers would then underinvest in relationship-specific green technologies, as they are concerned with their commitment being potentially expropriated by their customers (e.g., Klein 1988; Drake and Haka 2008; Hermalin and Katz 2009).[6] Research suggests that customers and suppliers often differ in their perspectives on what collaborative relationship means in supply chains; i.e., suppliers look more to safeguard their relationship-specific investments while customers care more about relationship outputs (Nyaga, Whipple, and Lynch 2010). As such, to achieve a greener supply chain, it is crucial for customers to foster an environment where suppliers are willing to accommodate the customer's climate strategy by alleviating uncertainties and mitigating risks to be borne by the suppliers when undertaking relationship-specific investment as aligned with the customer's strategy.

2.2 Hypotheses Development

The Greenhouse Gas (GHG) Protocol classifies a firm's greenhouse gas emissions into three scopes; direct emissions from the firm (Scope 1 emissions), indirect emissions, such as the generation of purchased energy (Scope 2 emissions), and indirect emissions that occur in the firm's value chain, including emissions from the production of goods and services purchased by the company in the same year (Scope 3 emissions). Studies suggest that firms should focus on

[6] Another reason could be that suppliers are usually smaller than customers in size and reputation, lacking competencies and resources sufficient to prioritize their supply chains' sustainability. While possibly creating maximum value along the supply chain in the long run, compliance with sustainability standards would require suppliers to operate with sub-optimal costs in the short run. (e.g., Linton, Klassen, and Jayaraman 2007; Wu and Pagell 2011).

Scope 3 emissions to reduce emissions most effectively because the emissions in their supply chains account for a substantial portion of overall emissions (e.g., Matthews, Hendrickson, and Weber 2008; Jira and Toffel 2013). For example, Matthews, Hendrickson, and Weber (2008) find that across all industries, a company's direct emissions are, on average, 14% of the emissions from their value chains. Since 14% is the figure before emissions in use and disposal of goods are taken into account, the percentage would be even lower after accounting for those emissions. However, reductions in supply chain emissions require collaboration by multiple firms along the supply chain and cannot be easily achieved by a single company (e.g., Plambeck 2012).

We hypothesize that a customer's Scope 3 emissions disclosure will result in a decline in its suppliers' greenhouse gas emissions as it can generate externalities on its suppliers, serving as a signal of the customer's commitment to decarbonized supply chains for suppliers and other stakeholders. As mentioned above, given that a firm's investment in green energy or technologies requires a long-term effort with non-trivial costs, suppliers are less likely to cooperate with customers in making environmental investments if they face higher uncertainties regarding the customers' willingness to make joint efforts. However, to the extent that the customer's Scope 3 emissions disclosure resolves uncertainties concerning the customer's commitment to building a more sustainable supply chain, it can help mitigate the supplier's hold-up problems in green investments.

In particular, Ferreira and Rezende (2007) show that managers' announcements of corporate strategy are perceived to be more credible when made public accessible to a global audience compared to when the strategy is privately communicated to partners, as public disclosure acts as a deterrent, discouraging managers from changing the declared strategic

directions.[7] Consequently, facing lower uncertainties, partners are more inclined and better equipped to participate in investments aligned with the specific strategy as intended by managers (Ferreira and Rezende 2007). Therefore, on top of private communication with suppliers concerning the customer's commitment to advancing sustainability in supply chains, if a customer discloses Scope 3 emissions publicly, the disclosure can bolster the credibility of its commitment to sustainability, reinforcing the message already conveyed or to be conveyed privately to suppliers. Suppliers are then better positioned to collaborate with the customer in decarbonization efforts, including making essential investments to foster more sustainable supply chains. As a result, we expect to find a reduction in suppliers' greenhouse gas emissions, consistent with public disclosure resolving coordination frictions in the customer-supplier relationship (Ferreira and Rezende 2007).

However, the Scope 3 emissions disclosure may not affect suppliers' emissions if it is perceived as an act of greenwashing by suppliers. Although the customer may request information on supplier emissions and subsequently publicly disclose it as part of the Scope 3 emissions, suppliers may discern the authenticity of the customer's intentions behind the disclosure through their private communications. For example, while the customer emphasizes environmental responsibility in its sustainability report, suppliers may notice inconsistencies behind closed doors, where the customer's requests for emission data seem more like a procedural obligation than a sincere dedication to sustainability. In instances where suppliers fail to perceive the customer's disclosure as a genuine commitment to fostering sustainable supply chains, they may not exert sufficient efforts to mitigate greenhouse gas emissions. As such,

[7] The potential reputational risk in the managerial labor market creates an incentive for managers to adhere to their original plans. Deviation from the original plan is perceived as a lack of precision in the managers' initial information. Despite the potential for a more optimal deviation, managers are inclined to avoid changes that might be viewed unfavorably in the managerial labor market.

whether the initiation of a customer's Scope 3 emissions disclosure will affect its supplier's emissions is not clear ex-ante. With this tension in mind, we state our main hypothesis (H1) in alternative form as follows:

H1: Ceteris paribus, a supplier will reduce its greenhouse gas emissions after its customer initiates Scope 3 emissions disclosure.

To shed additional light on our inference, we provide the following cross-sectional hypotheses. First, suppliers are more likely to heed a signal more strongly from the customer's decision to disclose Scope 3 emissions if they emit a greater amount of greenhouse gases and thus would end up posing a higher climate risk to the customer if they did not collaborate with the customer in decarbonization. Therefore, the customer's Scope 3 emissions disclosure should entail a greater reduction in the supplier's emissions if the supplier previously emitted a greater amount of greenhouse gases. We thus present H2 in alternative form as follows:

H2: The effect of a customer's initiation of Scope 3 emissions disclosure, as stated in H1, will be greater when the supplier poses a greater climate risk for the customer.

Second, the extent to which a supplier is willing to collaborate with its customer is likely to depend on various aspects of the customer-supplier relationship. For example, when the supplier has lower bargaining power, it would be more cooperative with the customer in decarbonizing the supply chain to prevent being replaced by other more collaborative suppliers. As a result, the customer's Scope 3 emissions disclosure should entail a greater reduction in the suppliers' emissions. We also expect the supplier to be more willing to cooperate with the customer if the two parties have stronger economic or long-standing ties. Since the supplier's cooperation in green projects requires significant relationship-specific investments, the customer can better engage the supplier when there is greater trust between the two parties. We reason the more closely tied the two firms are, the more information they have regarding each other, which in turn can facilitate information sharing and hence mitigate hold-up problems. The supplier would

then engage in more investments in relationship-specific green technologies. Therefore, the customer's Scope 3 emissions disclosure should entail a greater reduction in the suppliers' emissions when the supplier relies more heavily on the customer in its sales or when it has maintained a longer relationship with the customer.

H3a: The effect of a customer's initiation of Scope 3 emissions disclosure, as stated in H1, will be more pronounced when the supplier has weaker bargaining power.

H3b: The effect of a customer's initiation of Scope 3 emissions disclosure, as stated in H1, will be more pronounced when the customer-supplier pair has a strong economic relationship.

H3c: The effect of a customer's initiation of Scope 3 emissions disclosure, as stated in H1, will be more pronounced when the customer-supplier pair has long-standing ties.

III. Research Design

3.1 Data and Sample Construction

SFAS No. 131, the U.S. segment reporting standards, requires firms to report the identity of and the sales to their customers if more than 10% of the firms' sales stem from a particular customer (often called "major customers"). We regard a firm that reports its customers in its 10-K filings as a supplier and obtain the information on this supplier and its customers from Compustat Segment files. We then merge this with greenhouse gas emissions data from S&P Trucost. We also collect firms' financial information from Compustat Fundamentals. Table 1 reports the sample selection procedures. After removing observations with missing values on firm financials, our final sample consists of 6,401 firm-years (i.e., supplier-years) with disclosures about major customers in 10-Ks between 2004 and 2019.

[Insert Table 1]

In Table 2, Panel A reports the yearly distribution of our sample firms. Treated firms refer to suppliers whose major customers initiate Scope 3 emissions disclosure in our sample

period. To distinguish between the pre- and the post-Scope 3 emissions disclosure period for treated firms, we create an indicator variable, *PostScope3*, that equals one for years after their customers started to provide Scope 3 emissions disclosures (i.e., the post-Scope 3 emissions disclosure period) and zero otherwise (i.e., the pre-Scope 3 emissions disclosure period). Control firms refer to suppliers whose major customers have never disclosed Scope 3 emissions during our sample period. Hence, for control firms, *PostScope3* takes a value of zero every year in our sample period. Our sample consists of 3,162 (3,239) treated (control) suppliers in total. The proportion of treated suppliers with their customers disclosing Scope 3 emissions (i.e., *PostScope3* = 1) increases over time as more and more customers begin to disclose Scope 3 emissions voluntarily in our sample period. For example, in 2004 when our sample period begins, none of the 112 treated suppliers belong to the post-disclosure period, but in 2019 when our sample period ends, 400 of the 407 treated suppliers belong to the post-disclosure period.[8]

[Insert Table 2]

3.2 Regression Model

We use a generalized difference-in-differences design by running the following regression model:

$$\begin{aligned} S\_Emission = {} & \alpha + \beta_1 PostScope3 + \beta_2 S\_TotalAssets + \beta_3 S\_Tangible + \beta_4 S\_SalesGrowth \\ & + \beta_5 S\_ROA + \beta_6 S\_Leverage + \beta_7 C\_TotalAssets + \beta_8 C\_SalesGrowth \\ & + \beta_9 C\_ROA + \text{Fixed Effects} + \varepsilon \end{aligned} \quad (1)$$

The dependent variable is *S_Emission*, the amount of the supplier's greenhouse gas emissions, excluding emissions from downstream activities such as sold products.[9] We follow Shive and Foster (2020) and measure this variable as the natural log transformation of one plus total

[8] Table 2 shows that the number of firms (both the treated and control firms) increases over time in our sample period mainly because of increased coverage of S&P Trucost.

[9] For example, if a firm produces electronic equipment, it needs to estimate the amount of lifetime electricity to be consumed by its customers for all products sold in the reporting year.

greenhouse gas emissions as reported by S&P Trucost (as in metric tons of CO_2 equivalent). *PostScope3* is our main test variable. As defined above, it is an indicator variable that equals one for the firm's post-Scope 3 emissions disclosure period and zero otherwise. Under H1, we expect to find a significantly negative coefficient on this variable.

For control variables, we include an array of supplier and customer characteristics likely correlated with the supplier's emissions and its customer's decision to provide Scope 3 emissions disclosure. For example, *S_TotalAssets* is the supplier's total assets, measured as the natural log transformation of total assets. *S_Tangible* is the supplier's tangible assets, defined as property, plant, and equipment, net of accumulated depreciation, scaled by total assets. *S_SalesGrowth* is the supplier's sales growth, defined as the change in the supplier's sales scaled by sales at the beginning of the year. *S_ROA* is the supplier's return on assets, defined as operating income after depreciation, scaled by average total assets. *S_Leverage* is the supplier's leverage ratio, defined as long-term debt scaled by total assets. C_*TotalAssets* is the customer's total assets, measured as the natural log transformation of total assets. C_*SalesGrowth* is the customer's sales growth, defined as the change in the customer's sales scaled by sales at the beginning of the year. *C_ROA* is the customer's return on assets, defined as operating income after depreciation, scaled by average total assets.

Finally, we include either firm fixed or firm-customer fixed effects to account for time-invariant firm-specific or supplier-customer relationship-specific factors. We also include industry-year fixed effects to address the potential correlations of emissions attributable to industry-specific policies or macroeconomic conditions. We cluster standard errors at the industry-year level to account for the potential correlation of Scope 3 emissions by industry-level shocks.

3.3 Descriptive Statistics

Panel B of Table 2 reports the summary statistics for variables used in our regression analyses. The means of *S_Emission* and *S_Emission (Raw)* are 12.863 and 2,833, respectively, suggesting that an average supplier in our sample emits approximately 2.833 million metric tons of CO_2 equivalent annually. The mean of *PostScope3* is 0.269, suggesting that 27% of our sample suppliers operate in their customers' post-Scope 3 emissions disclosure period. When it comes to supplier characteristics, the means of *S_TotalAssets* and *S_Tangible* are 7.905 and 0.258, suggesting that an average supplier in our sample has total assets of $2,711 million and tangible assets equal to 26% of its total assets. The table also shows that the average supplier has *S_Salesgrowth* of 0.219, *S_ROA* of 0.015, and *S_Leverage* of 0.244. When it comes to customer characteristics, the mean of *C_TotalAssets* is 10.669, suggesting that an average customer in our sample has total assets of $43,012 million, a lot larger than those of its suppliers. This table also shows that customers in our sample have an average sales growth and *ROA* of 0.149 and 0.051, respectively.

IV. Main Analyses

4.1 Test of H1: Effect of Customers' Scope 3 Emissions Disclosures

Table 3 presents the results of the regression analysis estimating Equation (1). In column (1), when we use firm and industry-year fixed effects without any controls, we find that the coefficient on *PostScope3* is -0.118, significantly negative at the 1% level. In column (2), when we add controls for supplier characteristics, we find that the coefficient on *PostScope3* is -0.067, also significantly negative at the 1% level. In column (3), when we add controls for customer characteristics, we continue to find a similar result. In particular, the coefficient of -0.066 in

column (3) implies a 6.4% reduction in green gas emissions (i.e., exp(-0.066) – 1 = -0.0638) for a supplier after its customer started to issue Scope 3 emission disclosures. We also find similar results when we replace firm fixed effects with firm-customer fixed effects in columns (4) through (6), suggesting that suppliers in our sample reduced greenhouse gas emissions after their customers started to measure and disclose the Scope 3 emissions.

When it comes to control variables, we find that the coefficient on *S_TotalAssets* is significantly positive for the supplier's greenhouse gas emissions; 0.628 at the 1% level and 0.609 at the 1% level in columns (3) and (6), respectively. The coefficient on *S_Tangible* is also significantly positive; 0.603 at the 5% level and 0.680 at the 1% level in columns (3) and (6), respectively, consistent with larger firms with higher intensity in tangible assets emitting a greater amount of greenhouse gases. We also find that the coefficient on *C_SalesGrowth* is 0.004, significantly positive at the 1% level in column (6), suggesting that suppliers are likely to emit a greater amount of greenhouse gases to deliver their products on time when their customers' demands for these products are growing more rapidly. Overall, the results reported in Table 3 are consistent with suppliers reducing their GHG emissions after their major customers initiated to disclose their Scope 3 emissions.

[Insert Table 3]

4.2 Placebo Tests

To strengthen our inference, we conduct several placebo tests by replacing *PostScope3* with one of the following three indicator variables, $PostScope3^{Placebo1}$, $PostScope3^{Placebo2}$, and $PostScope3^{Placebo3}$: $PostScope3^{Placebo1}$ is an indicator variable that equals one for years after the customer voluntarily initiates Scope 1 or 2 emissions disclosure and zero otherwise. While a customer's decision to disclose Scope 1 or 2 emissions is correlated with various factors

influencing the company's overall decision to issue climate-related disclosures, customers do not account for emissions from suppliers in their Scope 1 and 2 disclosures. $PostScope3^{Placebo2}$ is an indicator variable that equals one for years after a pseudo customer, selected from a list of major customers and randomly assigned to each supplier, initiates Scope 3 emissions disclosures and zero otherwise. $PostScope3^{Placebo3}$ is an indicator variable similarly defined as $PostScope3^{Placebo2}$ except that we require the pseudo customer to operate in the same industry as the true customer (based on the 2-digit SIC code).

Table 4 reports the results from the placebo tests. When using firm and industry-year fixed effects, in column (1), the coefficient on $PostScope3^{Placebo1}$ is insignificant, mitigating the possibility that the reduction in supplier emissions we document above is driven by customer characteristics correlated with the customer's decision to issue climate-related disclosures (including their commitment to combat climate risks in general) or by customer-supplier matching where customers tend to choose suppliers with similar environmental policies. In columns (2) and (3), we continue to find an insignificant coefficient on $PostScope3^{Placebo2}$ and $PostScope3^{Placebo3}$, respectively, alleviating the concern that the reduction in supplier emissions we document above is due to any market-wide or industry-wide, climate-related common shocks concurrently experienced by both the customer and its suppliers. When replacing firm fixed effect with firm-customer fixed effect, in columns (4) through (6), the coefficients on these pseudo variables are still all insignificant, reinforcing our inference that the reduced emissions we document in our main analysis are attributable mainly to a customer's Scope 3 emissions disclosure.

[Insert Table 4]

4.3 Dynamic Analysis

To ensure there is no pre-period trend in greenhouse gas emissions, we conduct a dynamic analysis by estimating the following regression equation.

$$\begin{aligned} S\_Emission = \; & \alpha + \beta_1 PostScope3^{-4} + \beta_2 PostScope3\text{-}^{3} + \beta_3 PostScope3^{-2} + \beta_4 PostScope3^{-1} \\ & + \beta_5 PostScope3^{0} + \beta_6 PostScope3^{+1} + \beta_7 PostScope3^{+2} + \beta_8 PostScope3^{+3} \\ & + \beta_9 PostScope3^{+4+} + Controls + Fixed\ Effects + \varepsilon \end{aligned} \quad (2)$$

$PostScope3^{-t}$ is an indicator variable that equals one for firm-years t years before the customer initiated the Scope 3 emissions disclosure and zero otherwise. $PostScope3^{0}$ is an indicator variable that equals one for firm-years in the year when the customer initiated the Scope 3 emissions disclosure and zero otherwise.[10] $PostScope3^{+t}$ equals one for firm-years t years after the customer initiated the Scope 3 emissions disclosure and zero otherwise. $PostScope3^{+4+}$ equals one for firm-years four or more years after the customer initiated the Scope 3 emissions disclosure and zero otherwise. As such, the coefficients on these indicator variables capture the changes in the supplier's greenhouse gas emissions in those years relative to the earliest years in the pre-period, i.e., four or more years before the customer started the Scope 3 emissions disclosure.

Tabe 5 reports the results from the dynamic analysis estimating Equation (2). In column (1), when we use firm and industry-year fixed effects, the coefficients on $PostScope3^{+1}$, $PostScope3^{+2}$, $PostScope3^{+3}$ and $PostScope3^{+4+}$ are -0.106, -0.138, -0.140, and -0.106, respectively, mostly significantly negative at the 1% or 5% level, except for the coefficient on $PostScope3^{+1}$. These results suggest that suppliers begin to reduce their emissions one year after the initiation of their customer's Scope 3 emissions disclosures. Taking into account the adjustment time required for suppliers, a one-year lag in observing the effect is deemed

[10] The initiation year is regarded as part of the pre-period in our main analysis.

reasonable. More importantly, we find that the coefficients on $PostScope3^{-4}$, $PostScope3^{-3}$, $PostScope3^{-2}$, $PostScope3^{-1}$ and $PostScope3^{0}$ are all insignificant, suggesting that there is no differential time trend in greenhouse gas emissions during the pre-period between suppliers affected by the customers' disclosures and those who are not. Hence the parallel trend assumption holds. In column (2), when we replace firm fixed effects with firm-customer fixed effects, we continue to find no differential pre-trend between the two groups of suppliers.

In addition, the results in Tabe 5 further assure that the reduction in greenhouse gases emitted by suppliers in the post-period is not attributable to supply chain-specific common shocks simultaneously affecting the customers and their suppliers. For example, if a customer and its supplier were concurrently pressured to improve their sustainability practices by a common shock (e.g., increased public attention due to environmental scandals caused by peer firms in competing supply chains), we should observe the customer's initiation of the Scope 3 emissions disclosure at the same time as the supplier's reduction in greenhouse gas emissions. We then would expect to find a significantly negative coefficient on $PostScope3^{0}$. However, given the coefficient on $PostScope3^{0}$ is not significant, it mitigates the possibility that any concurrent shocks common to both firms might have led them to exert efforts to go green either by enhancing emissions disclosures or by reducing emissions.

[Insert Tabe 5]

V. Cross-Sectional Analyses

5.1 Test of H2: Role of Supplier's Climate Risks

H2 suggests that a supplier's reduction in greenhouse gas emissions in the post-period would be greater when the supplier poses a greater climate risk for its customer. Hence we split the sample into two groups based on the amount of greenhouse gases emitted by the supplier as

measured at the beginning of each year. We construct an indicator variable, *HighRisk*, that equals one if the supplier's emission is above the sample median and zero otherwise. We also construct $PostScope3^{HighRisk}$ and $PostScope3^{LowRisk}$ as the product of *PostScope3* and *HighRisk*, and the product of *PostScope3* and (1 - *HighRisk*), respectively. We then estimate the following regression equation to test H2.

$$S\_Emission = \alpha + \beta_1 PostScope3^{HighRisk} + \beta_2 PostScope3^{LowRisk} + \beta_3 HighRisk + Controls + Fixed\ Effects + \varepsilon \quad (3)$$

Tabe 6 reports the results from the cross-sectional analysis estimating Equation (3). In column (1), when we use firm and industry-year fixed effects, the coefficient on $PostScope3^{HighRisk}$ is -0.119, significantly negative at the 1% level, but the coefficient on $PostScope3^{LowRisk}$ is insignificant. The difference in the magnitude of these coefficients is 0.147, significantly different from zero at the 1% level. Also, in column (2), when we replace firm fixed effects with firm-customer fixed effects, the coefficient on $PostScope3^{HighRisk}$ is -0.118, significantly negative at the 1% level, but the coefficient on $PostScope3^{LowRisk}$ is insignificant. The difference in the magnitude of these coefficients is 0.156, significantly different from zero at the 1% level. Overall, the findings in Table 6 align with H2, indicating that when a supplier's emissions could potentially pose a higher climate risk to the customer if left unaddressed, the disclosure of Scope 3 emissions by the customer has a more significant impact on the supplier's emissions reduction efforts.

[Insert Tabe 6]

5.2 Test of H3: Role of Customer-Supplier Relationship

5.2.1 Supplier's Bargaining Power

H3a suggests that a supplier's reduction in greenhouse gas emissions in the post-period would be greater when it has lower bargaining power. Hence we split the sample into two groups

based on the strength of the supplier's bargaining power. We construct an indicator variable, *LowBargain*, that equals one if the supplier's bargaining power is below the sample median and zero otherwise. We also construct $PostScope3^{LowBargain}$ and $PostScope3^{HighBargain}$ as the product of *PostScope3* and *LowBargain* and the product of *PostScope3* and (1 - *LowBargain*), respectively. We then estimate the following regression equation to test H3a.

$$S\_Emission = \alpha + \beta_1 PostScope3^{HighBargain} + \beta_2 PostScope3^{LowBargain} + \beta_3 HighBargain + Controls + Fixed\ Effects + \varepsilon \quad (4)$$

Panel A of Tabe 7 reports the results from the cross-sectional analysis estimating Equation (4). In columns (1) and (2), *LowBargain* is defined based on the number of firms in the customer's industry, where the supplier would have lower bargaining power with more firms due to higher supplier substitutability. *LowBargain* thus equals one if the number of firms in the customer's SIC 2-digit industry is below the sample median and zero otherwise. We find that the coefficient on $PostScope3^{High\ Bargain}$ is -0.115 with firm fixed effects in column (1) and -0.107 with firm-customer fixed effects in column (2), both significantly negative at the 1% level. However, the coefficient on $PostScope3^{LowBargain}$ is insignificant in both columns (1) and (2). Moreover, the coefficient on $PostScope3^{HighBargain}$ is significantly greater than that on $PostScope3^{LowBargain}$ at the 5% level in both columns, suggesting that the effect of a customer's Scope 3 emissions disclosure is more pronounced when its supplier can be more easily replaced by other firms in the supplier's industry.

5.2.2 Strength of Economic Relationship

H3b suggests that a supplier's reduction in greenhouse gas emissions in the post-period would be greater when the supplier has stronger economic ties with its customer. Hence we split the sample into two groups based on the strength of the customer-supplier economic relationship. We construct an indicator variable, *HighRelation*, that equals one if the strength of the

relationship is above the sample median and zero otherwise. We also construct $PostScope3^{HighRelation}$ and $PostScope3^{LowRelation}$ as the product of *PostScope3* and *HighRelation* and the product of *PostScope3* and (1 - *HighRelation*), respectively. We then estimate the following regression equation to test H3b.

$$S\_Emission = \alpha + \beta_1 PostScope3^{HighRelation} + \beta_2 PostScope3^{LowRelation} + \beta_3 HighRelation + Controls + Fixed\ Effects + \varepsilon \quad (5)$$

Panel B of Table 7 reports the results from the cross-sectional analysis estimating Equation (5). In columns (1) and (2), *HighRelation* is defined based on the extent to which a supplier relies on its customer in sales, being equal to one if the sales reliance (i.e., the supplier's sales to the customer scaled by the supplier's total sales) is above the sample median and zero otherwise. We find that the coefficient on $PostScope3^{HighRelation}$ is -0.121 with firm fixed effects in column (1) and -0.108 with firm-customer fixed effects in column (2), both significantly negative at the 1% level. However, the coefficient on $PostScope3^{LowRelation}$ is insignificant in both columns (1) and (2). Moreover, the coefficient on $PostScope3^{HighRelation}$ is significantly greater than that on $PostScope3^{LowRelation}$ at the 1% level in both columns (1) and (2), suggesting that the effect of a customer's Scope 3 emissions disclosure is more pronounced when its supplier generates a greater amount of sales from the customer.

5.2.3 Duration of Business Relationship

H3c predicts that a supplier's reduction in greenhouse gas emissions in the post-period would be greater when the customer-supplier pair has long-standing ties. Hence we split the sample into two groups based on the duration of the customer-supplier business relationship. *LongDuration* is defined based on the duration of the customer-supplier relationship, being equal to one if the number of consecutive years a supplier reports its customer as a major customer in its 10-K in the current and past years is above the sample median and zero otherwise. We also

construct $PostScope3^{LongDuration}$ and $PostScope3^{ShortDuration}$ as the product of *PostScope3* and *LongDuration* and the product of *PostScope3* and (1 - *LongDuration*), respectively.

We then estimate the following regression equation to test H3c.

$$S\_Emission = \alpha + \beta_1 PostScope3^{LongDuration} + \beta_2 PostScope3^{ShortDuration} + \beta_3 LongDuration + Controls + Fixed\ Effects + \varepsilon \quad (6)$$

Panel C of Tabe 7 presents the results from estimating Equation (6). We find that the coefficient on $PostScope3^{High\ Relation}$ is -0.106 with firm fixed effects in column (1) and -0.116 with firm-customer fixed effects in column (2), both significantly negative at the 1% level. However, the coefficient on $PostScope3^{ShortDuration}$ is insignificant in both columns (1) and (2). Moreover, the coefficient on $PostScope3^{HighDuration}$ is also significantly greater than that on $PostScope3^{ShortDuration}$ at the 1% level in both columns (1) and (2).

Overall, the results in Tabe 7 provide evidence consistent with H3, suggesting that a customer's Scope 3 emissions disclosure has a more pronounced effect in greening supply chains when the supplier has weaker bargaining power and when the customer-supplier pair have stronger economic and long-standing ties.

[Insert Tabe 7]

VI. Additional Analyses

6.1 Alternative Explanation: Customer Monitoring and Sustainability Endeavors

An alternative explanation to our findings is that customers committed to combating climate risks are more likely to pressure suppliers to reduce emissions and at the same time initiate Scope 3 emissions disclosures. Dai, Liang, and Ng (2021) suggest that socially responsible corporate customers exert influence on suppliers to adopt comparable socially responsible business practices. Thus, our findings could be attributable to the customer's private

monitoring through direct intervention with suppliers, rather than the signals that public disclosures send to suppliers. While we acknowledge that suppliers are under the influence of the customer's direct and private monitoring (and thus we are unable to completely rule out this possibility), to establish that the customer's Scope 3 emissions disclosure can at least play an incremental role in reducing supplier emissions over and above the direct pressure from the customer, we conduct the following additional tests.

First, if our findings are driven by the customer's endeavor to instill a commitment to sustainability in its suppliers, we should find no effect of Scope 3 emissions disclosure once we control for the customer's overall commitment to ESG. We thus use *C_Escore*, the customer's environmental score from Sustainalytics, to proxy for the customer's sustainable endeavor and include this variable as an additional control in estimating Equation (1). We report the results of this analysis in Panel A of Table 8. In column (1), when we use firm fixed effects, the coefficient on *C_Escore* is -0.001, significantly negative at the 5% level, suggesting that customers with higher environmental ratings have suppliers with lower emissions, consistent with socially responsible customers exerting influence supplies to be similarly socially responsible.[11] However, despite controlling for *C_Escore*, we continue to find that the coefficient on *PostScope3* is -0.022, significantly negative at the 10% level, suggesting that the effect of the customer's Scope 3 emissions disclosures is not subsumed by the customer's overall commitment to sustainability. In column (2), when we replace firm fixed effects with firm-customer fixed effects, the coefficient on *C_Escore* is insignificant, but we continue to find a significantly negative coefficient of -0.039 on *PostScope 3* at the 5% level, assuring again that the customer's Scope 3 emissions

[11] Alternatively, this result can also align with assortative matching between customers and supplies, where socially responsible customers tend to engage with socially responsible suppliers. However, this is less likely in our sample as we use firm-customer fixed effects and exclude cases where customer switches suppliers after the initiation of Scope 3 emissions disclosure.

disclosure plays an incremental role in reducing the suppliers' emissions beyond the customer's sustainability endeavor.

Second, customers that achieve a substantial reduction in their own emissions are likely to exhibit higher sustainability endeavor and thus exert more pressure on suppliers to follow suit. Hence, we split the sample into two groups based on the change in the customer's Scope 1 and 2 emissions before and after they initiate Scope 3 emissions disclosure. If our results are driven solely by direct pressure from socially responsible customers, we should find a greater reduction in supplier emissions for a subsample of suppliers where the customers reported a reduction in Scope 1 and 2 emissions. We thus construct an indicator variable, *HighEndeavor*, that equals one if the customer reports a reduction in Scope 1 and 2 emissions and zero otherwise. We also construct $PostScope3^{Hig\ Endeavor}$ and $PostScope3^{Lo\ Endeavor}$ as the product of *PostScope3* and *HighEndeavor* and the product of *PostScope3* and (1 - *HighEndeavor*), respectively. We then estimate the following regression equation.

$$S\_Emission = \alpha + \beta_1 PostScope3^{HighEndeavor} + \beta_2 PostScope3^{LowEndeavor} + B_3 HighEndeavor + Controls + Fixed\ Effects + \varepsilon \quad (7)$$

We report the results of this test in Panel B of Table 8. We find that the coefficient on $PostScope3^{HighEndeavor}$ is -0.051 with firm fixed effects in column (1) and -0.049 with firm-customer fixed effects in column (2), both significantly negative at the 10% level. However, the coefficient on $PostScope3^{LowEndeavor}$ is also significantly negative; -0.080 in column (1) and -0.075 in column (2). Moreover, in both columns (1) and (2), we do not find a significant difference in the coefficients between $PostScope3^{HighEndeavor}$ and $PostScope3^{LowEndeavor}$, suggesting the reduction in suppliers' emissions cannot be solely explained by customers' direct monitoring from their overall sustainability endeavor.

[Insert Table 8]

6.2 Robustness Tests

We perform the following robustness tests and report the results in Table 9. First, in columns (1) and (2), to rule out the possibility that our results are driven by a common location-specific environmental shock concurrently experienced by both the customer and its suppliers, we exclude firm-customer pairs with headquarters in the same city and show that the coefficient on *PostScope3* continues to be significantly negative. Second, in columns (3) and (4), to rule out the possibility that our results are driven by a common industry-specific environmental shock concurrently experienced by both the customer and its suppliers, we exclude firm-customer pairs in the same industry (based on 2-digit SIC code) and show that the coefficient on *PostScope3* continues to be significantly negative. Third, in columns (5) and (6), to rule out the possibility that our results are driven by common blockholders exerting concurrent pressure on both the customer and its suppliers, we exclude firm-customer pairs with common institutional investors holding more than 5% of the shares of both the supplier and the customer. We find that the coefficient on *PostScope3* continues to be significantly negative.

[Insert Table 9]

Lastly, we further perform the following untabulated tests. First, while prior studies on carbon emissions (e.g., Bolton and Kacperczyk 2022 and 2023) also rely on Trucost for firm-level carbon emissions data, Trucost occasionally provides *estimates* of the firm's carbon emissions when not disclosed by the companies themselves. This raises a concern about potential measurement errors influencing our results. To address this concern, we partition the sample into two groups based on whether the emissions are disclosed or estimated, as indicated in the Trucost database, and find that the coefficient on *PostScope3* continues to be significantly negative for the subsample with disclosed emissions (untabulated). Second, the supplier's

socially responsible behavior is likely to be a determinant of its emissions. Hence, we additionally control for the supplier's environmental rating from Sustainalytics, *S_Escore*, and find that our results continue to hold. The coefficient on *S_Escore* is negative but insignificant possibly due to the significant drop in sample size and the lack of variation in ratings over time given we control for either firm or firm-customer fixed effects (untabulated).[12] Lastly, to rule out the possibility that our results are driven by the supplier's overall production, we re-estimate equation (1) with emissions intensity as an alternative dependent variable. *S_EmissionIntensity* is defined as the natural log of the supplier's emission scaled by lagged total assets. Consistent with our main analysis, we find that the coefficient on *PostScope3* continues to be negative and significant at the 1% level (untabulated).

VII. Conclusion

We examine the role of a corporate customer's Scope 3 emissions disclosure in greening supply chains. While studies in operations and supply chain management suggest that customers can monitor or guide suppliers to diffuse environmental practices across firms in their supply chains, the role of the customer's emissions disclosure in greening supply chains has been less explored. Building on accounting and supply chain literature, we argue that a customer's Scope 3 emissions disclosure signals the customer's commitment to decarbonized supply chains and thus mitigates uncertainties that suppliers face regarding the customer's environmental strategies, allowing suppliers to make more efforts in collaborating with the customer for sustainability. Consistent with this argument, we find that suppliers reduce greenhouse gas emissions after their customer initiates Scope 3 emissions disclosure. We also find that the customers' disclosures

[12] We do not include *S_Escore* as one of the main control variables in Equation (1) due to the lack of ratings for many of the suppliers in our sample.

entail greater effects on the supplier's emissions when the supplier poses greater climate risk for their customers, when the customer has higher bargaining power, and when the customer and supplier have stronger economic and longer-standing ties.

Our study informs regulators and policy makers currently considering whether and how to mandate climate-related disclosures. Although Scope 3 emissions account for a substantial portion of greenhouse gases emitted by firms and hence pose critical climate risks, their disclosure has yet to be mandated. Our study provides novel evidence on the beneficial consequence that a customer's Scope 3 emissions disclosure can bring about for its supply chain in the absence of regulation. We also contribute to the environmental and social (E&S) studies in the accounting and finance literature. Our results suggest that corporate disclosures can also facilitate the spillover of E&S practices. Lastly, we contribute to the literature in operations and supply chain management by highlighting the role of a customer's emissions disclosure for green supply chains.

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Appendix A Definition of Variables

Variable	Definition
Variables for Main Analyses	
S_Emission (Raw)	= Supplier's total greenhouse gas emissions in metric tons of CO2 equivalent (in thousands).
S_Emission	= Supplier's greenhouse gas emissions, measured as the natural log transformation of one plus the firm's total greenhouse gas emissions in metric tons of CO2 equivalent.
PostScope3	= An indicator variable that equals one for the post-Scope3 disclosure period and zero otherwise.
S_TotalAssets	= Supplier's total assets, measured as the natural log transformation of the firm's total assets at the beginning of the year.
S_Tangible	= Supplier's tangible assets, measured as the firm's property, plant, and equipment, net of accumulated depreciation, scaled by total assets at the beginning of the year.
S_SalesGrowth	= Supplier's sales growth, measured as the firm's change in sales between the current and the previous years, scaled by sales in the previous year.
S_ROA	= Supplier's return on assets (ROA), measured as the firm's operating income after depreciation, scaled by total assets averaged across the beginning and the end of the year.
S_Leverage	= Supplier's leverage, measured as the firm's long-term debt scaled by total assets at the beginning of the year.
C_TotalAssets	= Customer's total assets, measured as the natural log transformation of the firm's total assets at the beginning of the year.
C_SaleGrowth	= Customer's sales growth, measured as the firm's change in sales between the current and the previous year, scaled by the sales in the previous year.
C_ROA	= Customer's return on assets (ROA), measured as the firm's operating income after depreciation, scaled by total assets averaged across the beginning and the end of the year.
Variables for Placebo Test	
PostScope3 ^{Placebo1}	= An indicator variable that equals one for years after the customer initiated the disclosure of Scope 1 or 2 emissions and zero otherwise.
PostScope3 ^{Placebo2}	= An indicator variable that equals one for years after a pseudo customer, selected from a list of major customers and randomly assigned to each supplier, initiates the discourse of Scope 3 emissions and zero otherwise.
PostScope3 ^{Placebo3}	= An indicator variable that equals one for years after a pseudo customer, selected from a list of major customers operating in the same industry as the true customers and randomly assigned to each supplier, initiates the discourse of Scope 3 emissions and zero otherwise.
Variables for Cross-Sectional Tests	
HighRisk	= An indicator variable that equals one if the supplier's Scope 1 and 2 emissions measured at the beginning of the year is above the sample

	median and zero otherwise.
LowBargain	= An indicator variable that equals one if the number of firms in the customer's industry (based on the 2-digit SIC code) is below the sample median and zero otherwise.
HighRelation	= An indicator variable that equals one if the supplier's sales reliance on the customer (i.e., the supplier's sales to the customer scaled by the supplier's total sales) is above the sample median and zero otherwise.
LongDuration	= An indicator variable that equals one if the number of consecutive years the supplier reports the customer as its major customer in its 10-K in the current and past years is above the sample median and zero otherwise.

Table 1 Sample Selection

This table outlines our sample selection procedure.

	The number of firm-years
Compustat-S&P Trucost databases (2004-2019)	7,774
Exclude firms with missing firm-level characteristics	(1,319)
Exclude firms with missing major customer characteristics	(54)
Final Sample	6,401

Table 2 Descriptive Statistics

This table reports descriptive statistics. Panel A shows the yearly distribution of the firm-year observations in our sample. Panel B presents summary statistics for the variables used in our analyses. See Appendix A for variable definitions.

Panel A: Yearly Distribution of Sample Firms

Year	The number of treated firms			The number of control firms	Total
	PostScope3 = 1	*PostScope3* = 0	Total		
2004	0	112	112	78	190
2005	0	138	138	119	257
2006	1	126	127	108	235
2007	1	122	123	94	217
2008	5	122	127	90	217
2009	8	122	130	107	237
2010	12	118	130	125	255
2011	28	104	132	115	247
2012	44	89	133	112	245
2013	100	47	147	142	289
2014	106	41	147	159	306
2015	105	40	145	165	310
2016	278	105	383	436	819
2017	298	87	385	469	854
2018	338	58	396	446	842
2019	400	7	407	474	881
Total	1,724	1,438	3,162	3,239	6,401

Panel B: Summary Statistics

	N	Mean	Std Dev	25th Pctl	50th Pctl	75th Pctl
S_Emission	6,401	12.863	2.263	11.391	13.043	14.522
S_Emission (Raw)	6,401	2,833	9,674	88	461	2,026
PostScope3	6,401	0.269	0.444	0.000	0.000	1.000
S_TotalAssets	6,401	7.905	1.672	6.800	7.985	8.903
S_Tangible	6,401	0.258	0.261	0.062	0.158	0.346
S_SalesGrowth	6,401	0.219	2.041	-0.011	0.074	0.194
S_ROA	6,401	0.015	0.193	0.001	0.045	0.084
S_Leverage	6,401	0.244	0.247	0.070	0.206	0.360
C_TotalAssets	6,401	10.669	1.658	9.630	10.723	12.004
C_SalesGrowth	6,401	0.149	3.400	-0.005	0.054	0.123
C_ROA	6,401	0.051	0.103	0.024	0.051	0.084

Table 3 Test of H1: Effect of Customers' Scope 3 Emissions Disclosure

This table reports the results from the regression estimating Equation (1). Columns (1) through (3) report the result with firm and industry-year fixed effects. Columns (4) through (6) report the result with firm-customer and industry-year fixed effects. See Appendix A for variable definitions. All p-values are two-sided and are calculated based on standard errors adjusted for industry-year clustering. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

	Dependent Variable: *S_Emission*					
	(1)	(2)	(3)	(4)	(5)	(6)
PostScope3	**-0.118*** **	**-0.067*** **	**-0.066** **	**-0.114*** **	**-0.064*** **	**-0.061*** **
	(0.034)	**(0.025)**	**(0.026)**	**(0.028)**	**(0.021)**	**(0.021)**
S_TotalAssets		0.628***	0.628***		0.608***	0.609***
		(0.029)	(0.030)		(0.033)	(0.033)
S_Tangible		0.595**	0.603**		0.667**	0.680***
		(0.275)	(0.274)		(0.259)	(0.259)
S_SaleGrowth		-0.001	-0.001		-0.004	-0.004
		(0.009)	(0.009)		(0.007)	(0.007)
S_ROA		0.106	0.107		0.099	0.095
		(0.097)	(0.096)		(0.087)	(0.086)
S_Leverage		0.039	0.038		0.086	0.086
		(0.090)	(0.090)		(0.098)	(0.098)
C_TotalAssets			0.002			-0.006
			(0.004)			(0.023)
C_SaleGrowth			0.001			0.004***
			(0.001)			(0.000)
C_ROA			0.165***			0.236***
			(0.043)			(0.080)
No. of Obs.	6,401	6,401	6,401	6,401	6,401	6,401
R^2	0.976	0.984	0.984	0.981	0.987	0.987
Firm FE	Yes	Yes	Yes	No	No	No
Firm-Customer FE	No	No	No	Yes	Yes	Yes
Industry-Year FE	Yes	Yes	Yes	Yes	Yes	Yes

Table 4 Placebo Test of Customers' Scope 3 Emissions Disclosure

This table reports the results from the placebo test. Columns (1) through (3) report the result with firm and industry-year fixed effects. Columns (4) through (6) report the result with firm-customer and industry-year fixed effects. See Appendix A for variable definitions. All p-values are two-sided and are calculated based on standard errors adjusted for industry-year clustering. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

	Dependent Variable: *S_Emission*					
	(1)	(2)	(3)	(4)	(5)	(6)
PostScope3 ^{Placebo1}	**-0.017**			**-0.006**		
	(0.017)			**(0.030)**		
PostScope3 ^{Placebo2}		**-0.003**			**0.032**	
		(0.039)			**(0.047)**	
PostScope3 ^{Placebo3}			**-0.053**			**-0.024**
			(0.034)			**(0.032)**
S_TotalAssets	0.630***	0.631***	0.629***	0.610***	0.609***	0.610***
	(0.030)	(0.030)	(0.030)	(0.033)	(0.033)	(0.033)
S_Tangible	0.610**	0.611**	0.607**	0.687***	0.683***	0.685***
	(0.275)	(0.276)	(0.275)	(0.260)	(0.259)	(0.260)
S_SaleGrowth	-0.001	-0.001	-0.001	-0.004	-0.004	-0.004
	(0.009)	(0.009)	(0.009)	(0.007)	(0.007)	(0.007)
S_ROA	0.105	0.106	0.104	0.093	0.093	0.092
	(0.096)	(0.096)	(0.096)	(0.086)	(0.086)	(0.085)
S_Leverage	0.037	0.037	0.032	0.084	0.083	0.082
	(0.091)	(0.091)	(0.092)	(0.099)	(0.099)	(0.099)
C_TotalAssets	0.003	0.002	0.002	-0.007	-0.006	-0.006
	(0.004)	(0.004)	(0.004)	(0.022)	(0.023)	(0.022)
C_SaleGrowth	0.001	0.001	0.001	0.004***	0.004***	0.004***
	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)
C_ROA	0.173***	0.171***	0.169***	0.246***	0.247***	0.245***
	(0.043)	(0.043)	(0.043)	(0.080)	(0.081)	(0.080)
No. of Obs.	6,401	6,401	6,401	6,401	6,401	6,401
R^2	0.984	0.984	0.984	0.987	0.987	0.987
Firm FE	Yes	Yes	Yes	No	No	No
Firm-Customer FE	No	No	No	Yes	Yes	Yes
Industry-Year FE	Yes	Yes	Yes	Yes	Yes	Yes

Table 5 Dynamic Analysis of Customers' Scope 3 Emissions Disclosure

This table reports the results from the dynamic analysis estimating Equation (2). Column (1) reports the result with firm and industry-year fixed effects. Column (2) reports the result with firm-customer and industry-year fixed effects. $PostScope3^{-t}$ equals one for firm-years t year(s) before the customer initiated the Scope 3 emissions disclosures and zero otherwise. $PostScope3^{0}$ equals one for firm-years in the year when the customer initiated the Scope 3 emissions disclosures and zero otherwise. $PostScope3^{+t}$ equals one for firm-years t year(s) after the customer initiated the Scope 3 emissions disclosures and zero otherwise. $PostScope3^{+4+}$ equals one for firm-years four or more years after the customer initiated the Scope 3 emissions disclosure and zero otherwise. See Appendix A for variable definitions. All p-values are two-sided and are calculated based on standard errors adjusted for industry-year clustering. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

	Dependent Variable: *S_Emission*	
	(1)	(2)
$PostScope3^{-4}$	-0.003	-0.001
	(0.052)	(0.043)
$PostScope3^{-3}$	-0.019	-0.007
	(0.050)	(0.038)
$PostScope3^{-2}$	-0.064	-0.053
	(0.051)	(0.041)
$PostScope3^{-1}$	-0.090	-0.074
	(0.056)	(0.046)
$PostScope3^{0}$	-0.060	-0.051
	(0.058)	(0.047)
$PostScope3^{+1}$	-0.106	-0.092*
	(0.069)	(0.055)
$PostScope3^{+2}$	-0.138**	-0.133**
	(0.065)	(0.054)
$PostScope3^{+3}$	-0.140**	-0.136**
	(0.064)	(0.055)
$PostScope3^{+4+}$	-0.106*	-0.102
	(0.064)	(0.064)
No. of Obs.	6,401	6,401
R^2	0.984	0.987
Controls	Yes	Yes
Firm FE	Yes	No
Firm-Customer FE	No	Yes
Industry-Year FE	Yes	Yes

Table 6 Test of H2: Role of Suppliers' Climate Risks

This table reports the results from the cross-sectional tests estimating Equation (3) based on suppliers' climate risks. $PostScope3^{Hig\ Risk}$ is the product of *PostScope3* and *HighRisk*. $PostScope3^{LowRisk}$ is the product of *PostScope3* and (*1 - HighRisk*). *HighRisk* is an indicator variable that equals one if the supplier's emission measured at the beginning of the year is above the sample median and zero otherwise. Column (1) reports the result with firm and industry-year fixed effects. Column (2) reports the result with firm-customer and industry-year fixed effects. See Appendix A for variable definitions. All p-values are two-sided and are calculated based on standard errors adjusted for industry-year clustering. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

	Dependent Variable: *S_Emission*	
	(1)	(2)
PostScope3^{HighRisk}	**-0.119*** **	**-0.118*** **
	(0.029)	**(0.024)**
PostScope3^{LowRisk}	**0.028**	**0.038**
	(0.038)	(0.041)
HighRisk	0.348***	0.336***
	(0.048)	(0.047)
No. of Obs.	6,401	6,401
R^2	0.984	0.988
Controls	Yes	Yes
Firm FE	Yes	No
Firm-Customer FE	No	Yes
Industry-Year FE	Yes	Yes
Test of $PostScope3^{HighRisk} = PostScope3^{LowRisk}$		
Difference	0.147	0.156
P-value	[0.000]	[0.002]

Table 7 Test of H3: Role of Customer-Supplier Relationship

This table reports the results from the cross-sectional tests based on customer-supplier relationship estimating Equations (4), (5), and (6) in Panels A, B, and C, respectively. In Panel A, *LowBargain* is an indicator variable that equals one if the number of firms in the customer's industry (based on the 2-digit SIC code) is below the sample median and zero otherwise. $PostScope3^{LowBargain}$ is the product of *PostScope3* and *LowBargain*. $PostScope3^{HighBargain}$ is the product of *PostScope3* and (*1 – LowBargain*). In Panel B, *High Relation* is an indicator variable that equals one if the supplier's sales reliance on the customer (i.e., the supplier's sales to the customer scaled by the supplier's total sales) is above the sample median and zero otherwise. $PostScope3^{HighRelation}$ is the product of *PostScope3* and *HighRelation*. $PostScope3^{LowRelation}$ is the product of *PostScope3* and (*1 – HighRelation*). In Panel C, *LongDuration* is an indicator variable equal to one if the number of consecutive years the supplier reports the customer as its major customer in its 10-K in the current and past years is above the sample median and zero otherwise. $PostScope3^{LongDuration}$ is the product of *PostScope3* and *LongDuration*. $PostScope3^{ShortDuration}$ is the product of *PostScope3* and (*1 – LongDuration*). Column (1) reports the result with firm and industry-year fixed effects. Column (2) reports the result with firm-customer and industry-year fixed effects. See Appendix A for variable definitions. All p-values are two-sided and are calculated based on standard errors adjusted for industry-year clustering. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Panel A: High Bargaining Power

	Dependent Variable: *S_Emission*	
	(1)	(2)
$PostScope3^{LowBargain}$	**-0.115*** **	**-0.107*** **
	(0.033)	**(0.028)**
$PostScope3^{HighBargain}$	**-0.014**	**-0.015**
	(0.032)	**(0.034)**
LowBargain	-0.076***	-0.076*
	(0.021)	(0.045)
No. of Obs.	6,401	6,401
R^2	0.984	0.987
Controls	Yes	Yes
Firm FE	Yes	No
Firm-Customer FE	No	Yes
Industry-Year FE	Yes	Yes
Test of $PostScope3^{LowBargain} = PostScope3^{HighBargain}$		
Difference	0.101	0.092
P-value	[0.012]	[0.048]

Table 7, Continued

Panel B: High Economic Relationship

	Dependent Variable: *S_Emission*	
	(1)	(2)
PostScope3^{HighRelation}	**-0.121*** **	**-0.108*** **
	(0.032)	**(0.033)**
PostScope3^{LowRelation}	**-0.004**	**0.039**
	(0.027)	**(0.032)**
HighRelation	-0.065***	-0.102***
	(0.025)	(0.037)
No. of Obs.	4,640	4,640
R^2	0.984	0.987
Controls	Yes	Yes
Firm FE	Yes	No
Firm-Customer FE	No	Yes
Industry-Year FE	Yes	Yes
Test of *PostScope3^{HighRelation} = PostScope3^{LowRelation}*		
Difference	0.118	0.146
P-value	[0.000]	[0.000]

Table 7, Continued

Panel C: Long Relationship Duration

	Dependent Variable: *S_Emission*	
	(1)	(2)
PostScope3^{LongDuration}	**-0.106*** **	**-0.116*** **
	(0.030)	**(0.028)**
PostScope3^{ShortDuration}	**-0.016**	**0.030**
	(0.032)	**(0.038)**
LongDuration	0.013	0.081***
	(0.014)	(0.026)
No. of Obs.	6,401	6,401
R^2	0.984	0.987
Controls	Yes	Yes
Firm FE	Yes	No
Firm-Customer FE	No	Yes
Industry-Year FE	Yes	Yes
Test of *PostScope3^{LongDuration} = PostScope3^{ShortDuration}*		
Difference	0.090	0.146
P-value	[0.005]	[0.004]

Table 8 Disclosure Effects Incremental to Customer Monitoring and Sustainability Endeavors

This table reports the results of the analyses conducted to mitigate the possibility that our main finding is solely attributable to customer monitoring and sustainability endeavor. Panel A reports the result when the customer's environmental score (*C_Escore*) designated by Sustainalytics is included as an additional control variable in estimating Equation (1). Panel B reports the result of a cross-sectional test estimation Equation (7), comparing the effect of the customer's Scope 3 emissions disclosure on supplier emissions between customers exhibiting higher versus lower sustainability endeavor. *High Endeavor*, is an indicator variable equal to one if the customer reports a reduction in Scope 1 and 2 emissions and zero otherwise. We also construct $PostScope3^{Hign\ Endeavor}$ and $PostScope3^{Low\ Endeavor}$ as the product of *PostScope3* and *High Endeavor* and the product of *PostScope3* and (1 - *High Endeavor*), respectively. Column (1) reports the result with firm and industry-year fixed effects. Column (2) reports the result with firm-customer and industry-year fixed effects. See Appendix A for variable definitions. Panel A excludes All p-values are two-sided and are calculated based on standard errors adjusted for industry-year clustering. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Panel A: Controlling for Customer's Environmental Score

	Dependent Variable: *S_Emission*	
	(1)	(2)
PostScope3	**-0.022***	**-0.039****
	(0.013)	**(0.019)**
C_Escore	-0.001**	-0.001
	(0.001)	(0.001)
No. of Obs.	4,408	4,408
R^2	0.990	0.991
Controls	Yes	Yes
Firm FE	Yes	No
Firm-Customer FE	No	Yes
Industry-Year FE	Yes	Yes

Table 8, Continued

Panel B: Comparing the Effect between Customers with High versus Low Sustainability Endeavors

	Dependent Variable: *S_Emission*	
	(1)	(2)
PostScope3^{HighEndeavor}	**-0.051***	**-0.049***
	(0.027)	**(0.026)**
PostScope3^{LowEndeavor}	**-0.080*****	**-0.075*****
	(0.030)	**(0.027)**
HighEndeavor	-0.013	-0.009
	(0.013)	(0.016)
No. of Obs.	6,401	6,401
R^2	0.984	0.987
Controls	Yes	Yes
Firm FE	Yes	No
Firm-Customer FE	No	Yes
Industry-Year FE	Yes	Yes
Test of *PostScope3^{HighEndeavor} = PostScope3^{LowEndeavor}*		
Difference	-0.029	-0.027
P-value	[0.228]	[0.387]

Table 9 Robustness Tests

This table reports the results from several robustness tests in estimating Equation (1). Columns (1) and (2) report the results when excluding firms whose headquarters are located in the same city as their customers. Columns (3) and (4) report the results when excluding firms operating in the same industry as their customers (based on the 2-digit SIC code). Columns (5) and (6) report the results when excluding firms owned by a blockholder who also blockholds their customers at the same time. Columns (1), (3), and (5) report the result with firm and industry-year fixed effects. Columns (2), (4), and (6) report the result with firm-customer and industry-year fixed effects. See Appendix A for variable definitions. All p-values are two-sided and are calculated based on standard errors adjusted for industry-year clustering. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

	Dependent Variable: *S_Emission*					
	Excluding Customer-Supplier Sharing the Same Location		Excluding Customer-Supplier Sharing the Same Industry		Excluding Customer-Supplier Sharing the Same Blockholders	
	(1)	(2)	(3)	(4)	(5)	(6)
PostScope3	**-0.060****	**-0.053****	**-0.053****	**-0.049***	**-0.149*****	**-0.168*****
	(0.026)	**(0.021)**	**(0.021)**	**(0.026)**	**(0.053)**	**(0.051)**
No. of Obs.	6,290	6,290	4,948	4,948	3,806	3,806
R^2	0.984	0.987	0.987	0.989	0.986	0.990
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	No	Yes	No	Yes	No
Firm-Customer FE	No	Yes	No	Yes	No	Yes
Industry-Year FE	Yes	Yes	Yes	Yes	Yes	Yes