Carbon Pricing and Global Supply Chain Networks

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Abstract

This paper examines how carbon pricing policies influence the reshaping of global supply chain networks. Using the staggered implementation of carbon taxes and emissions trading schemes (ETS) in supplier countries, we document contrasting impacts of the two policies on customers' sourcing decisions. Carbon taxes, by increasing compliance costs, prompt cost-sensitive customers to reduce collaboration with suppliers in taxed countries, especially when customers are financially constrained, less profitable, and facing fierce product market competition, consistent with a cost-avoidance channel. In contrast, ETS encourages customers with a sustainable orientation and innovation capacity to expand their cooperation with suppliers that demonstrate superior environmental performance, reflecting a transformational incentive channel. Additional analysis of the U.S. cap-and-trade market initiatives substantiates the ETS effect of carbon pricing. Overall, our findings highlight the reconfiguration of the global supply chain and demonstrate how carbon pricing policies drive its sustainable transformation.

Keywords: carbon taxes, emission trading schemes (ETS), supply chain, climate policy
JEL Classification: Q58 · F18 · L14 · H23 · Q54

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Carbon prices provide incentives which radiate up and down supply chains and potentially across entire economies, delivering emissions reductions where they make sense.

——— Cameron Hepburn, expert on economically-informed global environmental policy

1. Introduction

Primarily driven by carbon emissions, climate change poses escalating environmental and economic risks worldwide. In response, numerous governments have implemented two major carbon pricing policies over the past decade to curb emissions and incentivize cleaner practices: carbon taxes and emissions trading scheme (ETS).[2] Recent studies predominantly adopted single-country settings to examine carbon pricing policies on carbon footprint, economic outcomes, or firm performance (Metcalf and Stock, 2023; Colmer et al., 2025). However, we know little about how carbon pricing policies affect global supply chains, despite firms being deeply connected across borders.

Environmental factors are increasingly shaping supply chains, affecting sourcing, logistics, and partner selection. For governments, the key challenge lies in reducing carbon emissions without undermining firms' efficiency or competitiveness. It is therefore essential to understand how carbon pricing policies influence the structure and dynamics of global supply chain networks. Studying this impact helps reveal significant spillover effects of climate policy and offers valuable guidance for policymakers. In this study, we aim to empirically address three questions: (1) how carbon pricing policies reconfigure international supply chain linkages; (2) the mechanisms through which such policies alter firm- and network-level behaviors; and (3) the broader economic consequences and policy trade-offs in balancing environmental objectives with efficiency in global production.

The carbon pricing policies implemented in supplier countries can significantly influence downstream customers' sourcing decisions because they directly alter the cost structure and strategic positioning of suppliers. By design, these policies either impose explicit costs on emissions (such as carbon taxes) or create market-based incentives for emissions reduction (through an ETS). As such, their effects on global supply chains may be twofold and potentially divergent. Hence, we develop the

[2] By the end of 2024, 43 carbon taxes and 37 ETSs had been implemented globally (World Bank, 2025).

main hypotheses that carbon pricing policy affects global supply chains through two underlying economic mechanisms. The first is the cost-avoidance channel, whereby cost-sensitive customers reduce sourcing from suppliers facing higher carbon costs under carbon pricing policies. The second is the transformational-incentive channel, through which socially responsible, sustainability-oriented customers strengthen relationships with suppliers that exhibit strong potential for sustainable transformation in response to carbon pricing policies.

The proposed mechanisms are critical because they imply fundamentally different policy outcomes. Through the cost-avoidance channel, carbon pricing may discourage downstream customers from sourcing from suppliers burdened with higher carbon-related costs, potentially weakening a country's position within global supply chains (Martin et al., 2014; Metcalf, 2019).[3] By contrast, the transformational-incentive channel suggests that carbon pricing can attract downstream customers who prioritize suppliers' capacity for green transformation and long-term sustainability (Andersson, 2019; Bai and Ru, 2024). These mechanisms offer valuable guidance for policymakers seeking to anticipate the consequences of different carbon pricing instruments, as well as for firms, particularly suppliers, seeking to understand the evolving priorities of their business partners (e.g., Dai et al., 2021). By examining both mechanisms in the context of carbon taxes and ETS, our study develops a comprehensive framework for assessing how carbon pricing reshapes supply chain structures and incentives.

To test these conjectures empirically, our primary analysis leverages a separate investigation and compares the causal effects of carbon tax adoption and ETS initiatives on the country's downstream supply chain relationships. Although both policies place a carbon price to encourage greener practices, their mechanisms and incentive structures differ fundamentally by design. Carbon taxes impose a fixed, predictable charge per unit of emissions, offering firms little flexibility in managing compliance costs and often compelling them to either reduce emissions or pass costs on to downstream customers (Martin et al., 2014; Parry et al., 2015; Martinsson et al., 2024). By contrast, ETS operates through a

[3] In transaction-cost economics, rising transaction costs incentivize firms to seek lower-cost exchange partners (Williamson, 1979).

cap-and-trade framework that provides greater flexibility and stronger incentives, particularly for firms with high abatement potential. Suppliers emitting below their allowances can sell surplus permits to generate revenue and offset production costs, while firms can adopt diverse compliance strategies such as investing in cleaner technologies, improving efficiency, or trading permits (Ellerman et al., 2010; Bartram et al., 2022; Bai and Ru, 2024; Colmer et al., 2025).[4]

Employing a difference-in-difference framework on the staggered policy initiation of carbon pricing across suppliers' countries, we study the impact of supplier-side carbon taxes and ETS on customer firms' sourcing decisions, which compares the change in the total number of supply chain contracts of customer firms in supplier countries with carbon taxes and ETS (treatment group) with that of customer firms in supplier countries without carbon pricing instruments (control group), respectively. Our sample compiled a comprehensive dataset of global public firms that integrates domestic and cross-border supply chain relationships with carbon pricing, as well as firm-level and country-level information. We use the carbon pricing information in Bai and Ru (2024) and add the initiatives adopted in recent years using other credible sources (e.g., World Bank Carbon Pricing Dashboard).[5] The core of our supply chain data is from FactSet Revere, which identifies firm-to-firm contractual linkages using annual reports, regulatory filings, and other publicly available sources, covering the period from 2003 to 2024.[6]

Our analysis reveals the opposite impact of the carbon taxes and ETS on the global supply chain. Customer firms' sourcing supply chains significantly decline in response to country-level carbon tax adoptions but substantially increase following the initiation of ETS. Economically, after the adoption of a carbon tax in the supplier country, the average decline in the sourcing supply chain of affected customer firms is 1.8% greater than that of customer firms experiencing no carbon tax in their supplier

[4] These design differences shape distinct transmission channels and policy outcomes. A poorly calibrated instrument risks disrupting downstream supply chains, whereas a well-designed policy can both reduce emissions and strengthen resilient, sustainable production networks. Recognizing these distinctions is therefore crucial for effective climate policy, climate finance, and international policy coordination (OECD/IEA/NEA/ITF, 2015; Flues and van Dender, 2020).

[5] Bai and Ru (2024) provide the first international evidence, showing that ETSs reduce emissions more effectively, generate larger economic effects than carbon taxes, and foster renewable energy adoption. Following Bai and Ru (2024), we set the adoption year of the first carbon tax and ETS as the adoption year in the supplier country, respectively.

[6] Our analysis started in 2003 because the FactSet Revere supply chain data began in 2003. Literature has extensively utilized this database, as demonstrated by studies such as Dai et al. (2021), Ersahin et al. (2024), and Pankratz and Schiller (2024).

country. After an ETS initiation, the average increase in customer firms' sourcing supply chain of affected firms is 4.2% more than that of firms without ETS in their supplier country. Overall, customer firms' sourcing choices vary with the carbon pricing policies. The contrasting net effects of carbon taxes and ETS indicate that customer firms are more concerned about the direct cost burden of carbon taxes and reduce their sourcing supply chain. In contrast, the increase after ETS shows that market-based incentives for sustainable transformation can primarily drive customer sourcing choices.[7]

To address potential endogeneity, we conduct multiple diagnostic tests. Our primary DiD design probes the parallel-trends condition by adding pre-event indicators before the adoption of the carbon pricing policy. We find no differential pre-trends in customer firms' sourcing supply chain between treated and control groups before carbon pricing policies were adopted in supplier countries. Our parallel trend assumption remains robust when examining the dynamic effects of sourcing supply chain around the carbon pricing adoption event. The dynamic effects test shows that the treated groups' sourcing supply chain declines significantly after adopting the carbon tax and increases substantially following the initiation of the ETS, exhibiting no subsequent reversals. This suggests that carbon pricing policies drive permanent shifts in firms' sourcing supply chain choices. We validate our results using alternative supply chain measures and the stacked DiD approach. Collectively, our diagnostic tests point to a causal effect of carbon pricing on global supply chain networks.

In cross-sectional analyses, we demonstrate that the cost sensitivity of firms' sourcing supply chains to carbon pricing is less pronounced for firms with stronger financing capacity, higher profitability, and less product market competition. The findings are consistent with the cost-avoidance channel, which suggests that firms with greater cost sensitivity incur less sourcing from suppliers facing higher carbon costs under carbon pricing policies. Additionally, we show that the incentives for sustainable transformation of firms' sourcing supply chain in response to carbon pricing increase with better environmental performance, longer sustainability orientation, higher innovation capacity, and

[7] In the cross-sectional heterogeneity analysis, we show that both channels are present in the carbon taxes and ETS, while their net effects are outweighed by the dominant channel in each policy.

larger low-carbon energy use. These results present the transformational incentives channel as socially responsible, sustainability-oriented customers strengthen relationships with suppliers that exhibit strong potential for sustainable transformation in response to carbon pricing policies.

Beyond these channels, we conduct additional heterogeneity tests to explore whether the effects of carbon pricing policies differ systematically across suppliers with varying carbon intensity and carbon pricing policy exposure, across countries with differing levels of climate change performance, and across regimes with differing carbon price levels.[8] We find that firms' sourcing supply chains decline (increase) more in response to the carbon tax (ETS) when their suppliers are emitting more, have higher exposure to carbon pricing policies, and operate in countries with better climate change performance. In addition, we find that customer firms' supply chains decrease (increase) more significantly with higher carbon tax (ETS) prices. More interestingly, when we include the square of the carbon price in the regression, the coefficient on the squared ETS price turns negative, indicating that when the ETS price becomes sufficiently high, the cost channel dominates, and supply chains begin to decrease in response. Based on this result, we estimate the optimal ETS price that maximizes the benefits of ETS without disrupting supply chains due to cost concerns to be US$12.82 /t$CO_2$e. Together, these analyses provide a more nuanced understanding of the mechanisms through which carbon pricing policies reshape global supply chain networks.

Additional analysis on the economic consequences of the supply chain shows that customer firms' CO_2 emissions do not respond significantly to carbon pricing in supplier countries. In contrast, the average CO_2 emissions of supplier firms decline significantly with such policies. These results suggest that, regardless of the source, customers do not reduce their own emissions. Instead, they reallocate sourcing supply chain away from taxed countries and lower upstream emissions. Notably, although customer firms increase their sourcing supply chain in countries that initiate ETS, their total

[8] The Climate Change Performance Index (CCPI) is intended to proxy the realized climate-change performance of the supplier country, as captured by observed outcomes. As such, it should be interpreted as a measure that captures the net effect of time-varying country conditions, such as economic development, technology adoption, the stringency of climate policies (e.g., Bolton and Kacperczyk, 2023), or external shocks. Using the CCPI, therefore, helps us absorb these combined influences and mitigate omitted-variable bias from unobserved or difficult-to-measure confounders in our empirical estimates.

upstream emissions still decrease, highlighting the potential effectiveness of ETS in reducing CO_2 emissions. Furthermore, we examine the impact on the contract transaction amount in the supply chain and find that carbon taxes reduce the total and average transaction amount of customer firms' sourcing supply chains, implying lower deal values. By contrast, ETS increases the total and average transaction amount. These patterns indicate our baseline findings do not merely capture customer firms uniformly adapting their sourcing supply chain in response to the carbon pricing policy in supplier countries. Instead, they prefer ETS among current carbon pricing instruments by increasing transaction amounts in ETS countries, sustaining the transformation of the upstream supply chain, and reducing transaction amounts in taxed countries as the cost pressure escalates.

Finally, we validate the adaptation of customer firms' sourcing supply chains to carbon pricing by examining the initiation of cap-and-trade markets in the U.S., which is a state-level staggered adoption of carbon pricing policies. In line with our main results, customer firms increased their sourcing supply chain contracts by 4.6% after a state launches a cap-and-trade market, highlighting that the policy substantially stimulates firms' sourcing activity. In addition, relative to states without the cap-and-trade market, firms' sourcing supply chains on average rise by 2.2% in the RGGI (Regional Greenhouse Gas Initiative) states and 7.2% in the WCI (Western Climate Initiative) states, indicating stronger responses where the program has broader emissions coverage.[9]

In this study, we make two major contributions. First, we contribute to the carbon pricing literature by moving beyond firm-level or industry-specific outcomes to examine network-wide adjustments in supply chains. Existing research focuses on the impact on carbon footprint, firm performance, and investments.[10] Our study is among the first to emphasize that carbon pricing can systematically influence firms' network decisions. In particular, we highlight the heterogeneity between carbon taxes and ETS, as carbon taxes tend to weaken collaboration with more cost-sensitive

[9] The RGGI covers 14% of GHG emissions across participating states. In the WCI, California's carbon market covers 76%, and Washington's carbon market covers 71%. (World Bank, 2025).

[10] Previous research has explored how carbon pricing influences corporate performance, including carbon emissions (Bai and Ru, 2024), investments (Colmer et al., 2025), and profitability (Duan et al., 2025).

customers. At the same time, ETS creates incentives for forward-looking customers to strengthen ties with suppliers and credibly transition to low-carbon production.[11] While these single-country studies offer valuable insights, the empirical evidence on how carbon pricing works globally is more comprehensive and can help avoid potential confounding effects[12]. Furthermore, we provide a complementary perspective on the environmental policy debate over the existence and pricing of carbon risk (Bolton and Kacperczyk, 2021; Ilhan et al., 2021; Aswani et al., 2024). Specifically, carbon pricing shapes firm-level outcomes and propagates through global production networks, influencing capital allocation across countries.

Second, our study enriches the literature on supply chain shocks by identifying a policy-induced, systematic, and persistent source of disruption, distinct from natural disasters or geopolitical events. Building on the importance of regulatory compliance across jurisdictions, our study is among the first to identify carbon pricing as a policy shock of global supply chain networks.[13] We integrate these insights to offer new evidence on how climate policies reshape the architecture of global value chains and, in turn, influence competitiveness and resilience. The findings generate implications not only for academic research but also for policy design and corporate strategy.[14] Policymakers can use these insights to refine carbon taxation and market mechanisms to minimize unintended distortions while advancing environmental objectives. Firms can better anticipate and manage supply chain adjustments, aligning compliance with innovation and competitiveness. Ultimately, our research underscores the importance of integrating environmental regulation into the study of global supply chains, advancing a more sustainable and efficient global production system.

The remaining sections are structured as follows. We review the literature in Section 2 and develop our main hypotheses in Section 3. We outline our sample and methodology in Section 4. We

[11] Research on carbon pricing policies reveals heterogeneous effects across firms with varying emission intensities, beliefs about climate regulation, natural resource rents, technological capabilities, and cost pass-through capacities (Andersson, 2019; Martin et al., 2014; Ramadorai and Zeni, 2024; Colmer et al., 2025).
[12] See, among others, Bai and Ru (2024), Duan et al. (2025).
[13] The supply chain literature identifies various shocks on the global supply chain, such as geopolitical events (Aral et al., 2025), the Covid-19 pandemic (Bonadio et al., 2021), natural disasters (Carvalho et al., 2021), and cyber attacks (Crosignani et al., 2023).
[14] Existing evidence highlights short-run contractionary and distributional risks depending on carbon pricing policy design (Metcalf and Stock, 2023; Känzig, 2023).

report empirical results in Section 5 and provide further analysis in Section 6. In Section 7, we conclude the paper.

2. Literature Review

2.1 The impacts of Carbon Pricing Policies

Carbon pricing policies, such as carbon taxes and ETS, have become an important policy tool to mitigate climate change. Many studies investigate their domestic impacts in specific countries or regions. At the macroeconomic level, most evidence suggests limited or no adverse. For example, Metcalf and Stock (2023) find no robust evidence of adverse impacts of carbon taxes in European countries on employment or GDP growth, and de Silva and Tenreyro (2021) find that carbon tax has no effects on output or inflation. Similarly, Colmer et al. (2025) demonstrate that ETS reduce emissions in manufacturing without compromising production or leading to job losses. A regional study by Yamazaki (2017) finds that the carbon tax implemented in British Columbia even led to increased employment. However, some studies point to short-run contractionary or distributional effects. Känzig (2023) demonstrates that tighter carbon pricing regimes result in substantial increases in energy costs and negatively impact overall economic activity. Similarly, Mangiante (2024) highlights greater sensitivity of poorer Euro Area countries to carbon price shocks, raising concerns about distributional effects across countries. Hensel et al. (2024) also show that France's carbon price shock raises firms' short-term inflation expectations.

At the microeconomic level, evidence generally shows that carbon pricing reduces emissions without harming firm performance. For the carbon tax, Martin et al. (2014) show that moderate and predictable taxes in manufacturing lower emissions without affecting output or jobs, while Andersson (2019) and Martinsson et al. (2024) document that Sweden’s rising carbon tax cuts transportation and firm-level emissions without slowing growth or productivity. Colmer et al. (2025) find that ETS reduced carbon emissions by 14–16% among regulated manufacturing firms in the EU, primarily through the use of cleaner inputs and improved energy efficiency, without compromising production

or job losses. Moreover, firms' responses to carbon pricing exhibit substantial heterogeneity depending on emission intensity, technological capabilities, and cost pass-through potential. In Canada, Jacob and Zerwer (2024) show that carbon taxes curb investment mainly among firms unable to pass higher costs to customers, while those in more competitive or regulated markets are scarcely affected. In the U.S. power sector, firms achieving the largest emission cuts earn positive abnormal returns, suggesting investors reward credible decarbonisation (Kumar and Purnanandam, 2022).

Beyond single-country settings, research has investigated the effects of carbon taxes and ETS in global contexts. Bai and Ru (2024) find that ETS implementation across 43 countries reduced carbon intensity by 6–10%, primarily through technological upgrading and energy transitions rather than output cuts. Duan et al. (2025) use a global sample of publicly listed firms and show that carbon pricing reallocates profits and capital away from high-emission firms, whose cash flows, valuations, and investment decline toward low-emission rivals, without reducing aggregate profitability. However, little is known about whether these policies influence firms' supply chain strategies, particularly in the global context.

2.2 External Shocks and Global Supply Chain Networks

A growing economics and finance literature shows that seemingly disparate events (e.g., trade disputes, pandemic lockdowns, geopolitical frictions, and cyber-attacks) share a common transmission channel: the input–output links binding firms and countries. Firm-level studies of the 2018 U.S.-China tariffs and the COVID-19 outbreak (Aral et al., 2025; Huang et al., 2023) reveal that sales and market value losses are largest where supply bases are highly concentrated and product market competition is intense, leaving little room to pass on higher costs. Complementing these micro findings, Bonadio et al. (2021) use a model of 64 countries to show that global value chains explain roughly one quarter of the pandemic-induced GDP decline, yet the same cross-border ties cushion economies when lockdowns are staggered, underscoring the insurance value of diversification. Evidence on "decoupling" tells a similar story: customs records indicate that firms reroute sourcing toward nearby or "friendly" nations, but the new suppliers often remain embedded in Chinese networks

(Alfaro and Chor, 2023; Freund et al., 2024). A dynamic general equilibrium framework by Grossman et al. (2023) confirms that reshoring mandates restrict firms' ability to hedge idiosyncratic and systemic risks, reducing welfare. Finally, Crosignani et al. (2023) demonstrate that cyber-attacks reverberate along trade credit links, depressing profitability and widening credit spreads for the target's partners. Across these studies, one lesson stands out: openness and supplier diversification remain the bedrock of supply chain resilience.

The same production-network logic governs the transmission of environmental shocks. Carvalho et al. (2021) show that Japan's 2011 earthquake cut national output by nearly half a percentage point through upstream and downstream spillovers. Extreme heat and floods at supplier locations similarly propagate: Pankratz and Schiller (2024) find that such events lower operating income for suppliers and customers and prompt firms to replace vulnerable partners with those in safer regions. Normative pressures also travel through supply chains: customers with good corporate-social-responsibility profiles induce suppliers to upgrade environmental practices (Dai et al., 2021), while cross-border E and S standards affect emissions and stock-return correlations (Schiller, 2018; 2023).

Although prior research has shown that shocks like trade frictions and natural disasters can propagate through global supply chain networks, the role of carbon pricing as a potential driver of such spillovers remains largely unexplored. We address these gaps by testing whether carbon taxes and ETS implemented in supplier countries affect customers' responses and how policy design shapes supply chain network adjustments.

3. Hypothesis Development

3.1 The cost-avoidance channel of carbon taxes on global supply chains

When a carbon tax is implemented, governments impose a fixed levy per ton of CO_2 emissions. This creates a predictable, linear increase in costs that suppliers have limited flexibility to offset through market strategies. Consequently, they must either reduce emissions or pass the additional costs

on to customers through higher prices (Martin et al., 2014; Parry et al., 2015; Martinsson et al., 2024). As carbon tax rates are expected to rise over time, the financial burden on affected suppliers will intensify, further constraining profit margins (Martin et al., 2014; Andersson, 2019). Suppliers in carbon tax jurisdictions are thus more likely to reflect these costs promptly and consistently in their quotations. According to transaction cost economics, when transaction costs increase and are difficult to mitigate, buyers seek to reduce exposure by switching to alternative suppliers (Klein et al., 1978; Williamson, 1979). Customers, particularly those that are cost-sensitive, are therefore expected to reduce procurement from suppliers in high-tax countries and reallocate sourcing to suppliers in jurisdictions with lower or no carbon costs (Aldy and Stavins, 2012).

3.2 The transformational-incentive channel of carbon taxes on global supply chains

At the same time, carbon taxes provide strong incentives for suppliers to accelerate low-carbon transitions. To reduce long-term tax burdens, firms adopt cleaner technologies, shift to renewable energy sources, and enhance operational efficiency (Martinsson et al., 2024; Duan et al., 2025). For customers, the stability and predictability of carbon taxes enhance the accuracy of cost forecasting, thereby lowering transaction uncertainty (Andersson, 2019). Suppliers that respond by investing in low-carbon capabilities not only strengthen compliance and transparency but also become more attractive partners for customers pursuing long-term sustainability goals. With growing regulatory pressures on Scope 3 emissions, partnerships with such suppliers help buyers meet ESG commitments and disclosure requirements. In this way, carbon taxes can improve supplier transparency and reliability, fostering more sustainable supply chain relationships.

3.3 The cost-avoidance channel of ETS on global supply chains

Under an ETS, suppliers must hold tradable allowances for their emissions, generating both the direct cost of purchasing allowances and the opportunity cost of holding them. Although some sectors may initially benefit from free allocations (Jaraite et al., 2010; Koch et al., 2014), tightening caps and a higher share of auctioned permits increase exposure to carbon costs, particularly for emission-

intensive firms (Fabra and Reguant, 2014; Colmer et al., 2025). Thus, suppliers are compelled to purchase additional allowances at rising prices, thereby increasing marginal production costs and passing these costs on to customers (Martin et al., 2014; Känzig and Konradt, 2024). Unlike the fixed price of a carbon tax, ETS prices are market-determined—characterized by a long-term upward trend but subject to short-term volatility driven by macroeconomic conditions, energy markets, and policy expectations (Ellerman et al., 2010; Bredin and Muckley, 2011; Metcalf, 2019). Such volatility amplifies financial pressures on suppliers and creates procurement uncertainty for buyers, encouraging cost-sensitive customers to diversify away from suppliers in ETS jurisdictions to avoid unpredictable cost fluctuations.

3.4 The transformational-incentive channel of ETS on global supply chains

At the same time, ETS provides strong incentives for emission reductions. Suppliers that can sell surplus allowances if they cut emissions below the cap, generating revenue to offset production costs and enhance competitiveness (Martinsson et al., 2024; Colmer et al., 2025; Bartram et al., 2022). The scheme's flexibility—whether to invest in cleaner technologies, improve processes, or trade allowances—supports long-term innovation and the development of more efficient, low-carbon products (Ellerman et al., 2010; Bai and Ru, 2024). Active participation in allowance trading or verified emissions reductions serves as a credible signal of low-carbon commitment (Dai et al., 2021). For customers oriented toward sustainability, such signals are critical in identifying reliable partners aligned with ESG and Scope 3 disclosure requirements (Kumar and Purnanandam, 2022). By engaging in long-term contracts, green-premium agreements, or joint carbon disclosures, customers can strategically integrate suppliers' low-carbon performance into their own climate strategies. In this way, ETS strengthens collaboration by aligning mutual sustainability goals and reinforcing incentives for long-term cooperation.

Given the two offsetting channels—cost avoidance and transformational incentives—the overall impact of carbon pricing on global supply chains is theoretically ambiguous. On the one hand, higher transaction costs may drive customers away from suppliers in regulated countries; on the other hand,

stronger incentives for low-carbon transition may enhance supplier attractiveness and strengthen long-term relationships. Because we have no clear directional prediction, we state our hypotheses in null form:

*H1**(Null):** The implementation of a carbon tax in a supplier's country does not affect customers' sourcing relationships with suppliers located in that country.*

*H2**(Null):** The implementation of an ETS in a supplier's country does not affect customers' sourcing relationships with suppliers located in that country.*

In other words, they are framed this way because the two economic forces described above can co-exist, potentially influencing customer–supplier relationships in opposite directions, with the net effect uncertain ex ante. Suppose the empirical analysis reveals that a carbon pricing policy in suppliers' countries has a significantly positive effect on sourcing relationships. In that case, we can infer that the transformational incentive dominates the cost-avoidance effect. Conversely, a negative and significant effect would indicate that cost-avoidance dominates the transformational incentive.

4. Data and methodology

4.1 Sample construction

We compile a comprehensive dataset that integrates global supply chain relationships with carbon pricing, as well as firm-level and country-level information. Our sample started in 2003 because the FactSet Revere supply chain data began in 2003. We collect data on the national level global carbon pricing initiatives and the state level U.S. cap-and-trade markets from multiple sources, including Bai and Ru (2024), the World Bank Carbon Pricing Dashboard, the Tax Foundation website, the Center for Climate and Energy Solutions, and historical state statutes from the WCI and the RGGI website.[15] Our sample ends in 2024, covering 49 jurisdictions worldwide and 14 states in the U.S. with at least one

[15] Specifically, we obtain country-level carbon pricing initiatives from Table A1 of the Internet Appendix in Bai and Ru (2024) and extend the carbon pricing initiatives to 2024 using other sources. In our U.S. subsample test, we determine whether a local or regional ETS is in place and record the start year for each state. We extract the effective and withdrawn years of the carbon markets from the WCI website and the RGGI website. The list of global and U.S. ETS initiatives is presented in the Internet Appendix. When multiple programs exist, the earliest start year defines the state's ETS adoption date. For example, Massachusetts entered the RGGI in 2009 and later launched a local ETS in 2018, so we assign 2009 as its adoption year.

implemented carbon pricing instrument.

Data for carbon emissions is from the Trucost Environmental Dataset. We obtain firms' financial and accounting data from Compustat. We extract E-Scores from LSEG ESG Scores, Climate Change Performance Index from Germanwatch, climate change exposure from the follow-up update by Sautner et al. (2023), and carbon prices from the World Bank. We employ the classification of long-term orientation based on the linguistic features of future time reference, as described in Chen (2013). We merge FactSet with Compustat using ISIN and CUSIP identifiers to construct our baseline sample. After excluding customer-year observations with missing values, we aggregate customer–supplier contracts annually at the supplier-country level.

We further removed firms with a market capitalization of less than USD $10 million and firms headquartered in either customer or supplier countries with fewer than ten unique customers. To ensure a clear comparison and avoid confounding effects arising from supplier countries implementing both policies within a short timeframe, we exclude Switzerland, Japan, and Latvia as they adopted carbon tax and ETS within a three-year window.[16] We also exclude customers with only one distinct supplier country in the sample to further rule out the concern that some customers rely on a single supplier country due to unrelated factors. These filters leave an unbalanced panel data comprising 471,113 pair-year observations of customer firms and their supplier countries (16,150 customer firms, 163 supplier countries) between 2003 and 2024.

4.2. Key variables

The core of our supply chain data is sourced from FactSet Revere, which identifies firm-to-firm contractual linkages using annual reports, regulatory filings, and other publicly available sources. Recent studies have widely used FactSet Revere's supply chain data (e.g., Pankratz and Schiller, 2024). Its comprehensive international coverage is essential to our research, as decarbonization and

[16] In our state-level test, we restrict the sample to customers with at least one supplier operating in affected states and exclude customers from the regulated utility industries (SIC code 4000-4999). We also remove observations from states that have ever exited the RGGI (i.e., New Jersey, North Carolina, and Virginia).

combating climate change are a global effort, and supply chains commonly span multiple jurisdictions following decades of economic globalization.

To isolate the effects of carbon pricing on the global supply chain, we control lagged firm-level variables previously shown to influence supply chain stability (e.g., Ersahin et al., 2024). Specifically, we include the book assets (*Size*) to control for firm size and net sales (*Sales*) to proxy for firms' sales growth opportunities. We measure capital structure with the debt-to-assets ratio (*Leverage*) and asset tangibility (*Tangibility*). We further proxy profitability with return on assets (*ROA*) and capture firm maturity with age (*Age*).

4.3. Summary statistics

Chart A of Figure 1 maps the global distribution of carbon pricing initiatives across national and subnational jurisdictions as of 2024. Similar regional patterns emerge across policy instruments, with national schemes concentrated in Europe and East Asia, often overlapping in coverage. By contrast, the Americas exhibit uneven and predominantly subnational adoption, with comparatively few country-level programs. Coverage across Africa and South Asia remains limited, with only isolated cases. Figure IA1 summarizes U.S. state-level carbon pricing policies. The cap-and-trade markets are clustered on the West Coast and in the Northeast. Overall, we identify 34 carbon tax initiations and 38 ETS launches during our sample period. Within the United States, cap-and-trade programs are implemented in 14 states.

Table 1 shows that the average supply chain contracts for a customer in one supplier country are 1.92 (=exp(1.072)–1), with an average transaction amount of USD 1285.62 (=exp(7.159)) million. Table 1 also reports descriptive statistics in the baseline sample. Average firm size, return on equity (ROE), and leverage ratio are USD 17,242 million, 0.083, and 0.229, respectively. Additionally, customers have an average E-score of 50.54 and an average supplier E-score of 60.81, indicating a potential preference for greener suppliers, which is consistent with firms prioritizing environmental performance in their sourcing (Dai et al., 2021). Appendix Table IA.2 presents the distribution of customers and contracts across supplier economies. Among the top 20 supplier economies in our

sample, the United States records the most customer-year observations (72,410), accounting for 14.6% of the observations, followed by China, the UK, and Germany. By contrast, economies such as South Africa have relatively fewer observations. This dispersion reflects the cross-jurisdiction differences in global supply chain networks, which are closely related to economic scale and trade connectivity.

[Insert Table 1 about here]

4.4. Methodology

To mitigate endogeneity concerns, we use a staggered DiD specification to investigate the causal effects of carbon pricing policies on global supply chain networks. Specifically, we estimate the following regressions to identify the initiation of the carbon tax and ETS on global supply chains:

$$Total_Sup_{i,t} = \alpha + \beta_1 \times CO_2Pricing_{i,t=-1} + \beta_2 \times CO_2Pricing_{i,t=0} + \beta_3 \times CO_2Pricing_{i,t>0} + Controls_{i,t} + FE + \varepsilon_{i,t}, \quad (1)$$

where $Total_Sup_{i,t}$ is the natural logarithm plus one of the total supply chain contracts for a pair i of the customer and supplier country in the year t. $CO_2Pricing_{i,t}$ are dummies that equal one for t years relative to a country implementing the carbon pricing policies, respectively, and zero otherwise. We test the causal effect of the carbon tax and the ETS separately. Among the 163 supplier countries in our sample, 34 have initiated Carbon Taxes, and 38 have launched national or regional ETSs. We consider these countries as treated after they initiated their Carbon Taxes or ETSs. For the rest of the countries that have never had a carbon pricing policy, the value of $CO_2Pricing_{i,t}$ always zero. β_3 is the coefficient of interest on the effect of carbon pricing policies and global supply chains. For instance, a positive and significant β_3 in (1), suggests that customers expand their supply chain relationships with suppliers in countries that have recently adopted a carbon pricing policy. Control variables are size, sales, leverage, ROA, asset tangibility, and age. We use pair fixed effects to capture time-invariant heterogeneity across customer–supplier country. We include year fixed effects to absorb common global shocks. Due to the requirement for non-singleton observations in the fixed effect, the final sample comprises 456,157 firm-year observations across 14,899 firms.

5. Main results

5.1. The carbon pricing-supply chain relation

Table 2 presents the baseline DiD results, which reveal contrasting effects of the two carbon pricing policies on global supply chain networks. In Column (1), the coefficient on $CO_2Pricing_{t>0}$ is −0.018, and in Column (2), the coefficient on $CO_2Pricing_{t>0}$ is 0.042, both significant at the 1 % level. These results reject our null hypotheses 1 and 2, which state that implementing a carbon tax or ETS in a supplier's country has no effect on customers' sourcing relationships with suppliers located in that country. The pre-event dummy variables $CO_2Pricing_{t=-1}$ and $CO_2Pricing_{t=0}$ for both policies are economically small and insignificant, supporting the parallel-trend assumption and alleviating concerns about reverse causality.

The effect of carbon pricing on the global supply chain is economically sizeable. For carbon tax adoptions, the coefficient on $CO_2Pricing_{t>0}$, indicates that in post-implementation years, customer firms' sourcing relationships with suppliers located in the treated countries, on average, decline by about 1.8% relative to those in the control countries. By contrast, following the introduction of ETS, the corresponding $CO_2Pricing_{t>0}$ coefficient implies an increase of about 4.2%. Coefficients on the control variables suggest that firms with larger size, sales, and age have more supply chains, while firms with higher profitability and tangibility exhibit fewer supply chains. The coefficients of the leverage ratio are statistically insignificant.

[Insert Table 2 about here]

5.2. Additional identification tests

We perform several robustness checks to ensure our baseline estimates are valid, as shown in Table 3. First, we utilize a set of event-time indicators to confirm that supplier countries exhibited parallel pre-trends in the number of supply chain contracts prior to the adoption of carbon pricing. The coefficients on the pre-enactment dummies, $CO_2Pricing_{t=-3}$, $CO_2Pricing_{t=-2}$, $CO_2Pricing_{t=-1}$, and $CO_2Pricing_{t=0}$, are small and statistically insignificant for both carbon pricing policies, confirming that

supplier countries exhibited parallel pre-trends in the number of supply chain contracts before carbon pricing. After the initiation of carbon taxes, the indicators $CO_2Pricing_{t=1}$, $CO_2Pricing_{t=2}$, $CO_2Pricing_{t=3,}$ and $CO_2Pricing_{t>3}$ correspond to significant reductions of 1.7%, 1.7%, 1.9% and 2.6% in the total number of supply chain contracts, respectively, suggesting the gradual contraction in customer-supplier networks. In contrast, the ETS indicators $CO_2Pricing_{t=2}$, $CO_2Pricing_{t=3}$, and $CO_2Pricing_{t>3}$ is associated with significant increases of 4.5%, 4.7%, and 7.4%, respectively, indicating a growing expansion of supply chain contracts following the launch of ETS. Taken together, these results suggest that while the carbon tax discourages customers from maintaining supply chains, ETS exerts a sustained positive influence on customers' sourcing relationships with suppliers located in the treated country.

[Insert Table 3 about here]

Second, to address concerns with staggered DiD and potential biases from two-way fixed effects, we implement diagnostics following Baker et al. (2022) and adopt stacked DiD regressions as proposed by Cengiz et al. (2019) and Wing et al. (2024).[17] This involves constructing event-level panels for each treatment cohort, restricting the observation window, and re-estimating the specification with cohort-level fixed effects.[18] The checklist proposed by Baker et al. (2022) recommends examining the prevalence of "never-treated" observations because negative-weight distortions dissipate when clean controls dominate the sample. In our sample, never-treated observations comprise 56.7% of the carbon tax panel and 30.5% of the ETS panel, indicating limited exposure to problematic weights.

We perform the diagnostic stacked DiD regression, following Cengiz et al. (2019) and Wing et al. (2024). We closely mirror our sample at the customer-supplier country pair level in three steps. First, we drop firms that were already treated before the start of the observation window, because early adopters provide no variation for estimating the post-treatment effect. Second, for each treatment

[17] One potential concern with the staggered DID estimator is that the conventional two-way fixed effects specification delivers a weighted average of numerous 2×2 comparisons. If the treatment effects vary with time, already treated observations may serve as inappropriate controls, which introduce bias (e.g., de Chaisemartin and D'Haultfoeuille, 2020; Sun and Abraham, 2021).

[18] The Goodman-Bacon decomposition (Goodman-Bacon, 2021) would ordinarily reveal any residual forbidden comparisons. However, this procedure requires a fully balanced panel. As our panel contains intermittent gaps, this diagnostic is not feasible in our design.

year *k*, we create event-level panels that contain (i) the cohort of pairs that first receive the treatment in year *k*, and (ii) never-treated pairs in six years before and after year *k*. Third, we vertically concatenate all event-level panels to form a single "stacked" dataset. Lastly, we add cohort-firm and cohort-year fixed effects to the baseline DiD specification on this stacked sample.

Panel B of Table 3 reports the results. The coefficient on $CO_2Pricing_{t>0}$ of carbon tax is –0.016, whereas the coefficient on $CO_2Pricing_{t>0}$ of ETS is 0.039, both significant at the 1 % level. Relative to the baseline TWFE results in Table 2, the absolute magnitude of $CO_2Pricing_{t>0}$ for carbon tax and ETS dropped 0.002 and 0.003, respectively. This attenuation is consistent with the stacked DiD framework, which eliminates the downward bias that arises when early treated firms serve as inappropriate controls for later cohorts. Together with the diagnostic evidence above, these findings confirm that our central conclusions are robust to the latest econometric critiques of staggered DiD.

Third, we perform robustness tests to ensure the baseline findings hold under alternative supply chain measures and tabulate them in Panel C of Table 3. In the baseline regression, we calculate the total number of supply chain contracts to measure customers' sourcing supply chains in a supplier country. This measure captures the most comprehensive effect of carbon pricing on global supply chain networks. We further test the impact on customers' new supply chain contracts to supplement our baseline results.[19] In Column (1), the coefficient on $CO_2Pricing_{t>0}$ of the carbon tax is –0.013 and significant, suggesting a 1.3% decrease in the total number of new supply chains in countries that initiate carbon taxes. Column (2) shows a positive effect for countries that launch ETS. The coefficient on $CO_2Pricing_{t>0}$ of ETS is 0.078 and significant, suggesting that downstream customers have a 7.8% increase in new supply chain contracts in countries adopting ETS. Together, our results are robust when considering the variation in new supply chain contracts following the adoption of carbon pricing policies.

Furthermore, we conduct more robustness tests in Table IA5 of the Internet Appendix.

[19] We perceive a supply chain contract as a new contract under two circumstances: (1) contracts from customers who never had a supply chain contract in a country, and (2) contracts from customers who renew the contract that was ended previously.

Particularly, we incorporate additional industry-year fixed effects and progressively exclude subsamples that could bias the results, such as customers in the finance and regulated utilities sectors, U.S. customers, and customers from small economies. To absorb industry-specific shocks such as export restrictions (Alfaro et al., 2025), we add *Industry-Year* fixed effects. In Panel A of Table IA5. Panel B of Table IA5 shows similar results when we exclude customers from the finance industry (SIC 6000-6799) and regulated utilities (SIC 4900-4999). One may be concerned that our results are primarily driven by U.S. firms, as they hold the largest global market share (roughly 14.6% in the sample) and are perceived to enjoy outsized bargaining power in global supply chains. In Panel C of Table IA5, we exclude U.S. customers from our sample, and the results still hold. On the other hand, one may also be concerned that customers from small economies may dominate the results, as they have relatively less bargaining power than those from larger economies.[20] In Panel D of Table IA5, we exclude customers from small economies from our sample and demonstrate that the results remain robust.

We conduct additional robustness tests in Panels E–H of Table IA5. In these analyses, we further address concerns that our baseline estimates could be driven by recent regulatory adoption, geopolitical frictions, or policy heterogeneity across jurisdictions. Panel E excludes customer–supplier pair-years involving customers from China and suppliers from the United States, alleviating concerns that heightened bilateral tensions or trade-policy frictions between the two countries disproportionately influence the estimated effects (e.g., Huang et al., 2023). Similarly, Panel F excludes countries whose geopolitical risk index falls in the top decile of our sample, ensuring that extreme geopolitical instability does not mechanically drive the relation we document. Panel G excludes customers from countries that have implemented carbon pricing policies within the past decade, thereby mitigating the possibility that our results are confounded by transitional dynamics surrounding newly introduced climate regulations. Across Panels E–G of Table IA5, the estimated coefficients remain economically meaningful and statistically significant, and the inferences are unchanged, confirming that our results

[20] We define countries with fewer than 100 customers as small economies, which account for around 13.5% of our sample.

are robust to these additional sample restrictions and policy-specific implementations.

Lastly, a potential concern is that the initiations of carbon pricing policy may be correlated with particular years, so that concentrated policy starts could mechanically generate spurious results. Our key variable of interest, $CO_2Pricing_{t>0}$ is constructed using the actual carbon pricing policy initiation years, which exhibit a clustered pattern (Table IA1 of the Internet Appendix) in some regions. To address this issue, we use the methodology in Bekaert et al. (2005) and Chang et al. (2019). Specifically, we randomly assign "carbon pricing shocks" to supplier countries and re-estimate the baseline specification within the Carbon Tax and ETS subsamples to avoid cases where the random assignment would place the tax initiation year in an ETS year, or vice versa.[21] We use customer–supplier country pairs with randomly assigned initiation years and repeat the simulation procedure five hundred times. Because the simulation preserves the empirical distribution of carbon pricing start years, if our findings were mainly a consequence of clustered policy adoptions, a large share of the 500 placebo replications would produce estimates similar to those based on the true initiation years. In Panel I of Table IA5, the results suggest otherwise. Both the mean and the median of the coefficients for $CO_2Pricing_{t>0}$ are close to zero, which is constructed using randomly reassigned carbon pricing initiation years. In contrast, the coefficients reported in Panel H (–0.034 and 0.055) fall beyond the 5th and 99th percentiles, respectively. This pattern indicates that linking the right initiation years to the relevant customer–supplier country pairs is crucial, and the results are unlikely to be driven by generic time trends or event clustering.[22]

Together, these tests are designed to verify that our findings are not artifacts of pre-trend violations, model specification, sample composition, or econometric critiques of staggered DID estimators. Our baseline estimates indicate a two-sided adjustment in downstream customer strategies. After introducing the carbon tax, downstream customers significantly curtailed the number of their

[21] Panel H reports results from estimating the baseline specification separately for each type of carbon pricing policy, which also allows us to verify the main findings in the subsample analysis.
[22] We plot the resulting histogram of placebo estimates and the true estimate in Figure IA2. The true coefficient lies beyond the tail of the placebo distribution.

supply chain contracts, suggesting that cost-avoidance motives could dominate when suppliers are directly taxed on carbon emissions. In sharp contrast, the rollout of the ETS encourages downstream customers to maintain and broaden their supply chain bases, highlighting that the transformational incentives can become primary once suppliers operate under a market-based carbon pricing policy.

6. Additional analyses

6.1. Assess the relative importance of cost-avoidance and transformational-incentive mechanisms

To examine the mechanisms through which carbon pricing affects global supply chain networks, we extend our staggered DiD framework to a triple-difference (DDD) design. Specifically, we introduce a third dimension that captures either the cost-avoidance or transformational-incentive channels. The DDD specifications are as follows:

$$Total_Sup_{i,t} = \alpha + \beta_1 \times CO_2Pricing_{i,t>0} \times High\ Var_{i,t} + \beta_2 \times CO_2Pricing_{i,t>0} + \beta_3 \times High\ Var_{i,t} + Controls_{i,t} + FE + \varepsilon_{i,t}, \quad (2)$$

where $Total_Sup_{i,t}$ is the natural logarithm plus one of the total supply chain contracts for the pair i of the customer and supplier countries in the year t. $CO_2Pricing_{i,t>0}$ is a dummy equal to one if the supplier country has implemented carbon pricing policies, and zero otherwise. $High\ Var_{i,t}$ is a dummy equal to one if the value of a conditioning variable is above the sample median, and zero otherwise. The coefficient β_1 of $CO_2Pricing_{i,t>0} \times High\ Var_{i,t}$ captures how the effect of carbon pricing differs across subsamples defined by the third dimension. For the cost-avoidance channel, we examine firm fundamentals that may affect sensitivity to rising costs, including the role of capital structure (total assets, leverage ratio), profitability (customer and supplier ROE), and product market competition (Herfindahl-Hirschman index, market share). For the transformational-incentive channel, we consider proxies related to environmental performance, sustainability orientation, and innovation capacity: customer and supplier E-scores, green innovation, and a future-orientation proxy based on future time reference (FTR), a linguistic feature shown to correlate with forward-looking economic decisions (Chen, 2013; Falk et al., 2018; Ayres et al., 2023).

Table 4 presents an analysis of cross-sectional heterogeneity to identify the channels linking carbon pricing policies to firms' sourcing supply chain choices. If our baseline results are consistent with the cost-avoidance channel, it should be stronger (weaker) for firms less (more) sensitive to the rising costs. In Panel A, we use the total assets and leverage ratio to measure the firms' financing ability. We construct one indicator to denote a firm's financing ability based on the sample median of the total assets (leverage ratio) each year. In particular, *High Var* corresponds to high total assets (leverage ratio), i.e., higher (lower) financing ability. Panel A shows that firms' sourcing supply chain is less (more) sensitive to carbon pricing faced by suppliers when they have higher (lower) financing ability, which is consistent with the cost-avoidance channel. Columns (1) and (2) of Panel B test customer profitability based using a median partition of ROE in the sample, show similar results. By contrast, suppliers' profitability does not significantly impact the sensitivity of firms' sourcing supply chain to adopting the ETS.

Moreover, if carbon pricing affects the supply chain by altering the product market competition of firms, our baseline results should be less (more) pronounced for firms operating in less (more) competitive product market, which are less (more) sensitive to the rising cost due to carbon pricing policies in their sourcing supply chains (e.g., Aral et al., 2025; Franzoni et al., 2023). To examine this, we proxy competition in the product market using the Herfindahl–Hirschman Index (HHI), which is calculated annually by each two-digit SIC industry. A higher HHI indicates weaker product market competition. *High Var* represents high HHI, indicating weaker competition. We also define market share as the percentage of revenue for each two-digit SIC industry, measuring a firm's market power. We classify a firm as having higher market power each year if its market share exceeds the median value. Panel C confirm that the cost-insensitive effect of carbon pricing is more significant for firms in less competitive industries or those with stronger market power, implying that competition incentivizes the sourcing decisions of cost-insensitive firms, further substantiating the cost-avoidance channel.

[Insert Table 4 about here]

We further explore the transformational-incentive channel. First, environmental performance influences firms' supplier preferences. For instance, Dai et al (2021) document that socially responsible customers want to conduct business with suppliers who demonstrate superior environmental performance. We define a firm as having good (or bad) environmental performance if its E-Score is above (or below) the sample median in each year. We also assign a firm as having a good (or bad) supplier environmental performance if its suppliers' average E-Score is above the median each year. Panel D of Table 4 shows that the coefficients of $CO_2Pricing_{t>0} \times High\ Var$ are significantly positive for both customer and supplier, indicating that the transformational incentives of carbon pricing are more pronounced when customers and suppliers have better environmental performance.

Second, we explore the transformational incentives of customers' innovation capacity. Customers with greater green innovation capacity can co-develop technologies, share knowledge, and de-risk adoption choices, allowing suppliers to better leverage the flexibility of ETS to pursue deeper, longer-horizon decarbonization (Bai and Ru, 2024). Hence, we expect customers to exhibit a stronger transformation response to carbon pricing when they possess higher innovation capacity. We identify green innovation capacity based on the pure green technology of their patent applications. Based on the yearly average values of *Green Patent*, we construct a high (*High Var*) green patent application indicator. As shown in Columns (1) and (2) of Table 4 Panel E, firms with more green patents experience a more evident increase in their sourcing supply chain contracts to suppliers from countries adopting carbon pricing policies.

Third, we expect more future-oriented customers to induce a stronger transformational incentive in response to the carbon pricing faced by their suppliers. Kumar and Purnanandam (2022) find that customers pursuing ESG and Scope 3 objectives place greater weight on credible low-carbon signals, indicating a longer horizon that strengthens suppliers' incentives to transform. We thus create a long-term orientation indicator using the classification of low future time reference (FTR) proposed by Chen (2013). *High Var* corresponds to low FTR, indicating a long-term economic orientation. Columns (3) and (4) of Panel E reveal that the positive effects are stronger for firms with a long-term orientation,

confirming the importance of the sustainability horizon in shaping the relationship between carbon pricing and the supply chain.

Lastly, we examine the role of suppliers' electricity-generation mix, which influences the carbon intensity of production and, consequently, the feasibility and cost of operational decarbonization. Electricity is a key input for production activities. When suppliers operate in countries with carbon-intensive power systems, they face higher effective compliance and pass-through costs under carbon pricing, which may limit their ability to undertake deeper transformations. In Panel F, firms are classified as having higher supplier high-carbon (low-carbon) electricity use when, for each customer-year, the supplier country's share of electricity generated from oil, gas, and coal (nuclear and renewable energy) is above the median. *High Var* represents a high level of high-carbon (low-carbon) electricity, respectively. The results show that the interaction terms indicate a weaker (stronger) transformational response to carbon pricing when suppliers are embedded in more high-carbon (low-carbon) electricity environments, consistent with carbon pricing being more effective at re-shaping sourcing patterns when suppliers can leverage cleaner power systems to support long-horizon decarbonization.

6.2. Other moderating effects

After substantiating the cost-avoidance and transformational-incentive channels through which carbon pricing policies implemented in supplier countries can significantly influence downstream customers' sourcing decisions, we conduct heterogeneity tests in Table 4 Panel G to explore whether the impact varies across moderators of carbon emissions, climate change performance, and carbon pricing exposures. Columns (1) and (2) examine whether suppliers' carbon intensity amplifies the effect of carbon pricing. We measure carbon intensity as scope-1 carbon emission at the supplier country-year level and define *High Var* as above the median carbon intensity each year. The coefficient of $CO_2Pricing_{t>0} \times High\ Var$ is negative for carbon tax, consistent with the cost-avoidance channel and binding more strongly when abatement is costly. In ETS, the coefficient is significantly positive, indicating that the transformational-incentive channel encourages sourcing from suppliers with high emissions.

We further study the moderating role of the supplier's policy environment by using a country-level Climate Change Performance Index (CCPI).[23] We classify a supplier as operating in a strong climate regime if the supplier's headquarters country falls above the annual median of CCPI and construct a *High Var* indicator accordingly. Columns (3) and (4) show that the carbon tax (ETS) has a significantly more negative (positive) effect on sourcing in countries with high climate change performance. Lastly, we analyze whether suppliers' exposure to the carbon pricing policy moderates the policy–sourcing relation. We use the regulatory climate change exposure, a measure developed and updated by Sautner et al. (2023) to assess the extent to which suppliers are affected by carbon pricing policies.[24] *High Var* denotes above median yearly exposure, suggesting stronger carbon pricing exposure. Column (5) of Table 4 Panel G shows that the negative (positive) sourcing response to carbon tax (ETS) is concentrated among customers whose suppliers are more affected by the carbon pricing policies. Collectively, these moderating patterns align with our baseline estimates, which suggest that the net effects depend on emission intensity, climate change performance, and the level of exposure to carbon pricing policy.

6.3. Additional cross-sectional heterogeneity tests

Beyond these channels, we conduct additional heterogeneity tests. First, we investigate whether the effects of carbon pricing vary systematically in industries with different carbon intensities. Most carbon pricing instruments directly regulate the power and heavy industrial sectors, as the direct, point-source CO_2 emissions are concentrated in power generation and heavy industry. Hence, carbon pricing instruments typically place the compliance obligation on those plants and factories (Flues and Dender, 2020). By contrast, many emissions associated with services arise from the burning of fuels in vehicles and buildings, which are harder to regulate individually and are often priced upstream by

[23] Climate Change Performance Index (CCPI) is an instrument to measure climate policy stringency (Bolton and Kacperczyk, 2023), covering 67 countries in its latest publication. We collect the data from Germanwatch (https://ccpi.org/). Since 2005, Germanwatch collects worldwide climate policies and converts them into an index, where a higher score means a stricter climate policy tightness.
[24] The measures in Sautner et al. (2023) cover regulatory climate change topics. This definition of "exposure" differs from the risk exposure concept in the asset-pricing literature.

the fuel supplier. Thus, we classify suppliers' industry exposures into *Direct* and *Indirect Exposure*.[25] We add interaction terms of $CO_2Pricing_{t>0}$ × *Direct Exposure* and $CO_2Pricing_{t>0}$ × *Indirect Exposure* to eq.(2) to replace $CO_2Pricing_{t>0}$ and *High Var*. The results are tabulated in Table IA6 of the Internet Appendix. In Table IA6, the adverse effect of the carbon tax is stronger and more significant for customers whose suppliers are directly exposed, compared to those whose suppliers are indirectly exposed. The results for ETS are similar to those of directly and indirectly exposed suppliers. The coefficients of $CO_2Pricing_{t>0}$ × *Direct Exposure* and $CO_2Pricing_{t>0}$ × *Indirect Exposure* are 0.045 and 0.046, both significant. This suggests that suppliers that are indirectly exposed also benefit from ETS at a similar magnitude.

Second, we study the impact of carbon price on the global supply chain in Table 5. Research has demonstrated that the supply chain is affected by the variation in carbon prices. For example, di Giovanni et al. (2025) show that the stock markets react negatively to rising carbon prices. Higher carbon prices are negatively correlated with firms' sourcing supply chains via a cost-avoidance channel, but positively correlated via a transformational-incentive channel that shifts sourcing toward suppliers advantaged by carbon markets. The net effect depends on which channel dominates at a given price range.

[Insert Table 5 about here]

We separately examine whether changes in carbon prices can be effectively translated into firms' sourcing supply chains in countries that implement a carbon tax or an ETS. In particular, we augment our baseline tests by replacing policy dummies with the natural logarithm plus one of the annual average carbon prices.[26] The variables of interest are the linear term (CO_2Price) and the quadratic term (CO_2Price^2). Column (1) demonstrates a linear relationship between firms' sourcing supply

[25] Specifically, we assign those in the mining, construction, manufacturing, transportation, and utilities (the primary 4-digit SIC code from 1000 to 4999) as subject to direct exposure to the carbon pricing instruments, where the carbon pricing instruments statute in most jurisdictions levies the direct cost on fossil fuels or process emissions. We define suppliers in trade, finance, real estate, and services (the primary 4-digit SIC code from 5000 to 8999) as subject to indirect exposure, who face more indirect or pass-through costs of carbon pricing instruments. These two variables are the percentage of customers' suppliers under direct and indirect exposures in a supplier country, respectively.

[26] We conduct our analysis on the extensive margin. We set the carbon price to zero for countries lacking a carbon pricing policy and remove observations from countries that have adopted a carbon pricing policy but provide no price information from the World Bank.

chains and carbon price in carbon taxes. The coefficient on CO_2Price is −0.007 and significant, implying that a 1% increase in the carbon price is associated with a 0.007% decrease in the supply chain. The coefficients on CO_2Price and CO_2Price^2 in Column (4) are 0.026 and –0.005, significant at the 1% level, respectively. In this quadratic-in-logs specification, the relationship is inverted-U, with the predicted number of firms' sourcing supply chain contracts maximized at 2.63, corresponding to US$12.82 /tCO₂e. Column (5) of Table 5 re-estimates the CO_2Price using a two-piece linear spline with a single knot at the estimated turning point P_0 in Column (4). $CO_2Price_{p_left}$ and $CO_2Price_{p_right}$ are linear-spline terms in the CO_2Price of column (4) with a single knot at P_0. The coefficients on $CO_2Price_{p_left}$ and $CO_2Price_{p_right}$ are 0.013 and –0.011, significant at the 1% level, respectively. This suggests a piecewise price elasticity: below the knot price P_0, a 1% increase in ETS prices results in a 0.0133% increase in firms' sourcing supply chains, and a 0.011% decrease above P_0.

6.4. Does carbon pricing affect supply chain emissions and transaction amount?

Lastly, we examine the economic consequences of carbon pricing initiatives for firms' emissions and supply chain transactions. Specifically, we investigate whether carbon pricing policies influence customers' direct emissions and upstream emissions via their sourcing decisions and how these policies affect suppliers' emissions within regulated jurisdictions. This analysis allows us to assess whether carbon taxes and ETS reshape supply chains in ways that alter the carbon emissions of both customers and their chosen suppliers. Additionally, we examine the transactional implications by considering the total and average value of customer–supplier contracts. Using contract-level revenue linkages, we construct measures of transaction amount at the customer–supplier country level, applying filters to ensure economically meaningful relationships.[27] We then estimate whether the intensity of carbon tax and ETS adoption across supplier countries (i.e., the share of supplier countries subject to each policy)

[27] We restrict the sample to transactions with a volume of at least USD $15 million and exclude supplier countries accounting for less than 0.01% of the total transaction volumes for customers. We acknowledge several limitations of the consequence analyses. Since the variations in carbon emission and transaction amount are not necessarily exogenous, the evidence does not have a causal interpretation. Additionally, the revenue and revenue percentage data cover only a selected sample of suppliers. Nevertheless, the findings are broadly consistent with the literature.

affects the scale and structure of customers' transaction amount.[28]

To calculate the volume of transactions on the supply chain, we use the revenue percentage of each supply chain contract multiplied by the supplier's annual revenue as of the end of the fiscal year. The dependent variables, *Total_Amount* and *Mean_Amount*, are the natural logarithms of the customers' total and average transaction volume in supplier countries, respectively. Table 6 presents the results. In Panel A Columns (3) and (4), the coefficients of supplier emission and the intensity of carbon tax and ETS are –0.0015 and –0.0020, significant at the 1% level, respectively. This suggests that a one percent increase in supplier countries adopting carbon tax and ETS leads to a 0.15% and 0.20% decrease in the average suppliers' carbon emissions that customers choose from a given supplier country. The coefficients of customers' carbon emissions and the intensity of the carbon tax and ETS are insignificant, with a small magnitude.[29]

[Insert Table 6 about here]

As shown in Panel B, Columns (1) and (2), the coefficients of carbon tax intensity on *Total_Amount* and *Mean_Amount* are –0.0017 and –0.0020, both negative and significant. This indicates that a one percent increase in supplier countries adopting carbon tax induces a 0.17% and 0.20% reduction of total and average transaction volumes, respectively. By contrast, in Columns (3) and (4), the coefficients of ETS intensity are 0.0013 and 0.0010, indicating a 0.13% and 0.10% increase in transaction volume for every 1% increase in supplier countries that have implemented ETS. Together, these tests help us understand how carbon pricing policies influence the composition of global supply chains and their economic and environmental outcomes.

6.5. Initiation of the cap-and-trade market and supply chains in the U.S.

We validate our primary findings using the U.S. RGGI (Regional Greenhouse Gas Initiative) and the WCI (Western Climate Initiative), which are regional carbon market initiatives. RGGI is a

[28] Given that the customer emission data is at the firm-year level, we changed our staggered DiD setting by using the percentage of supplier countries under the carbon pricing policy, $CO_2Pricing$, to represent the coverage of the carbon pricing.
[29] Our finding is consistent with Dai et al. (2021), which documents that corporate social responsibility (CSR) can only have a unilateral effect on customers and suppliers.

mandatory market-based program that limits CO_2 emissions from the power sector in regions of the Northeastern and Mid-Atlantic, going into effect in 2009. WCI is a cross-border carbon market that links California, Washington, and Québec, featuring a declining cap and joint allowance auctions.[30] The initiation of RGGI and WCI enables clear contrasts in varying exposure to decarbonization, creating measurable differences compared to states without a carbon pricing initiative.

We examine the staggered initiation of the cap-and-trade markets and add interaction terms with states under RGGI or WCI, respectively. The independent variable, $ETS_{t>0}$, is a dummy equal to one for t years after a state initiates the cap-and-trade market. We aggregate customer–supplier contracts annually at the supplier-state level.[31] *Total_Sup* is the natural logarithm plus one of the firms' sourcing supply chain contracts in a state each year. Column (1) of Table 7 Panel A presents the results. The coefficient of $ETS_{t>0}$ (β = 0.046, p < 0.01) indicates that, after the cap-and-trade market took effect, firms' sourcing supply chain contracts on average increased by 4.6%. Column (2) includes $ETS_{t>0}$ and its interaction term with *RGGI* and *WCI* in the regressions. $ETS_{t>0}$, *RGGI,* and *WCI* are not separately included as they are subsumed by pair and year fixed effects. The coefficients on $ETS_{t>0} \times RGGI$ (β = 0.022, p < 0.01) and $ETS_{t>0} \times WCI$ (β = 0.072, p < 0.01) in Column (2) suggest that in response to the RGGI and WCI, the average increase in firms' sourcing supply chains for RGGI and WCI states is 2.2% and 7.2% more than that for states without a carbon pricing policy, respectively.

[Insert Table 7 about here]

We perform regression analyses in Panel B using firms' new sourcing supply chain contracts as dependent variables and repeat the U.S. state-level tests in Panel C by restricting the sample to U.S. firms. In both panels, the coefficients $ETS_{t>0} \times RGGI$ and $ETS_{t>0} \times WCI$ are all positive and significant. The evidence from the U.S. state-level cap-and-trade market initiatives aligns with our primary findings, confirming that firms' sourcing supply chain contracts is stimulated by the ETS

[30] While the Western Climate Initiative (WCI) links internationally and is expanding to more jurisdictions, our analysis is restricted to U.S. jurisdictions by the end of 2024.
[31] We tabulate the summary statistics in Table IA4 of the Internet Appendix.

adoption faced by their suppliers.

7. Conclusions

Global supply chain reconfiguration represents a central channel through which firms respond to climate policies and international regulatory shifts. This study seeks to provide the first systematic evidence on how carbon taxes and ETS influence customer–supplier relationships within global supply chain networks. Using a staggered difference-in-differences design across 163 supplier countries, we document starkly contrasting effects of the two policies: carbon taxes lead to a 1.8% reduction in customer-supplier relationships, while ETS implementation results in a 4.2% increase. The estimated impact of carbon pricing is additionally corroborated by the U.S. state-level initiation of the cap-and-trade market within the RGGI and WCI. Both policies activate the cost-avoidance and transformational-incentive mechanisms. Yet, the relative strength of these mechanisms varies across the two policy instruments, resulting in distinct impacts on supply chain structures and outcomes. We show that the cost channel primarily drives the effects of carbon taxes, whereas the incentive channel dominates in the case of ETS.

Taken together, our findings suggest that carbon pricing helps reduce emissions domestically and reshapes global supply chain networks. While both the carbon tax and ETS reduce customers' upstream emissions, their divergent effects on supply chain relationships and transaction amounts suggest that ETS shows greater potential to drive decarbonization without undermining supply chain resilience. By uncovering these differential effects, the study offers policymakers and firms novel insights into how to align climate policy with the stability and sustainability of global supply chains. Therefore, the design of carbon pricing schemes can strike a balance between cost containment and incentives for sustainable transformation. Future research could further explore the broader spillover effects of supply chain reconfiguration on customer firms' performance through carbon pricing.

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Chart A: Implementation of carbon pricing instruments across the world (source: World Bank)

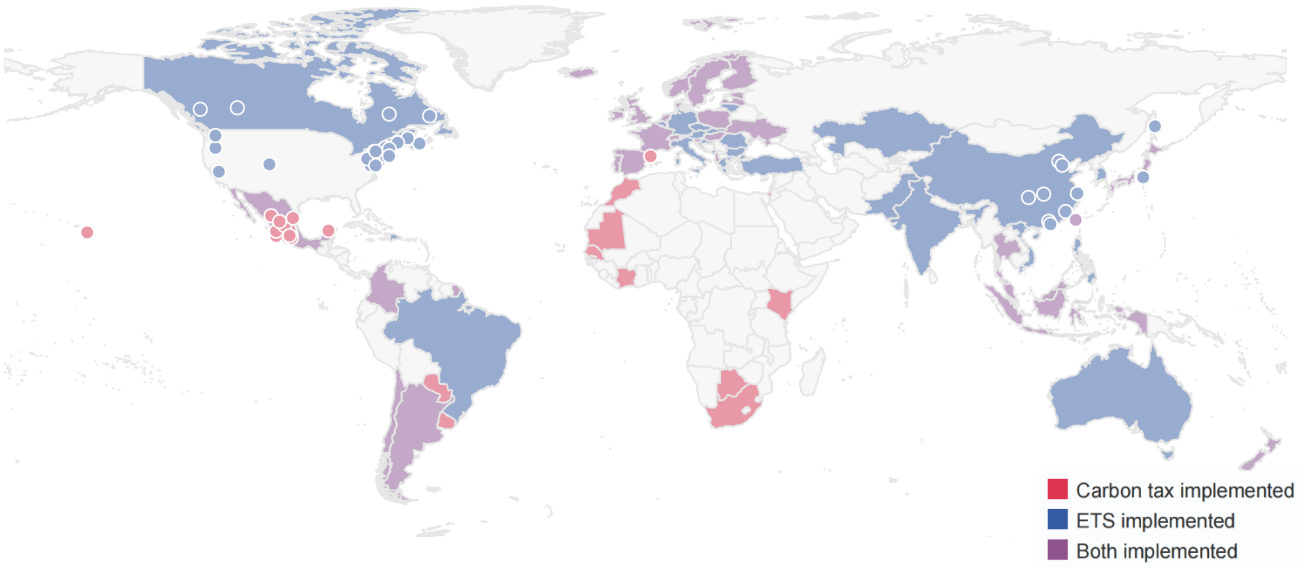


Chart B: The dynamics of carbon pricing and total supply chains at the 95% confidence interval

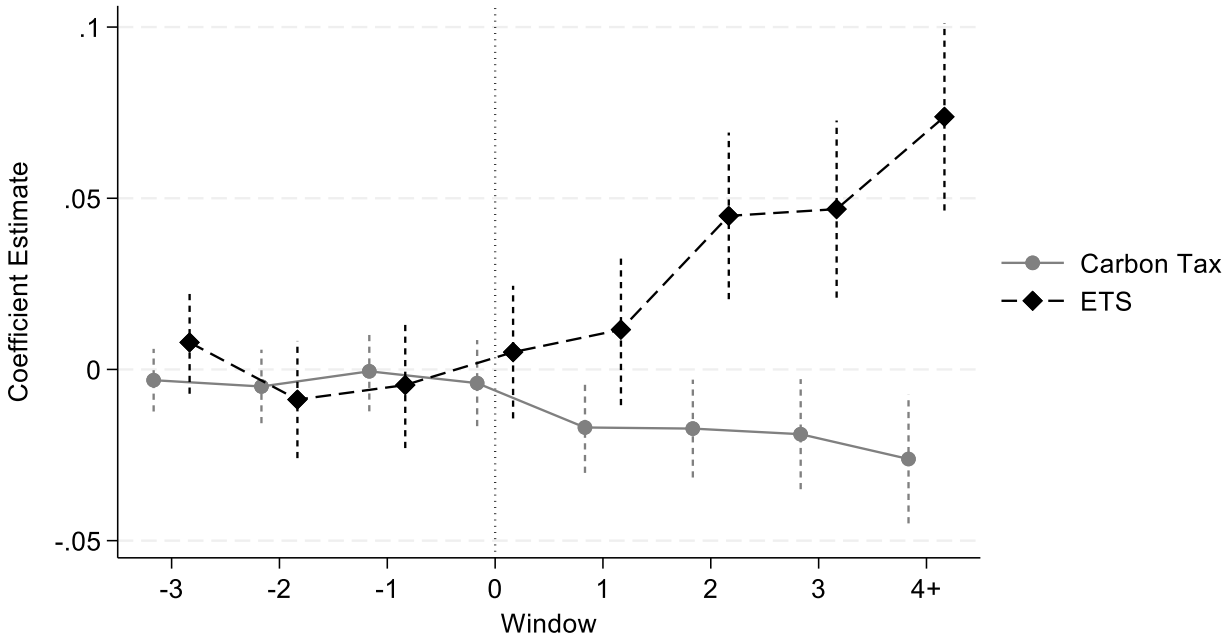


Figure 1: Status of Carbon Tax, ETS, and dynamic effects on supply chains. Chart A plots the implementation of compliance carbon pricing instruments across all countries between 1990 and 2024. We obtain the carbon pricing status of all countries from the World Bank Carbon Pricing Dashboard. Countries are classified into three groups using their instrument status. A red color indicates carbon tax implementation. Blue represents ETS adoption. Purple suggests the initiation of both carbon pricing instruments. Chart B shows the dynamic effects of adopting carbon pricing and the total number of supply chain contracts in the adopted countries worldwide from 2003 to 2024. This chart plots the eight coefficient estimates of time dummies, indicating years relative to the enactment of the Carbon Tax and ETS. The gray solid line represents the coefficient estimates of the supply chain changes before and after the carbon tax, and the dashed black line denotes the estimates of ETS. The vertical dashed line for each estimate represents the 95% confidence interval.

Table 1: Summary Statistics

The sample consists of pair-years of customer and supplier countries jointly covered by FactSet Revere, Compustat, World Bank, LSEG Refinitiv, S&P Trucost, GermanWatch, and the data for firm-level regulatory climate change exposure (Sautner et al., 2023). The definitions of the variables are in the Appendix. Variables in non-dollar values are converted to U.S. dollars using Compustat's annual average exchange rate. All continuous variables are winsorized at the 1% level at both tails of their distributions.

	N	Mean	S.D.	Q1	Median	Q3
Total_Sup	471,113	1.072	0.593	0.693	0.693	1.386
Total_New	471,113	0.450	0.576	0	0	0.693
Total_Amount	52,196	7.409	2.369	5.818	7.636	9.205
Mean_Amount	52,196	7.159	2.337	5.596	7.364	8.908
CO_2*Price_Tax*	468,795	0.833	1.517	0	0	0.075
CO_2Price^2*_Tax*	468,795	2.995	5.935	0	0	0.006
CO_2*Price_ETS*	470,924	1.685	1.518	0	1.952	2.905
CO_2Price^2*_ETS*	470,924	5.143	5.838	0	3.811	8.439
Climate Change Performance	399,183	35.704	19.120	18	38	54
Total assets	470,450	17242.236	50619.289	295.643	1316.125	8023.707
ROE	469,186	0.083	0.384	0.029	0.109	0.198
HHI	471,113	271.358	314.036	106.798	177.427	262.036
Leverage ratio	442,718	0.229	0.178	0.086	0.207	0.337
E-Score	467,425	50.54	21.453	38.584	53.432	61.852
Market share	443,779	0.007	0.018	0	0.001	0.005
Green Patent	471,201	0.668	1.511	0	0	0
*Cus_*CO_2	304,108	10.786	2.902	8.808	10.647	12.633
Supplier ROE	301,656	0.076	0.385	0.030	0.096	0.169
Supplier E-Score	470,220	60.809	18.071	56.531	62.372	68.376
*Sup_*CO_2	271,599	12.563	2.914	10.542	12.588	14.581
$Size_{t\text{-}1}$	471,113	7.320	2.312	5.635	7.130	8.948
$Sales_{t\text{-}1}$	471,113	6.868	2.377	5.228	6.742	8.593
$Leverage_{t\text{-}1}$	471,113	0.153	0.152	0.021	0.117	0.235
$ROA_{t\text{-}1}$	471,113	0.044	0.124	0.019	0.055	0.096
$Tangibility_{t\text{-}1}$	471,113	0.243	0.201	0.084	0.189	0.353
$Age_{t\text{-}1}$	471,113	2.629	0.494	2.398	2.773	2.996

Table 2: The effects of carbon pricing initiatives on the supply chain

The sample consists of pair-years of customer and supplier countries jointly covered by FactSet Revere, Compustat between 2003 and 2024. *Total_Sup* is the natural logarithm plus one of the total supply chain contracts. This table shows the results of baseline regressions. $CO_2Pricing_t$ are dummies that equal one for t years relative to a country implementing the carbon pricing policies, respectively, and zero otherwise. The control variables are firm fundamentals, including $Size_{t-1}$, $Sales_{t-1}$, $Leverage_{t-1}$, ROA_{t-1}, $Tangibility_{t-1}$, and Age_{t-1}. The regressions include pair and year fixed effects. The definitions of all variables are in the Appendix. Standard errors are clustered at the pair level. The *t*-statistics are reported in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

$CO_2Pricing$=	Tax	ETS
Dependent variable: *Total_Sup*	(1)	(2)
$CO_2Pricing_{t=-1}$	0.002	-0.009
	(0.45)	(-1.36)
$CO_2Pricing_{t=0}$	-0.002	-0.002
	(-0.36)	(-0.32)
$CO_2Pricing_{t>0}$	-0.018***	0.042***
	(-2.86)	(4.40)
$Size_{t-1}$	0.033***	0.033***
	(7.72)	(7.69)
$Sales_{t-1}$	0.026***	0.026***
	(7.58)	(7.53)
$Leverage_{t-1}$	0.016	0.016
	(1.29)	(1.28)
ROA_{t-1}	-0.065***	-0.065***
	(-4.42)	(-4.41)
$Tangibility_{t-1}$	-0.030*	-0.030*
	(-1.70)	(-1.68)
Age_{t-1}	0.074***	0.074***
	(5.80)	(5.83)
Pair FE	Yes	Yes
Year FE	Yes	Yes
R^2	0.746	0.746
N	456,157	456,157

Table 3: Additional endogeneity tests

The sample consists of pair-years of customer and supplier countries jointly covered by FactSet Revere, Compustat between 2003 and 2024. *Total_Sup* is the natural logarithm plus one of the total supply chain contracts. $CO_2Pricing_t$ are dummies that equal one for t years relative to a country implementing the carbon pricing policies, respectively, and zero otherwise. All control variables are the same as those in Table 2, but their coefficients are not tabulated. Panel A presents the results based on extended time dummies from three years before and after the initiation year, respectively. Panel B uses a stacked DiD method with Cohort × Pair and Cohort × Year fixed effects. Panel C shows the results of using variables for new contracts. *Total_New* is the natural logarithm plus one of the total new supply chain contracts. The definitions of all variables are in the Appendix. Standard errors are clustered at the pair level. The *t*-statistics are reported in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

$CO_2Pricing$=	Tax	ETS
Panel A: Dynamics of carbon pricing effects on the supply chain over the years surrounding carbon pricing initiations		
Dependent variable: *Total_Sup*	(1)	(2)
$CO_2Pricing_{t=-3}$	-0.003	0.008
	(-0.67)	(1.03)
$CO_2Pricing_{t=-2}$	-0.005	-0.009
	(-0.91)	(-1.01)
$CO_2Pricing_{t=-1}$	-0.001	-0.005
	(-0.09)	(-0.48)
$CO_2Pricing_{t=0}$	-0.004	0.005
	(-0.62)	(0.52)
$CO_2Pricing_{t=1}$	-0.017**	0.012
	(-2.50)	(1.04)
$CO_2Pricing_{t=2}$	-0.017**	0.045***
	(-2.37)	(3.62)
$CO_2Pricing_{t=3}$	-0.019**	0.047***
	(-2.31)	(3.55)
$CO_2Pricing_{t>3}$	-0.026***	0.074***
	(-2.73)	(5.28)
Controls	Yes	Yes
Pair FE	Yes	Yes
Year FE	Yes	Yes
R^2	0.746	0.746
N	456,157	456,157
Panel B: Stacked DiD method		
Dependent variable: *Total_Sup*	(1)	(2)
$CO_2Pricing_{t>0}$	-0.016***	0.039***
	(-3.44)	(5.31)
Controls	Yes	Yes
Cohort × Pair FE	Yes	Yes
Cohort × Year FE	Yes	Yes
R^2	0.797	0.790
N	2,169,939	666,905
Panel C: Alternative supply chain measures using new contracts		
Dependent variable: *Total_New*	(1)	(2)
$CO_2Pricing_{t>0}$	-0.013***	0.078***
	(-2.73)	(11.32)
Controls	Yes	Yes
Pair FE	Yes	Yes
Year FE	Yes	Yes
R^2	0.364	0.365
N	456,157	456,157

Table 4: Cross-sectional heterogeneity in the carbon pricing-supply chain relation

The sample consists of pair-years of customer and supplier countries jointly covered by FactSet Revere, Compustat, LSEG Refinitiv, Sautner et al. (2023), Germanwatch, World Bank, and S&P Trucost between 2003 and 2024. *Total_Sup* is the natural logarithm plus one of the total supply chain contracts. $CO_2Pricing_{t>0}$ is a dummy that equals one for *t* years after a country implements carbon pricing policies, respectively, and zero otherwise. All control variables are the same as those in Table 2, but their coefficients are not tabulated. We restrict the sample to firms with a carbon tax and an ETS adopted in their supplier countries. We exclude firms from the finance and utility industries in the cost avoidance channel. Panels A, B, and C present the cost avoidance channel. In columns (1) and (2) of Panel A, firms are classified as having large assets when their total assets are above the median each year. *High Var* represents high *Total assets*. In columns (3) and (4) of Panel A, firms are classified as having a high leverage ratio when their leverage ratio is above the median each year. *High Var* represents a high *Leverage ratio.* In columns (1) and (2) of Panel B, firms are classified as having high profitability when the return on equity (ROE) of the firm is above the median in each year. *High Var* represents high *ROE*. In columns (3) and (4) of Panel B, firms are classified as having high supplier profitability when the average return on equity (*ROE*) of their suppliers is above the median in each year. *High Var* represents high *Supplier ROE*. In columns (1) and (2) of Panel C, firms are classified as operating in an industry with low competition when the Herfindahl-Hirschman index (HHI) of the industry is above the median in each year. *High Var* represents high *HHI*. In columns (3) and (4) of Panel C, firms are classified as having a high market share when their market share is above the median each year. *High Var* represents high *Market share*. Panels D, E, and F present the transformational incentive channel. In columns (1) and (2) of Panel D, firms are classified as having good environmental performance when their E-Scores are above the median each year. *High Var* represents high *E-Score*. In columns (3) and (4) of Panel D, firms are classified as having good supplier environmental performance when the average E-Scores of their suppliers are above the median each year. *High Var* represents a high *Supplier E-Score*. In columns (1) and (2) of Panel E, firms are classified as having high sustainability innovation capacity when their green patent applications are above the average each year. *High Var* represents high green patents. In columns (3) and (4) of Panel E, firms are classified as operating in a country with long-time oriented decisions when they have weak future-time-reference (FTR) strength. *High Var* represents long-time oriented decisions. In columns (1) and (2) of Panel F, firms are classified as having higher supplier high-carbon electricity use when, for each customer-year, the supplier country's share of electricity generated from oil, gas, and coal is above the median. *High Var* represents a high level of *High-carbon electricity*. In columns (3) and (4) of Panel F, firms are classified as having higher supplier low-carbon electricity use when, for each customer-year, the supplier country's share of electricity generated from nuclear and renewable energy is above the median. *High Var* represents a high level of *Low-carbon electricity*. Panel G presents other moderating effects and the results on supplier carbon pricing exposure. In columns (1) and (2) of Panel G, firms are classified as having higher supplier emissions when their suppliers' average scope one emissions are above the median each year. *High Var* represents high *Supplier scope-1 carbon emission*. In columns (3) and (4) of Panel G, firms are classified as having higher climate change performance when their supplier countries' climate change performance index is above the median each year. *High Var* represents a high level of *Supplier climate change performance.* In columns (5) and (6) of Panel G, firms are classified as having higher exposure to their suppliers' carbon pricing policies when their suppliers' regulatory climate change exposure exceeds the average each year. *High Var* represents high *Supplier carbon pricing exposure.* The definitions of all variables are in the Appendix. Standard errors are clustered at the pair level. The *t*-statistics are reported in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

$CO_2Pricing$=	Tax	ETS	Tax	ETS
Panel A: Testing the cost avoidance channel: financing ability				
Partitioning variables	*Total assets*		*Leverage ratio*	
Dependent variable: *Total_Sup*	(1)	(2)	(3)	(4)
$CO_2Pricing_{t>0}$ × *High Var*	0.020***	0.058***	-0.024***	-0.015***
	(2.67)	(6.30)	(-4.34)	(-2.68)
$CO_2Pricing_{t>0}$	-0.026***	0.008	-0.000	0.047***
	(-4.24)	(0.93)	(-0.05)	(5.36)
High Var	-0.037***	-0.071***	0.011***	0.015***
	(-6.38)	(-8.60)	(3.43)	(3.40)
Controls	Yes	Yes	Yes	Yes
Pair FE	Yes	Yes	Yes	Yes

Year FE	Yes	Yes	Yes	Yes
R^2	0.747	0.747	0.755	0.755
N	414,871	414,871	364,977	364,977

Panel B: Testing the cost avoidance channel: profitability

Partitioning variables	*ROE*		*Supplier ROE*	
Dependent variable: *Total_Sup*	(1)	(2)	(3)	(4)
$CO_2Pricing_{t>0}$ × *High Var*	0.010**	0.013***	0.015***	-0.002
	(1.96)	(2.63)	(2.69)	(-0.40)
$CO_2Pricing_{t>0}$	-0.023***	0.036***	-0.015*	0.049***
	(-3.49)	(4.10)	(-1.92)	(4.70)
High Var	-0.002	-0.008**	-0.009***	-0.004
	(-0.87)	(-2.24)	(-2.72)	(-0.99)
Controls	Yes	Yes	Yes	Yes
Pair FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
R^2	0.751	0.751	0.781	0.781
N	319,956	319,956	214,912	214,912

Panel C: Testing the cost avoidance channel: competition

Partitioning variables	*HHI*		*Market share*	
Dependent variable: *Total_Sup*	(1)	(2)	(3)	(4)
$CO_2Pricing_{t>0}$ × *High Var*	0.017***	0.035***	0.021***	0.062***
	(2.71)	(4.62)	(2.82)	(6.77)
$CO_2Pricing_{t>0}$	-0.022***	0.024***	-0.031***	0.005
	(-3.81)	(2.95)	(-4.82)	(0.61)
High Var	0.003	-0.014**	-0.026***	-0.060***
	(0.58)	(-2.32)	(-4.41)	(-7.64)
Controls	Yes	Yes	Yes	Yes
Pair FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
R^2	0.746	0.747	0.750	0.750
N	415,578	415,578	390,531	390,531

Panel D: Tests for transformational incentives: environmental performance

Partitioning variables	*E-Score*		*Supplier E-Score*	
Dependent variable: T*otal_Sup*	(1)	(2)	(3)	(4)
$CO_2Pricing_{t>0}$ × *High Var*	0.013***	0.015***	0.032***	0.031***
	(2.64)	(2.84)	(6.16)	(6.03)
$CO_2Pricing_{t>0}$	-0.024***	0.039***	-0.035***	0.031***
	(-4.27)	(5.01)	(-5.90)	(3.86)
High Var	0.006*	-0.000	-0.029***	-0.040***
	(1.84)	(-0.11)	(-9.38)	(-10.64)
Controls	Yes	Yes	Yes	Yes
Pair FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
R^2	0.748	0.748	0.748	0.748
N	435,075	435,075	437,822	437,822

Panel E: Tests for transformational incentives: sustainability orientation and innovation capacity

Partitioning variables	*Green patents*		*Long-time orientation*	
Dependent variable: T*otal_Sup*	(1)	(2)	(3)	(4)
$CO_2Pricing_{t>0}$ × *High Var*	0.013**	0.032***	0.019**	0.040**
	(2.02)	(4.14)	(2.00)	(2.23)
$CO_2Pricing_{t>0}$	-0.019***	0.036***	-0.021***	0.036***
	(-3.62)	(4.75)	(-3.52)	(4.48)
High Var	-0.012***	-0.029***		
	(-3.30)	(-5.27)		
Controls	Yes	Yes	Yes	Yes
Pair FE	Yes	Yes	Yes	Yes

Year FE	Yes	Yes	Yes	Yes
R^2	0.747	0.747	0.747	0.747
N	438,773	438,773	438,773	438,773

Panel F: Tests for transformational incentives: supplier country energy structure

Partitioning variables	*High-carbon electricity*		*Low-carbon electricity*	
Dependent variable: T*otal_Sup*	(1)	(2)	(3)	(4)
$CO_2Pricing_{t>0}$ × *High Var*	-0.053***	0.005	0.058***	0.019**
	(-8.41)	(0.77)	(6.58)	(2.47)
$CO_2Pricing_{t>0}$	0.005	0.055***	-0.052***	0.043***
	(0.91)	(6.66)	(-6.07)	(4.92)
High Var	0.052***	0.041***	-0.107***	-0.113***
	(15.93)	(8.02)	(-23.43)	(-16.86)
Controls	Yes	Yes	Yes	Yes
Pair FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
R^2	0.754	0.754	0.769	0.769
N	404,935	404,935	335,013	335,013

$CO_2Pricing$=	Tax	ETS	Tax	ETS	Tax	ETS

Panel G: Other moderating effects and the tests for carbon pricing exposure

Partitioning variables	*Supplier scope-1 carbon emission*		*Supplier climate change performance*		*Supplier carbon pricing exposure*	
Dependent variable: *Total_Sup*	(1)	(2)	(3)	(4)	(5)	(6)
$CO_2Pricing_{t>0}$ × *High Var*	-0.052***	0.069***	-0.022***	0.014**	-0.010*	0.020***
	(-5.94)	(6.85)	(-3.68)	(2.19)	(-1.71)	(2.65)
$CO_2Pricing_{t>0}$	0.040***	-0.024**	-0.008	0.046***	0.021***	0.027**
	(4.90)	(-2.18)	(-1.36)	(5.75)	(2.72)	(2.34)
High Var	0.189***	0.131***	0.013***	-0.003	0.031***	0.012*
	(31.41)	(14.63)	(3.75)	(-0.60)	(7.47)	(1.89)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Pair FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.802	0.802	0.747	0.747	0.805	0.805
N	238,109	238,109	385,901	385,901	185,762	185,762

Table 5: The effects of carbon prices on the supply chain

The sample consists of pair-years of customer and supplier countries jointly covered by FactSet Revere, Compustat, and World Bank Carbon Pricing Dashboard between 2003 and 2024. *Total_Sup* is the natural logarithm plus one of the total supply chain contracts. CO_2Price is the natural logarithm plus one of the average carbon prices in the supplier country. CO_2Price^2 is the quadratic term of CO_2Price. We exclude firms with negative shareholder equity and those from the finance and utility industries. Columns (1) and (2) present the linear regression results. Columns (3) and (4) present the polynomial regression results. Column (5) presents the results of re-estimating the model with a two-piece linear spline in the carbon price of ETS with a single knot at the estimated turning point. $CO_2Price_{p_left}$ and $CO_2Price_{p_right}$ are linear-spline terms in the CO_2Price of Column (4) with a single knot at the estimated turning point p. All control variables are the same as those in Table 2, but their coefficients are not tabulated. The definitions of all variables are in the Appendix. Standard errors are clustered at the pair level. The t-statistics are reported in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

CO_2Price=	Tax	ETS	Tax	ETS		ETS
Dependent variable: *Total_Sup*	(1)	(2)	(3)	(4)		(5)
CO_2Price	-0.007***	0.003	-0.015**	0.026***	$CO_2Price_{p_left}$	0.013***
	(-3.18)	(1.48)	(-2.49)	(4.38)		(3.87)
CO_2Price^2			0.002	-0.005***	$CO_2Price_{p_right}$	-0.011***
			(1.48)	(-4.44)		(-3.20)
Controls	Yes	Yes	Yes	Yes	Controls	Yes
Pair FE	Yes	Yes	Yes	Yes	Pair FE	Yes
Year FE	Yes	Yes	Yes	Yes	Year FE	Yes
R^2	0.747	0.747	0.747	0.747	R^2	0.747
N	418,347	420,540	418,347	420,540	N	420,540

Table 6: The effects of carbon pricing on supply chain emissions and transaction amount.
Columns (1) and (2) of Panel A examine the effects of carbon pricing on total carbon emissions of customers (*Cus_CO₂*). Columns (3) and (4) of Panel A examine the effects of carbon pricing on average carbon emissions of customers' suppliers (*Sup_CO₂*). Columns (1) and (2) of Panel B examine the effects of carbon pricing on the total transaction volume of pair-years of customer and supplier countries (*Total_Amount*). Columns (3) and (4) of Panel B examine the effects of carbon pricing on the average transaction volume of pair-years of customer and supplier countries (*Mean_Amount*). *CO₂Pricing* is the percentage of customers' supplier countries that initiate a carbon tax or ETS. The regression approach is OLS. Panel B restricts the sample to transactions with a volume of at least $15 million. All control variables are the same as those in Table 2, but their coefficients are not tabulated. The definitions of all variables are in the Appendix. Columns (1) and (2) of Panel A include firm and year fixed effects; the standard errors are clustered at the firm level. The remaining columns include pair and year fixed effects; the standard errors are clustered at the pair level. The t-statistics are reported in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

CO₂Pricing=	Tax	ETS	Tax	ETS
Panel A: The effects of carbon pricing on supply chain emissions.				
Dependent variables	*Cus_CO₂*	*Cus_CO₂*	*Sup_CO₂*	*Sup_CO₂*
	(1)	(2)	(3)	(4)
CO₂Pricing	-0.0002	-0.0000	-0.0015***	-0.0020***
	(-0.93)	(-0.01)	(-3.34)	(-6.27)
Controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	No	No
Pair FE	No	No	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
R^2	0.947	0.947	0.845	0.845
N	66,791	66,791	260,116	260,116
Panel B: The effects of carbon pricing on supply chain transaction amount.				
Dependent variables	*Total_Amount*	*Total_Amount*	*Mean_Amount*	*Mean_Amount*
	(1)	(2)	(3)	(4)
CO₂Pricing	-0.0017**	0.0013**	-0.0020***	0.0010*
	(-2.22)	(2.12)	(-2.65)	(1.67)
Controls	Yes	Yes	Yes	Yes
Pair FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
R^2	0.888	0.888	0.896	0.896
N	24,926	24,926	24,926	24,926

Table 7: The effects of the U.S. state carbon pricing on the supply chain

The sample consists of pair-years of customer and supplier states jointly covered by FactSet Revere, Compustat between 2003 and 2024. *Total_Sup* is the natural logarithm plus one of the total supply chain contracts. $ETS_{t>0}$ are dummies that equal one for *t* years after a state initiates the cap-and-trade market under the Regional Greenhouse Gas Initiative (RGGI) scheme or the Western Climate Initiative (WCI), and zero otherwise. We restrict our sample to customers with at least one supplier operating in affected states and exclude customers from the regulated utility industries. We exclude suppliers that have ever exited the RGGI schemes (i.e., NJ, NC, and VA). Panel A presents the results of state-level tests of U.S. cap-and-trade market initiatives on the sourcing supply chains of firms worldwide. Panel B replaces the dependent variable in Panel A with an alternative supply chain measure on new contracts. *Total_New* is the natural logarithm plus one of the customer's total new supply chain contracts. Panel C repeats the U.S. state-level tests by restricting the sample to U.S. firms. All control variables are the same as those in Table 2, but their coefficients are not tabulated. The regressions include pair and year fixed effects. The definitions of all variables and the initiation year of the cap-and-trade market are in the Appendix. Standard errors are clustered at the pair level. The *t*-statistics are reported in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel A: The tests for global firms and sourcing suppliers in the U.S.

Dependent variable: *Total_Sup*	(1)	(2)
$ETS_{t>0}$	0.046***	
	(6.63)	
$ETS_{t>0} \times RGGI$		0.022***
		(2.65)
$ETS_{t>0} \times WCI$		0.072***
		(6.53)
Controls	Yes	Yes
Pair FE	Yes	Yes
Year FE	Yes	Yes
R^2	0.744	0.745
N	242,150	242,150

Panel B: Alternative supply chain measures using new supplier contracts

Dependent variable: *Total_New*	(1)	(2)
$ETS_{t>0}$	0.062***	
	(10.67)	
$ETS_{t>0} \times RGGI$		0.015**
		(2.19)
$ETS_{t>0} \times WCI$		0.116***
		(13.10)
Controls	Yes	Yes
Pair FE	Yes	Yes
Year FE	Yes	Yes
R^2	0.362	0.363
N	242,150	242,150

Panel C: The tests for U.S. firms and sourcing suppliers in the U.S.

Dependent variable: *Total_Sup*	(1)	(2)
$ETS_{t>0}$	0.031***	
	(3.60)	
$ETS_{t>0} \times RGGI$		0.022**
		(2.13)
$ETS_{t>0} \times WCI$		0.044***
		(3.00)
Controls	Yes	Yes
Pair FE	Yes	Yes
Year FE	Yes	Yes
R^2	0.760	0.760
N	121,252	121,252

Appendix: Variable Definitions

Dependent Variables	Definitions
Customer-supplier country-year variables:	
Total_Sup	The natural logarithm of the customer's total supply chain contracts plus one.
Total_New	The natural logarithm of the customer's new supply chain contracts plus one.
Total_Amount	The natural logarithm of the customer's total transaction volume.
Mean_Amount	The natural logarithm of the customer's average transaction volume.
Independent Variables	Definitions
Supplier country–year variables:	
$CO_2Pricing_{t>0}$	A dummy variable equal to one if a country in which the supplier operates implements the carbon tax or ETS, and zero otherwise.
CO_2Price	The natural logarithm of the carbon price plus one in supplier countries.
CO_2Price^2	The square term of CO_2Price.
Climate Change Performance	A dummy variable equal to one for customers whose suppliers' Climate Change Performance Index (CCPI) is above the median and zero otherwise.
Customer-year variables:	
Total assets	A dummy variable equal to one for customers whose total assets are above the median value of all customers and zero otherwise.
ROE	A dummy variable equal to one for customers whose ROE is above the median value of all customers and zero otherwise.
HHI	A dummy variable equal to one for customers whose Herfindahl-Hirschman Index is above the median value of all customers and zero otherwise.
Leverage ratio	A dummy variable equal to one for customers whose leverage ratio is above the median value of all customers and zero otherwise.
E-Score	A dummy variable equal to one for customers whose environmental score is above the median value of all customers and zero otherwise.
Market Share	A dummy variable equal to one for customers whose market share in terms of total revenue is above the median value of all customers and zero otherwise.
Green Patent	A dummy variable equal to one for customers whose green patent applications are above the average of all customers and zero otherwise.
Cus_CO_2	The natural logarithm of the customer's total Scope 1 carbon emissions.
Customer country variable:	
Long-time orientation	A dummy variable equal to one for customers from countries with low Future-Time Reference (FTR) strength, and zero otherwise.
Customer-supplier country-year variables:	
High-carbon electricity	A dummy variable equal to one for each customer-year indicates that the supplier country's share of electricity generated from oil, gas, and coal is above the median and zero otherwise
Low-carbon electricity	A dummy variable equal to one for each customer-year indicates that the supplier country's share of electricity generated from nuclear and renewable energy is above the median and zero otherwise
Supplier ROE	A dummy variable equal to one for customers whose suppliers' average ROE is above the median value and zero otherwise.
Supplier Scope-1 Emission	A dummy variable equal to one for customers whose suppliers' average Scope 1 carbon emissions are above the median value and zero otherwise.
Supplier E-score	A dummy variable equal to one for customers whose suppliers' mean environmental score is above the median value and zero otherwise.
Supplier carbon pricing exposure	A dummy variable equal to one for customers whose suppliers' regulatory climate change exposure (Sautner et al., 2023) is above the average value and zero otherwise.
Sup_CO_2	The natural logarithm of customers' average supplier scope one carbon emissions in one supplier country.
Control Variables	Definitions
Customer-year variables:	

$Size_{t-1}$	The natural logarithm of the total assets in year *t*-1.
$Sales_{t-1}$	The natural logarithm of the total sales in year *t*-1.
$Leverage_{t-1}$	Book value of debt divided by the total assets in year *t*-1.
ROA_{t-1}	Net income divided by the total assets in year *t*-1.
$Tangibility_{t-1}$	Tangible assets divided by the total assets in year *t*-1.
Age_{t-1}	The natural logarithm of the company's age in year *t*-1.

Internet Appendix for
"Carbon Pricing and Global Supply Chain Networks"
(Not to be published)

This Internet Appendix provides additional summary statistics and empirical analyses of the main results presented in "Carbon Pricing and Global Supply Chain Networks". Table IA1 describes the year of initiation of country-level carbon pricing policies. Figure IA1 shows the status of carbon pricing policies (Center for Climate and Energy Solutions, 2024). Table IA2 lists the start and end years of the U.S cap-and-trade market. Table IA3 reports additional summary statistics on the location distribution of the global supply chain. Table IA4 reports the summary statistics of the U.S. cap-and-trade market sample. Table IA5 includes additional robustness checks regarding alternative fixed effects and sample filtering. Table IA6 explores additional cross-sectional heterogeneity in our baseline results using alternative measures for partitioning variables.

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Table IA1: The year of the carbon pricing policies initiation (updated by Dec. 2024)

Figure IA1: U.S. State Carbon Pricing Policies (source: Center for Climate and Energy Solutions)

Table IA2: Carbon pricing initiatives in the U.S.

Table IA3: Summary statistics of the U.S. cap-and-trade market sample

Table IA4: Sample distribution by location

Figure IA2: Placebo Tests (randomization inference)

Table IA5: Additional robustness tests

Table IA6: Additional cross-sectional heterogeneity at the industry level

Table IA1: The year of the carbon pricing policies initiation (updated by Dec. 2024)

Jurisdiction	Carbon Tax Initiation Year	ETS Launch Year
Albania	2010	N/A
Argentina	2018	N/A
Australia	2012	2023
Austria	2022	2005
Belgium	N/A	2005
Bulgaria	N/A	2007
Canada	2019	2013
Chile	2017	N/A
China	N/A	2013
Colombia	2017	N/A
Croatia	N/A	2013
Czech Republic	N/A	2005
Denmark	1992	2005
Estonia	2000	2005
Finland	1990	2005
France	2014	2005
Germany	2021	2005
Greece	N/A	2005
Hungary	2023	2005
Indonesia	N/A	2023
Ireland	2010	2005
Israel	2024	N/A
Italy	N/A	2005
Japan	2012	2010
Korea, Rep.	N/A	2015
Latvia	2004	2005
Lithuania	N/A	2005
Luxembourg	2021	2005
Mexico	2014	2020
Montenegro	N/A	2022
Netherlands	2021	2005
New Zealand	N/A	2008
Nigeria	2019	N/A
Norway	1991	2008
Poland	1990	2005
Portugal	2015	2005
Romania	N/A	2007
Singapore	2019	N/A
Slovak Republic	N/A	2005
Slovenia	1996	2005
South Africa	2019	N/A
Spain	2014	2005
Sweden	1991	2005
Switzerland	2008	2008
Taiwan	2024	N/A
Ukraine	2011	N/A
Uruguay	2022	N/A
United Kingdom	2013	2005
United States	N/A	2009

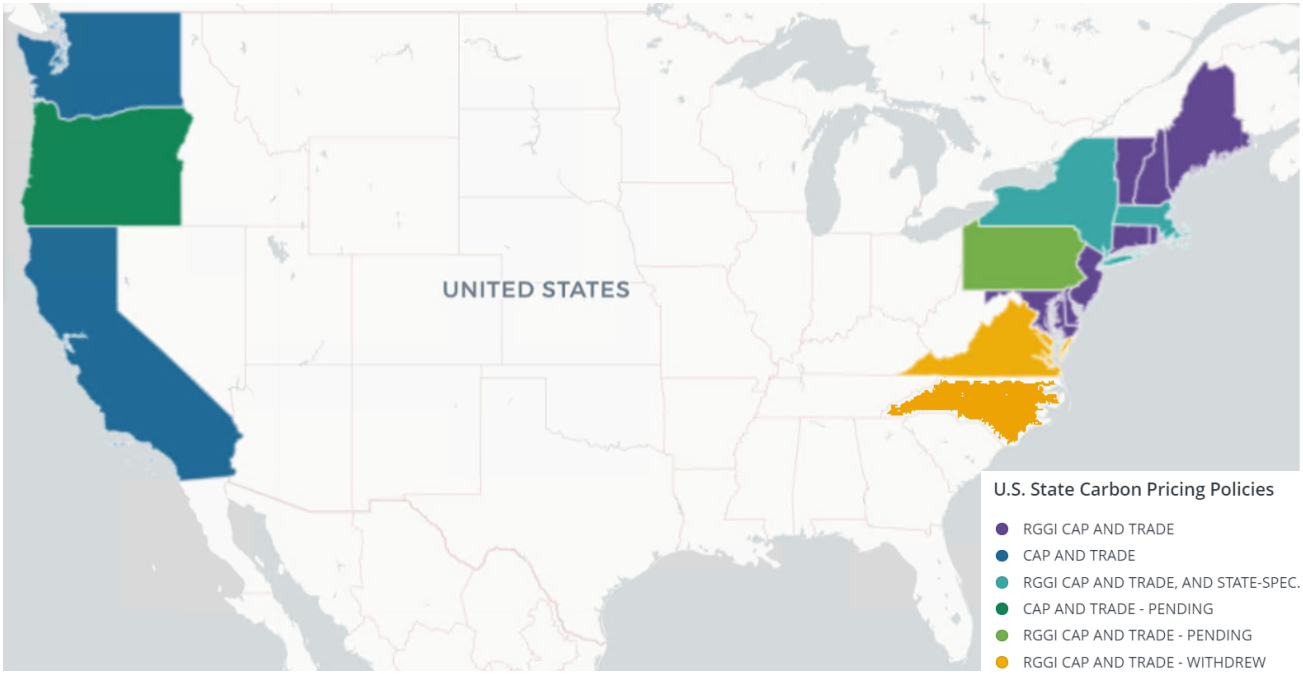


Figure IA1: U.S. State Carbon Pricing Policies (source: Center for Climate and Energy Solutions). Figure IA1 plots the status of carbon pricing policies across the U.S. by the end of 2024. We obtained the status of U.S. carbon pricing policies from the Center for Climate and Energy Solutions (https://www.c2es.org). States are classified into six groups using their initiative status. A purple color indicates RGGI cap-and-trade implementation. Dark blue represents the adoption of cap and trade. Light blue suggests the initiation of both RGGI and state-specific cap-and-trade programs. Green shows the initiative is pending implementation. Yellow is the state that has withdrawn from the RGGI cap-and-trade program.

Initiative name	State	Starting Year	Ending Year
Western Climate Initiative (WCI)			
California Cap-and-Trade Program	CA	2012	
Washington Climate Commitment Act	WA	2023	
Regional Greenhouse Gas Initiative (RGGI)			
Connecticut RGGI	CT	2009	
Delaware RGGI	DE	2009	
Maine RGGI	ME	2009	
Maryland RGGI	MD	2009	
Massachusetts RGGI	MA	2009	
New Hampshire RGGI	NH	2009	
New Jersey RGGI	NJ	2009, 2020	2011
New York RGGI	NY	2009	
North Carolina RGGI	NC	2022	2024
Rhode Island RGGI	RI	2009	
Vermont RGGI	VT	2009	
Virginia RGGI	VA	2021	2023

Table IA2: Carbon pricing initiatives in the U.S. The two main state carbon pricing initiatives are first identified by checking the World Bank Carbon Pricing Dashboard and the Western Climate Initiatives Program Design and Implementation. Detailed information on entry and exit years for each state in the Regional Greenhouse Gas Initiative (RGGI) is collected from the Elements of RGGI website (https://www.rggi.org/program-overview-and-design/elements).

Table IA3: Sample distribution by location

This table reports customer-year distribution by the top 25 supplier economies from 2003 to 2024. In our analysis, Switzerland, Latvia, and Japan are excluded from the final sample as they implemented both a carbon tax and an ETS within a three-year window. Column (1) reports the number of customer-years. Column (2) reports the percentage of customer-years in the sample. Column (3) reports the number of total supply chain-years. Column (4) reports the number of new supply chain-years.

Location	(1) Customer-years	(2) Percent	(3) Total supply chain-years	(4) New supply chain-years
Australia	11,110	2.24	25,430	9,749
Brazil	7,621	1.54	15,891	5,188
Canada	15,635	3.15	31,550	11,050
China	35,637	7.18	143,449	59,021
France	22,383	4.51	50,322	18,058
Germany	26,372	5.31	68,866	24,294
Hong Kong	15,037	3.03	25,890	9,329
India	12,917	2.60	51,174	19,325
Indonesia	8,457	1.70	28,942	9,609
Ireland	5,154	1.04	6,965	2,415
Israel	5,122	1.03	10,136	3,376
Italy	9,762	1.97	18,433	6,991
Malaysia	5,879	1.18	11,544	4,294
Mexico	5,308	1.07	10,636	3,399
Netherlands	13,187	2.66	21,088	7,912
Norway	5,075	1.02	10,050	3,833
Singapore	8,745	1.76	14,122	5,059
South Africa	4,975	1.00	8,584	3,086
South Korea	22,804	4.59	75,221	25,779
Spain	7,408	1.49	13,722	5,240
Sweden	10,537	2.12	20,940	7,830
Taiwan	15,172	3.06	34,206	11,565
Thailand	5,662	1.14	14,605	5,291
United Kingdom	30,892	6.22	84,205	30,307
United States	72,410	14.59	428,516	141,110
Top 25 total	383,261	77.20	1,224,487	433,110
Sample total	471,113	100.0	1,391,577	493,589

Table IA4: Summary Statistics of the U.S. cap-and-trade market sample

The sample consists of pair-years of customer and supplier countries jointly covered by FactSet Revere and Compustat. Panel A reports the summary statistics by the sample composition of global firms and their sourcing suppliers in the U.S. Panel B reports the composition of U.S. firms and their sourcing suppliers in the U.S. The definitions of the variables are in the Appendix. Variables in non-dollar values are converted to U.S. dollars using Compustat's annual average exchange rate. All continuous variables are winsorized at the 1% level at both tails of their distributions.

	N	Mean	S.D.	Q1	Median	Q3
Panel A: Global firms and their sourcing suppliers in the U.S.						
Total_Sup	228,166	0.982	0.473	0.693	0.693	1.099
Total_New	228,166	0.358	0.473	0	0	0.693
$Size_{t-1}$	228,166	8.717	2.366	7.108	8.918	10.406
$Sales_{t-1}$	228,166	8.387	2.306	6.982	8.723	10.088
$Leverage_{t-1}$	228,166	0.196	0.176	0.055	0.162	0.287
ROA_{t-1}	228,166	0.060	0.117	0.030	0.068	0.113
$Tangibility_{t-1}$	228,166	0.223	0.194	0.072	0.166	0.326
Age_{t-1}	228,166	2.503	0.542	2.079	2.639	2.944
Panel B: U.S. firms and their sourcing suppliers in the U.S.						
Total_Sup	127,534	0.982	0.475	0.693	0.693	1.099
Total_New	127,534	0.355	0.471	0	0	0.693
$Size_{t-1}$	127,534	8.459	2.360	6.881	8.609	10.149
$Sales_{t-1}$	127,534	8.117	2.463	6.755	8.483	9.867
$Leverage_{t-1}$	127,534	0.224	0.205	0.059	0.185	0.327
ROA_{t-1}	127,534	0.050	0.165	0.028	0.075	0.125
$Tangibility_{t-1}$	127,534	0.217	0.203	0.062	0.148	0.317
Age_{t-1}	127,534	2.386	0.552	1.946	2.485	2.833

Chart A: Placebo tests of randomly assigning the carbon tax initiation year 500 times

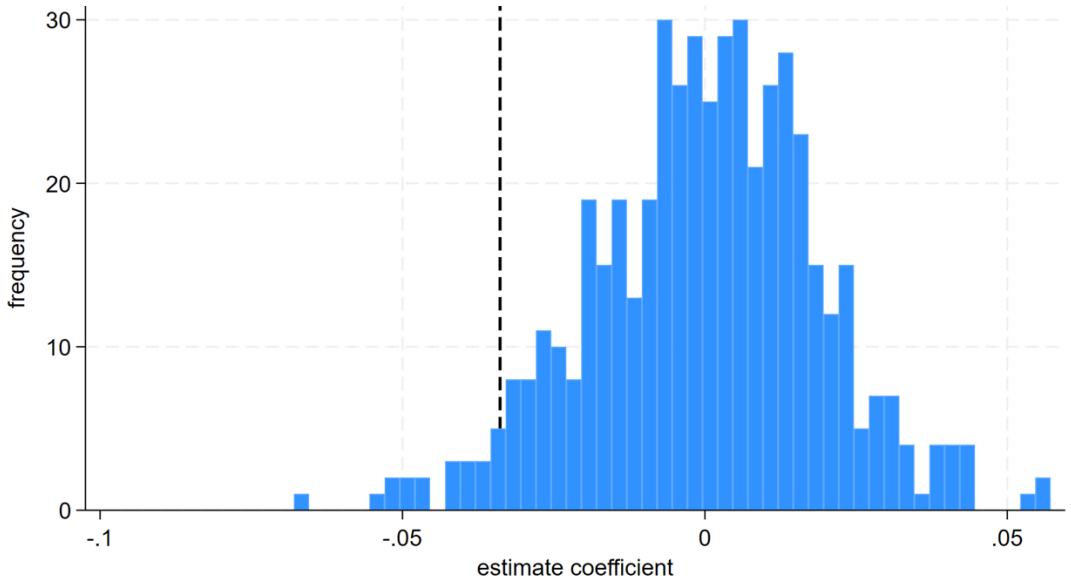


Chart B: Placebo tests of randomly assigning ETS adoption year 500 times

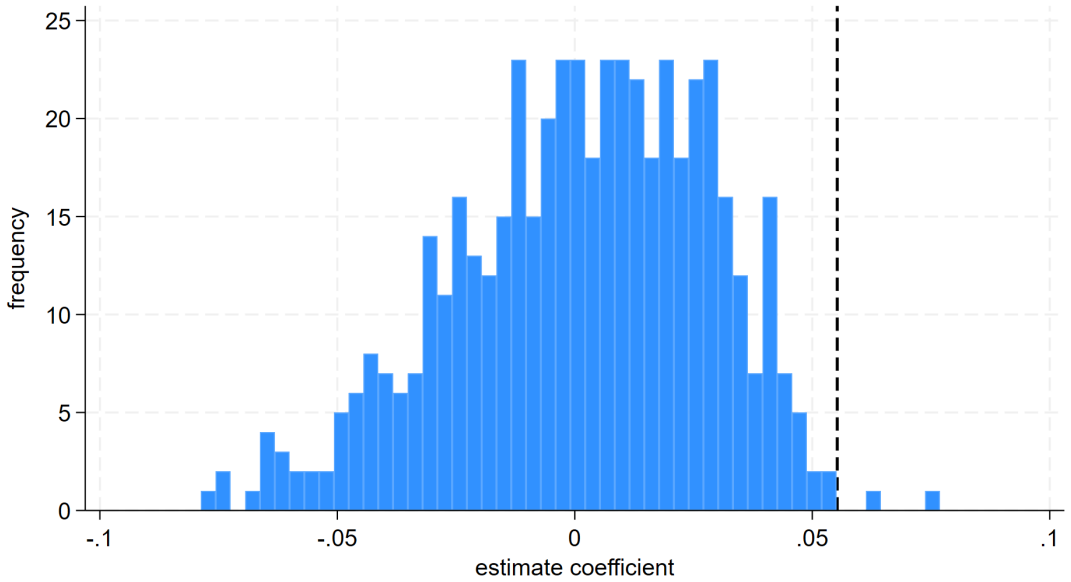


Figure IA2: Placebo Tests. Figure IA2 plots the results of randomized treatment assignment in the subsample analysis for each policy and visualizes the resulting distributions of estimated coefficients using a histogram density plot. Chart A plots the coefficient distribution of randomly assigning the carbon tax initiation year 500 times between 2003 and 2024. Chart B illustrates the coefficient distribution resulting from randomly assigning ETS adoption years 500 times, spanning from 2003 to 2024. In both charts, the dashed line is the coefficient of true estimate. Blue columns represent the distributions of estimated coefficients from placebo tests.

Table IA5: Additional robustness tests

The sample consists of pair-years of customer and supplier countries jointly covered by FactSet Revere, Compustat, Caldara and Iacoviello (2022) between 2003 and 2024. *Total_Sup* is the natural logarithm plus one of the total supply chain contracts. $CO_2Pricing_{t>0}$ is a dummy variable that equals one for *t* years after a country implements carbon pricing policies, respectively, and zero otherwise. All control variables are the same as those in Table 2, but their coefficients are not tabulated. Panel A includes an additional firm-level Industry × Year fixed effects. Panel B excludes firms from the finance sector (SIC code 6000-6799) and regulated utilities (SIC code 4900-4999) from the sample. Panel C excludes the U.S. firms in the sample, the country with the most customers. Panel D excludes countries with fewer than 100 customers in the sample. Panel E excludes pair-years of customers from China and suppliers from the U.S. Panel F excludes countries whose geopolitical risk index is in the top 10% of our sample in terms of geopolitical risks. Panel G excludes countries that have both carbon pricing policies implemented within the past 10 years. Panel H reports the results of implementing each carbon pricing policy in the subsample. Panel I presents the distribution of estimated coefficients on $CO_2Pricing_t$ and the corresponding t-statistics from placebo regressions in which the carbon pricing policy initiation year is randomly reassigned across sample firms 500 times. All panels include pair and year fixed effects. The definitions of all variables are in the Appendix. Standard errors are clustered at the pair level. The t-statistics are reported in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

$CO_2Pricing$=	Tax	ETS
Dependent variable: *Total_Sup*	(1)	(2)
Panel A: Include additional Industry × Year fixed effects		
$CO_2Pricing_{t>0}$	-0.014***	0.044***
	(-2.78)	(6.12)
Controls	Yes	Yes
Pair FEs	Yes	Yes
Year FEs	Yes	Yes
Industry × Year FE	Yes	Yes
R^2	0.750	0.750
N	455,989	455,989
Panel B: Excluding finance and utility customers		
$CO_2Pricing_{t>0}$	-0.015***	0.041***
	(-2.91)	(5.54)
Controls	Yes	Yes
Pair FEs	Yes	Yes
Year FEs	Yes	Yes
R^2	0.745	0.746
N	431,352	431,352
Panel C: Excluding U.S. customers		
$CO_2Pricing_{t>0}$	-0.025***	0.054***
	(-4.48)	(5.76)
Controls	Yes	Yes
Pair FEs	Yes	Yes
Year FEs	Yes	Yes
R^2	0.738	0.738
N	367,698	367,698
Panel D: Excluding countries with fewer than one hundred customers		
$CO_2Pricing_{t>0}$	-0.015***	0.052***
	(-2.72)	(6.93)
Controls	Yes	Yes
Pair FEs	Yes	Yes
Year FEs	Yes	Yes
R^2	0.749	0.749
N	394,789	394,789
Panel E: Exclude U.S. suppliers and Chinese customers		

$CO_2Pricing_{t>0}$	-0.023***	0.036***
	(-4.36)	(4.48)
Controls	Yes	Yes
Pair FEs	Yes	Yes
Year FEs	Yes	Yes
R^2	0.719	0.719
N	345,229	345,229

Panel F: Exclude countries with high geopolitical risks

$CO_2Pricing_{t>0}$	-0.037***	0.044***
	(-6.64)	(6.18)
Controls	Yes	Yes
Pair FEs	Yes	Yes
Year FEs	Yes	Yes
R^2	0.741	0.741
N	352,466	352,466

Panel G: Excluding countries with both policies implemented within 10 years

$CO_2Pricing_{t>0}$	-0.033***	0.046***
	(-3.25)	(4.94)
Controls	Yes	Yes
Pair FEs	Yes	Yes
Year FEs	Yes	Yes
R^2	0.749	0.749
N	394,789	394,789

Panel H: Subsample analysis for each policy

$CO_2Pricing_{t>0}$	-0.034***	0.055***
	(-3.27)	(6.10)
Controls	Yes	Yes
Pair FEs	Yes	Yes
Year FEs	Yes	Yes
R^2	0.733	0.757
N	148,062	283,033

Panel I: Distribution of the coefficients of $CO_2Pricing_{t>0}$ constructed using randomized carbon pricing initiation years

Dependent variable: *Total_Sup*	(1)	(2)
Mean	0.000	0.002
	(0.06)	(0.24)
Median	0.001	0.004
	(0.19)	(0.70)
1st percentile	-0.05	-0.065
	(-7.43)	(-12.62)
5th percentile	-0.032	-0.046
	(-5.36)	(-9.39)
25th percentile	-0.011	-0.016
	(-1.96)	(-2.92)
75th percentile	0.013	0.022
	(2.18)	(4.03)
95th percentile	0.031	0.042
	(5.14)	(7.79)
99th percentile	0.044	0.049
	(7.58)	(9.84)

Table IA6: Additional cross-sectional heterogeneity at the industry level

The sample consists of pair-years of customer and supplier countries jointly covered by FactSet Revere and Compustat between 2003 and 2024. *Total_Sup* is the natural logarithm plus one of the total supply chain contracts. $CO_2Pricing_t$ are dummies that equal one for t years relative to a country implementing the carbon pricing policies, respectively, and zero otherwise. All control variables are the same as those in Table 2, but their coefficients are not tabulated. *Direct Exposure* is the percentage of customers' supplier industries that initiate direct carbon pricing (i.e., SIC code 1000-4999). *Indirect Exposure* refers to the percentage of customers' supplier industries that do not initiate carbon pricing directly (i.e., SIC codes 5000-8999). The definitions of all variables are in the Appendix. Standard errors are clustered at the pair level. The *t*-statistics are reported in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

$CO_2Pricing$=	Tax	ETS
Dependent variable: *Total_Sup*	(1)	(2)
$CO_2Pricing_{t>0}$ × *Direct Exposure*	-0.021***	0.045***
	(-3.70)	(5.95)
$CO_2Pricing_{t>0}$ × *Indirect Exposure*	-0.009	0.046***
	(-1.26)	(4.55)
Direct Exposure	-0.016***	-0.018**
	(-2.69)	(-2.27)
Controls	Yes	Yes
Pair FE	Yes	Yes
Year FE	Yes	Yes
R^2	0.746	0.746
N	456,157	456,157