US-China Trade War & Supply Chain Restructuring: What is the Impact on Buyer GHG Emissions, Buyer's Governance and Suppliers Emission Disclosure?

Fernando Greve[1]

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Abstract
Sustainable supply chain management has become a critical focus for global companies aiming to reduce emissions. Additionally, the US-China trade war has had profound impacts on global supply chain operations, speeding up supply chain reallocation and making global companies to restructure their global supply chain networks and sourcing strategies. This work explores the impact of the U.S.-China tariff war and supply chain restructure on companies' environmental supply chain management for emissions reductions. Specifically, I examine how tariffs and restructuring of supply chains influence these strategies, focusing on buyer GHG emissions, buyer's supply chain governance and suppliers' emission disclosure. To do this, I theorize and empirically test the channels through which sourcing strategies–defined during the tariff war—influence environmental supply chain management for greenhouse gas (GHG) emissions. To empirically assess these impacts, I employ a difference-in-differences (DID) analysis that allows me to do causal inference. My dataset consists of U.S. publicly listed firms that imported from China and were affected by US tariffs. I complement this dataset with transshipment Bill of Lading information. This work contributes to the literature by analyzing the impact of global supply disruptions in environmental management and offers a novel approach on the current discussion about the trade war's impact on the environment by bringing a supply chain management perspective to this discussion. Particularly, I establish that reshoring might be beneficial, and diversifying strategies might be detrimental for the environment. This study gives insights into how companies can adapt their supply chain strategies to simultaneously address economic pressures and fulfill their commitments to reducing carbon footprints. This is relevant for managers and policymakers.

Keywords: U.S.-China Trade War, supply chain restructuring, environmental disclosure, GHG emissions, supply chain governance.

[1] fgreve@gmail.com

1. Introduction

In recent years, supply chain management has emerged as a crucial concern for global corporations seeking to mitigate emissions. Clear evidence of global warming and the acknowledgment that most emissions from multinational firms arise from their supplier chains have shifted stakeholders' focus towards supply chains to substantially reduce their climate impact. Considering compelling evidence of global warming, stakeholders have urged firms and their supply chains to significantly diminish their environmental effect (Jeong & Lee, 2022). Procter & Gamble pledged to decrease its emissions by 30% by 2020 (P&G, 2015), highlighting the increasing tendency of firms to incorporate sustainability into their operating strategy. Additionally, the Carbon Disclosure Project (2017) indicates that big firms are becoming acknowledging that approximately 80% of their carbon emissions stem from supply chains over which they possess limited direct control. This fact offers a significant opportunity for emissions reduction initiatives and underscores the crucial importance of supply chain management in attaining global emissions reduction objectives.

On the other hand, the global economy is witnessing significant upheavals and developments that are putting increasing pressure on global supply chains. Disruptive events such as the COVID-19 pandemic, the ongoing Russo-Ukrainian War and the US-China trade war have had profound impacts on global supply chain operations, speeding up supply chain reallocation concerning a significant shift in how countries source and produce goods, particularly in response to geopolitical tensions, trade policies, and economic pressures. In 2018 and 2019, the US imposed tariffs on over 60 percent of imports from China, mostly at the 25 percent level. In 2022, US imports from China in tariffed goods were 14 percent lower than in 2017, while imports from the rest of the world were 48 percent higher for those same products. As a result, China's share in US imports fell from 21.6 to 16.3 percent between 2017 and 2022 and is now back at the level it was in 2007, before the global financial crisis.

This situation poses novel challenges for firms in terms of restructuring their global supply chain networks to mitigate disruptions effectively (Jain et al. 2022). Supply chain restructuring refers to the significant changes that companies make to their supply chain strategies and operations, particularly in response to external challenges such as the US-China trade war. Companies are reevaluating their sourcing strategies,

leading to a diversification of suppliers and a reduction in dependence on single countries, notably China. For instance, companies have started to increase imports from other Asian nations like India and Vietnam, as well as from North American countries such as Canada and Mexico, to mitigate risks associated with supply chain disruptions. The goal of these changes is to enhance the robustness and resilience of supply chains, allowing companies to better navigate future uncertainties and disruptions. The ongoing tariff war has compelled companies to restructure their supply chains, adopting strategies aimed at enhancing robustness and resilience in the face of shifting trade policies (Cohen and Kouvelis, 2021). Key strategies include reshoring (Jung, 2020), nearshoring (Berger, 2023), supplier base diversification (Cohen et al., 2022), and China+1 (Cohen et al., 2023). A question that emerges is what is the impact of supply chain restructuring on the environmental supply chain management?

This work aims to explore the impact of the U.S.-China tariff war on companies' supply chain management strategies for emissions reductions. Specifically, it examines how tariffs imposed on US importers and their supply chains restructuring influence sustainability efforts within companies' global supply chain. As businesses navigate the challenges posed by tariffs, it is crucial to understand how the restructuring of supply chains influences their ability to manage and reduce emissions effectively. By examining the interplay between trade dynamics and environmental sustainability, this study aims to uncover insights into how companies can adapt their supply chain strategies to simultaneously address economic pressures and fulfill their commitments to reducing carbon footprints.

Academic research presents intriguing findings regarding U.S.-Trade war impact on the greenhouse gas (GHG) emissions. Kahn et al. (2024, NBER) utilize city-level data from Vietnam to demonstrate notable advancements in environmental sustainability. Meanwhile, Liu et al. (2020) apply a General Equilibrium Model to analyze emissions trends, revealing a decrease in GHG emissions from both the U.S. and China. However, this decline is accompanied by an increase in emissions from other countries, underscoring the complexity of global emissions dynamics and the interconnectedness of national environmental policies. Recent academic research at the firm level highlights the nuanced effects of tariffs on environmental, social, and governance (ESG) engagement. Xu, Huang, and Zhang (2024) find that U.S. tariffs boost ESG

engagement among Chinese exporters, indicating a shift towards more responsible business practices in response to trade barriers. Additionally, Xu and Wu (2022) examine how competition from China influences U.S. importers' ESG initiatives, demonstrating the interconnected nature of global trade and corporate sustainability efforts. Nonetheless, despite these findings, there is still a significant gap in the literature, as no research has examined the influence of tariffs on supply chain engagement concerning emissions reduction.

The aim of this study is to investigate how tariffs and supply chain restructuring impacts buyer emissions, buyer's supply chain emission governance and suppliers' emission disclosure. My identification strategy relies on the exogenous nature of the trade war, instigated by a sudden and largely unanticipated shift in U.S. trade policy that was not driven by the individual characteristics or performance of firms. This unpredictable environment provides a unique opportunity to analyze the strategic adaptations firms make in response to external pressures, particularly regarding their governance strategies and engagement in emissions reduction initiatives. To empirically assess these impacts, I employ a difference-in-differences (DID) analysis following the methodology outlined by Ho et al. (2017). Following the consensus in the public media (Bown 2023), I define the start of the trade War to be 2018-Q3 (See Figure 1), while tariff targets and source restructuring serve as our treatment variables. The output variables include buyer's emission, supply chain governance and supplier disclosure. I construct the sample from five datasets: Panjiva for company-to-company transshipment import data based on the bill of lading, CARD Trade War Tariffs Database for the detailed Tariff information from the Center for Agricultural and Rural Development Li (2018), Compustat for quarterly firm fundamentals, Carbon Disclosure Project (CDP) for suppliers' emission disclosure and drivers of supply base governance, and Bloomberg ESG for suppliers' GHG emission. My sample of interest consists of U.S. publicly listed firms that imported from China any period before the beginning of the Tarif War 2018q3 and imported from any country any period after 2018q3.

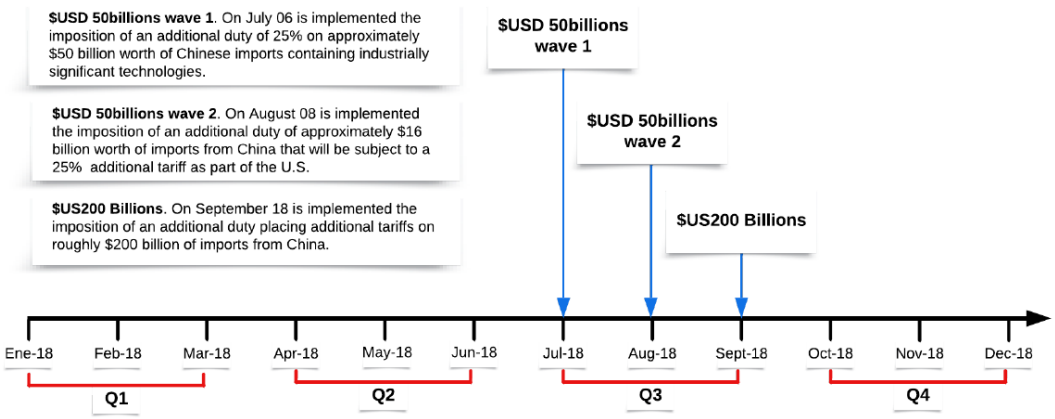

Figure 1: U.S. waves of import tariffs from China

This work contributes to several branches of supply chain literature. First, this work contributes to the environmental supply chain management literature in the following. While supply chain decarbonization has received growing attention in the literature (e.g., Gopalakrishnan et al., 2021), the impact of supply chain disruptions and global sourcing strategies on sustainable supply chain management has not received much attention. In this work, I study three relevant aspects of sustainable supply chain management. These are: emissions reduction, customer disclosure of emissions, and environmental governance. Importantly, I can establish a causal relationship, which is rarely found within the sustainable supply chain management literature.

Second, this work contributes to the literature of supply chain impact of trade war. Particularly, this work establishes a new scope of supply chain environmental impact to the discussion. Current literature has focused on understanding government policy impact on the supply chain management (Cohen and Lee 2020). None other work has linked tariffs and sourcing strategies and their impact on environmental supply chain management.

Third, this work provides a novel perspective on the ongoing discourse over the environmental impact of the trade war. This work specifically introduces a supply chain management viewpoint to the discussion. Furthermore, I can ascertain the diverse effects of firms' supply chain reorganization. Reshoring may be advantageous; however, diversification measures could be harmful to the environment.

This study is particularly relevant for managers aiming for carbon neutrality in their companies and supply chains, given that emissions reduction is a critical objective for global enterprises. By examining the effects of various supply chain restructurings on environmental supply chain management, I offer critical insights on how companies might harmonize their sourcing strategies with their environmental goals.

This work is also relevant for policymakers by expanding the analysis of tariff impacts to a broader Environmental, Social, and Governance (ESG) aspects. Specifically, greenhouse gas (GHG) emissions within the supply chain management. This is relevant considering the enacted of a variety of environmental disclosure mandates (Carrots & Sticks, 2020; Gensler, 2022) and the ongoing debate about these mandatory policies focusing on their scope, effectiveness, and negative influence on firm competitiveness (Aragòn-Correa et al., 2020; Seiger et al., 2022). And is relevant considering the announcement of new tariffs against Canada, Mexico and China (The New York Times, 2024).

2. Literature review

This work draws from two key branches of literature: Global Supply Chain Management and Sustainable Supply Chain Management. Within the branch of Global Supply Chain Management, I explore the impact of government policies, particularly the U.S.-China tariff war, and the adoption of robustness and resilience strategies to navigate the associated challenges. In contrast, the Sustainable Supply Chain Management literature emphasizes the importance of companies' emissions, supply chain governance and suppliers' emissions disclosure. Together, these branches provide a comprehensive framework for understanding how external policy influences supply chain dynamics and sustainability practices.

2.1 Global Supply Chain Management

Several works have studied global supply chain, both in the operations management and global trade economic field. In the context of the current global disruptions and particularly considering the U.S.-China trade war, the economic literature has focused on the optimal reallocation of the global supply chain. Antras and De Gortari (2020) study the optimal configuration of downstream stages and Alfaro et al. (2019)

complement this by studying the heterogeneity of this decision by companies' industry. Regarding supply chain evolution, Alfaro and Chor (2023) observed a decrease in direct US sourcing from China, and the increase of imports from Vietnam and nearshoring/friendshoring alternatives like Mexico. Acemoglu and Tahbaz-Salehi (2024) study how supply chains and aggregate output respond to shocks. Liu et al. (2024) investigate the effects of supply disruptions on firms' supply chain and found significant heterogeneity in disruptions among US firms. In the context of the operations management research field, there are two main research field relevant for this work: the impact of government policies, particularly the U.S.-China tariff war, and firms supply chain restructure that global companies have adopted to achieve robustness and resilience.

2.1.1 Impact of government policies on supply chain

Research has examined the influence of governmental policies, including the U.S.-China trade conflict, on supply chain dynamics. Cohen and Lee (2020) establish a framework for understanding government policy in the context of supply chain management.

Several research has studied the governmental policies regarding COVID-19 impact on global supply chain. Xu et al. (2023) classify pandemic-related disruptions as manufacturer and worldwide value chain lockdowns, input material shortages owing to healthcare resource shifts, and global logistics challenges from transportation lockdowns. Graves et al. (2022) detect pandemic demand and supply consequences. Demand volume, distribution patterns, and fulfillment channels changed significantly. Supply side shutdowns and slowdowns were caused by safety protocols and labor conditions. According to Dohmen et al. (2023), the epidemic increases supply and demand volatility and buffer inventories were insufficient to meet demand. Han et al. (2022) found that Alibaba's average package delivery time increased by 31% during the Wuhan lockout, indicating a major logistics capacity issue. Delivery times affect sales amount, explaining 60% of sales fluctuation. The company recovered sales within weeks as delivery times restored to pre-pandemic norms. Shen and Sun (2023) also found a recovery to pre-COVID product availability occurred within two months despite ongoing lockdowns.

More in line with this work, several studies have investigated the impact of tariffs on the configuration of global supply chains, emphasizing their significant implications (Hsu and Zhu, 2011; Dong and Kouvelis, 2020). Moreover, local content requirement laws can influence global sourcing options (Cui and Lu, 2019; Hsu et al., 2022), whereas tax policies impact production choices (Xiao et al., 2015; Lai et al., 2021). Furthermore, GSC restructuring arises as a reaction to uncertainties in trade and economic policies (Charoenwong et al., 2023) and geopolitical concerns (Leung et al., 2024), underscoring the necessity for companies to modify their strategy. None of these works have examined the impact of governmental policies on environmental supply chain management.

2.1.2 Risk, robustness and resilience

The second field in the Global Supply Chain Management literature focuses on robustness and resilience strategies in response to external pressures, particularly the tariff war. Companies have increasingly restructured their supply chains to enhance their robustness and resilience, as noted by Cohen and Kouvelis (2021). Key strategies include reshoring (Jung, 2020), which involves relocating production back to the home country, and nearshoring (Berger, 2023), which shifts production to nearby countries to mitigate risks. Additionally, diversification of the supplier base (Cohen et al., 2022) and the China plus one strategy (Cohen et al., 2023) are essential tactics companies employ to build resilience against disruptions. Together, these strategies reflect a proactive approach to managing uncertainties while ensuring supply chain stability and efficiency.

A body of literature has emerged on supply chain risk management (Sodhi et al. 2012). Several works have established a theoretical framework (Lee 2004; Sheffi 2007; Cohen and Kouvelis 2021). Elliott et al. (2022) discover that intermediate-productivity production networks are vulnerable to modest shocks and can exacerbate their effects. Kinnan et al. (2024) find stronger risk transmission through labor and supply chain connections. Bigio and Lao (2020) use input-output networks to show production network distortions, indicating that the US input-output structure exacerbated financial distortions during the 2008 financial

crisis. Carvalho et al. (2021) show that supply chain linkages propagate and amplify shocks upstream and downstream, as witnessed in the 2011 Great East Japan Earthquake.

Supply chain disruptions have emerged as a significant concern due to the offshoring of production to low-cost countries and the consequent growth in complex (Sodhi et al. 2012). Extensive research has addressed supply chain disruption, initially focusing on disruptions at single plant locations. Chopra and Sodhi (2004) study the impact of a fire at a semiconductor plant owned by Philips in New Mexico. Subsequent research focused on broader disruptions caused by natural disasters, such as floods and earthquakes. After the Great East Japan Earthquake in 2011, Durach et al. (2022) find that affected firms responded by increasing inventory levels and volume flexibility. Similarly, Sheffi (2020) highlights the impact of the Thai floods of 2011 on hard disk drive manufacturers. However, none of these works have examined the impact of supply companies restructure strategies for robustness and resilience on environmental supply chain management.

2.2 Sustainable Supply Chain Management

Existing literature analyzes and empirically examines sustainability. Drake and Spinler (2013) emphasize the importance of sustainable practices and new technology and supply chain procedures for companies seeking to reduce natural resource use. Agrawal and Lee (2019) developed a model showing how buyers can employ sourcing methods to improve supplier sustainability. Guo et al. (2016) explored how purchasers choose responsible and risky providers. Kraft et al. (2019) examined buyer investment decisions to improve supply chain visibility, while Caro et al. (2016) examined audit-penalty systems. These factors affect sustainability, but not emissions reduction. Due to consumer and regulatory pressures, empirical sustainability research has focused on corporate disclosure (Reid and Toffel 2009), customer valuations of supply chain visibility creation (Kraft et al. 2018), investments in Green IT (Khuntia et al. 2018), the effects of cradle-to-cradle closed-loop supply chains on solid waste (Dhanorkar 2018), and environmental management practices.

2.2.1 Emission reduction

In literature addressing GHG emissions reduction, prior research has predominantly concentrated on emissions disclosure and the quality of emissions data. For instance, Jira and Toffel (2013) investigated the factors that drive firms to respond to the CDP survey and share their information, identifying buyer pressure and the industry of suppliers as key influences on disclosure. Blanco et al. (2016) observed that companies participating in the CDP report only 22% of their total Scope 3 emissions. Additionally, Kim and Lyon (2011) found that participation in the CDP leads to an increase in shareholder value, while Jacobs (2014) established a positive relationship between voluntary emissions reductions and market reactions. Bellamy et al. (2019) developed metrics for gauging access to information within supply networks and assessed its effects on environmental disclosure. Although these studies represent significant contributions to the field, they do not investigate how governance practices impact emissions reduction.

2.2.2 Environmental disclosure and information sharing

This research relates to environmental disclosure and information sharing literature. Companies voluntarily disclose environmental information for various reasons, according to studies. Companies respond to pressures from supply chain members, industry peers, shareholders, and regulatory bodies (Jira & Toffel, 2013; Villena & Dhanorkar, 2020). Disclosure routes, scope, and quality vary (Clarkson et al., 2008; Bellamy et al., 2020; Marquis, 2016). The firm's environmental performance, stakeholder pressures, and organizational innovations also affect environmental performance reporting (Blanco, 2021; Clarkson et al., 2008; Fabrizio & Kim, 2019). Some research has examined how environmental disclosure affects firms' economic and financial performance (Buell & Kalkanci, 2021; Duan, Hofer, et al., 2021; Jacobs, 2014; Jacobs et al., 2010), while others have examined how it affects stakeholders' environmental practices. None of these works have studied the impact of a global disruption and supply chain restructuring on suppliers' emission disclosure.

2.2.3 Environmental governance

This study relates to environmental governance in supply chains concerning emissions reduction. Tachizawa and Wong (2015) and Villena (2018) delineate frameworks for environmental and sustainability governance that clarify how organizations should organize their governance for optimal impact. Formentini and Taticchi (2016) delineate both collaborative and non-collaborative governance models, elucidating their influence on relationships and outcomes in emissions control. Furthermore, Hoejmost et al. (2014) investigate the primary factors affecting these governance frameworks. The study by Huang, Narayanan, and Swaminathan (2020) investigates the impact of formal and informal governance on emission reductions, emphasizing the complex nature of governance and its critical function in promoting sustainability activities throughout supply chains. None of these works have studied the impact of global disruption and supply chain restructuring on environmental governance.

3. Hypotheses

The literature offers a comprehensive theoretical framework encompassing both relevant sourcing strategies and sustainable supply chain management. It highlights various sourcing strategies that companies can adopt to achieve robustness and resilience within their supply chains, as outlined by Cohen et al. (2022). These strategies are crucial for organizations seeking to navigate the complexities of global markets and mitigate risks effectively. Furthermore, the framework builds on the insights from Huang, Narayanan, and Swaminathan (2020), who investigate the roles of formal and informal governance in driving emission reductions. By integrating these perspectives, the framework underscores the importance of aligning sourcing decisions with sustainability goals, ultimately enabling firms to enhance their operational resilience while contributing to environmental sustainability. A figure with the theoretical framework is shown in Figure 2.

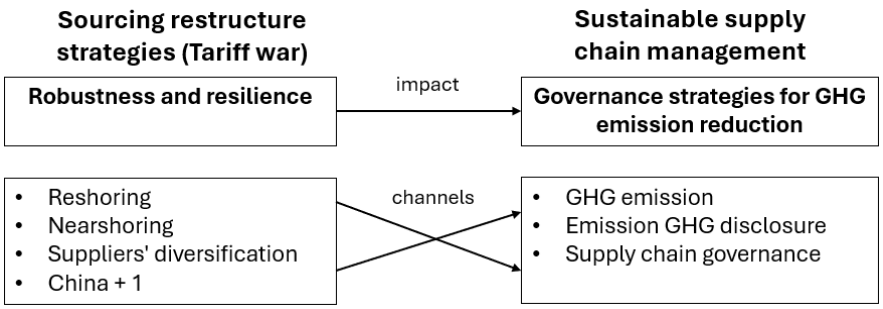

Figure 2: Impact channels of restructure strategies on sustainable supply chain

Regarding the influence of trade tariffs on buyer emissions, the regulation of emissions within the buyer's supply chain, and the disclosure of emissions by suppliers. The principal impact of tariffs is on import expenses, diminishing the comparative cost advantage of Chinese suppliers. Conversely, the intentional implementation of Environmental, Social, and Governance (ESG) policies serves to differentiate products and cultivate customer loyalty. However, during periods of tariff escalations, the significance of climate change engagement may wane, as immediate financial constraints overshadow long-term sustainability objectives, highlighting the intricacies of reconciling economic and environmental factors in supply chain management.

Hypotheses 1-3:
H1: The trade tariff increases the company's emission.
H2: The trade tariff decreases emission information sharing from suppliers.
H3: The trade tariff decreases the monitoring formality.

In the realm of supply chain strategy, approaches such as China+1 and supplier base diversification have emerged as critical responses to the challenges posed by trade policies and climate change. When buyers actively request climate change information, suppliers are more inclined to share relevant data, and this willingness is further enhanced by a commitment from buyers to engage in sustainability practices (Jira and Toffel, 2013). However, the imposition of tariffs increases import costs, altering the dynamics of buyer-supplier relationships. Under these conditions, the involvement of suppliers in climate change initiatives may serve as a differential mechanism to establish competitive advantage. Nonetheless, during times of

tariff increases, the relevance of climate change involvement can diminish, as immediate cost pressures take precedence over long-term sustainability goals, underscoring the complexity of balancing economic and environmental considerations in supply chain management.

Hypotheses 4-6:

H4: China+1 and diversification increases the company's emission.

H5: China+1 and diversification decreases the emission disclosure from suppliers.

H6: China+1 and diversification decreases the monitoring formality.

Reshoring has become an increasingly favored supply chain strategy as companies seek to enhance control over their operations and align with regulatory standards. Notably, suppliers located in regulated countries are more likely to share climate change information, reflecting a heightened level of transparency and compliance with environmental regulations (Jira and Toffel, 2013). This trend underscores the importance of regulatory environments in shaping supplier behavior, as heightened accountability encourages suppliers to actively engage in climate-related discussions and data sharing. By bringing production closer to home, firms can leverage these relationships to not only improve their sustainability practices but also strengthen their overall supply chain resilience in the face of growing environmental concerns.

Hypotheses 7-9:

H7: Reshoring decreases the company's emission.

H8: Reshoring increases the emission disclosure from suppliers.

H9: Reshoring increases the governance formality.

4. Data description

To examine the hypotheses, I construct the sample from five datasets: Panjiva for company-to-company transshipment import data based on the bill of lading, CARD Trade War Tariffs Database for the detailed Tariff information from the Center for Agricultural and Rural Development Li (2018), Compustat for quarterly firm fundamentals, Carbon Disclosure Project (CDP) for suppliers' emission disclosure and drivers of supply base governance, and Bloomberg ESG for companies' GHG emission.

The database consists of U.S. publicly listed firms that imported from China any period before the beginning of the Tarif War 2018q3 and imported from any country any period after 2018q3. I focus on firms with direct exposure to China prior to the Trade War in order to measure a direct impact of tariffs. This makes them a suitable sample to examine the supply chain restructuring (driven by the tariff war) impacts companies' supply chain management strategies for emissions reductions—the primary objective of our research. To study the aggregate impact of the trade tariff (H1-3), I define the treatment sample as companies impacted by tariffs.

I define two main variables that are critical to understanding sustainable supply chain dynamics. The first variable is the sourcing strategy, which Cohen et al. (2023) measured during the COVID-19 pandemic using data from PANJIVA. This analysis offers insights into how sourcing approaches evolved in response to global disruptions, emphasizing the importance of adaptability in supply chains. The second variable focuses on governance strategies for greenhouse gas (GHG) emission reduction. In their research, Huang, Narayanan, and Swaminathan (2020) developed a heuristic that employs natural language processing (NLP) to code governance strategies, specifically referencing the Carbon Disclosure Project (CDP) survey's Section 14 on Scope 3 emissions. This section poses the pivotal question: "How do you engage your value chain to mitigate GHG emissions?" Moreover, the CDP survey also inquiries about suppliers' emissions, a dimension utilized in their study to enhance the understanding of governance strategies in relation to emissions reduction. Together, these variables provide a framework for analyzing the intersection of sourcing and governance strategies in driving sustainability within supply chains.

5. Methodology

The aim of this study is to investigate how tariffs and supply chain restructuring impacts buyer emissions, buyer's supply chain emission governance and suppliers' emission disclosure. My identification strategy relies on the exogenous nature of the trade war, instigated by a sudden and largely unanticipated shift in U.S. trade policy that was not driven by the individual characteristics or performance of firms. This unpredictable environment provides a unique opportunity to analyze the strategic adaptations firms make

in response to external pressures, particularly regarding their governance strategies and engagement in emissions reduction initiatives.

To empirically assess these impacts, I employ a difference-in-differences (DID) analysis following the methodology outlined by Ho et al. (2017). Other works have analyzed the U.S. tariffs impact using Diff-in-Diff. (Freund et al. 2023; among others). Tariff targets and source restructuring serve as our treatment variables. The output variables include supply chain governance and supplier disclosure. To ensure the robustness of our findings, I incorporate multiple control variables to account for random differences and mitigate the risk of selection bias as a confounding factor (Ho et al. 2017).

To evaluate the impact of the trade tariff (H1-3), I employ a DID approach with continuous treatment and varying treatment timings, as outlined by Callaway et al. (2024). This methodology offers two key advantages over a binary treatment framework. First, it enables the execution of DID without the need to precisely define a control sample, by comparing companies subjected to different levels of tariffs. This significantly simplifies the analysis. Second, it allows for the incorporation of more detailed information, specifically the varying tariff levels and the time periods during which these tariffs were implemented.

Therefore, I estimate the following equation:

$$\mathrm{y_{ijt}} = \delta \cdot \tau_{\mathrm{jt}} + \gamma' \mathrm{X_{it}} + \mathrm{Year_t} + \mathrm{Firm_i} + \mathrm{Sector}_j + \epsilon_{\mathrm{ijt}} \qquad \text{(Eq. 1)}$$

where i indexes a firm, j indexes a 4-digit HS Code product, t indexes a year-quarter. The outcome variable $\mathrm{y_{ijt}}$ denotes the environmental outcomes (environmental governance or suppliers emission disclosure). $\mathrm{X_{it}}$ is a vector of controls consisting of the firm's lagged log total asset ($ln(\text{Total Asset})$), lagged ratio of inventory to total assets (Inventory), lagged ratio of property, plant, and equipment (net) to total assets (PPENT), lagged ratio of sales to total assets (Sales), and lagged return on assets (ROA). The coefficient of interest is δ, representing the magnitude of impact of supply chain restructure for the Trade War on the environmental output. To evaluate the impact of the trade tariff (H4-9). I estimate the following equation:

$$\mathrm{y_{ijt}} = \delta \cdot \mathrm{z_{ijt}} \times \mathrm{I_t}\{\tau_{\mathrm{jt}} > 0\} + \gamma' \mathrm{X_{it}} + \mathrm{Year_t} + \mathrm{Firm_i} + \mathrm{Sector}_j + \epsilon_{\mathrm{ijt}} \qquad \text{(Eq. 2)}$$

The treatment variable z_{ijt} is defined by the source restructure. The tariff variable $I_t\{\tau_{jt} > 0\}$ is an indicator of the periods after the beginning of tariff for product j.

The U.S.-China Trade War can be considered a quasi-natural experiment, in which reverse causality is unlikely. The U.S. tariffs on China are broad-based, covering many HS6-digit products. To address potential omitted variables that may simultaneously affect the degree to which firms are impacted by the Trade War and the magnitude of their indirect exposure to China, I control for time-invariant firm-level attributes via firm fixed effects Firm_i and include product fixed effects Sector_j. Additionally, I enhance the credibility of my results by employing a matching model to strengthen the analysis of the relationship between trade policy changes and supply chain emissions management strategies. I also address potential concerns regarding our identification strategy. Furthermore, we conduct various falsification tests, which provide robust support for our baseline results.

6. Potential challenges and robustness analysis

The first challenge is the selection biases in voluntary reporting of suppliers' GHG emissions (Villena & Dhanorkar, 2020). Following Song et al. (2023), I use a Heckman two-stage model (Heckman, 1979), starting with a probit model to estimate disclosure decisions. To meet exclusion criteria (Cameron & Trivedi, 2010), I use emissions disclosure by peers as an instrument. This measures the percentage of firms in a supplier's industry and country disclosing emissions, likely affecting the supplier's decision but not directly their response to customer environmental disclosures (Villena & Dhanorkar, 2020).

The second challenge is the issue of omitted variables, which may introduce bias into our estimation. Unobservable factors could affect both the source restructuring strategy and the reduction of GHG emissions. For instance, shareholders may demand more environmental transparency from customers and suppliers (Dai, Liang, et al., 2021). Following Song et al.'s (2023), I first conduct the endogeneity tests: Wooldridge's (1995) and Durbin–Wu–Hausman (DWH) tests. Second, I select three instruments: customer base social disclosure score, and average customer base environmental disclosure within a supplier's

industry and country. I perform a two-stage least square (2SLS) and validate the instruments with under-identification, over-identification, and weak-identification tests.

The third challenge is correctly isolating the effect of tariff changes on global trade patterns is the simultaneous occurrence of other significant influencing factors, such as the Covid-19 pandemic. The pandemic has caused unprecedented disruptions in global supply chains, altering trade flows, consumer demand, and production capacities across various sectors. This makes it difficult to disentangle the specific impact of tariffs from the broader economic shock induced by Covid-19. For example, while tariffs might have prompted shifts in sourcing strategies and trade routes, the pandemic's effect on transportation logistics and international market dynamics adds layers of complexity to the analysis. A solution I consider is to employ a control variable from countries trade restrictions regarding Covid-19 to accurately assess how much of the observed changes in trade patterns can be attributed to tariff policies as opposed to the widespread ramifications of the pandemic.

7. Conclusions and implications

This study analyses the impact of tariffs imposed on US imports from China and the supply chain restructuring on buyer emissions, buyer's supply chain emission governance and suppliers' emission disclosure. There are several conclusions we can establish.

First, regarding hypotheses 1-3. The results show that during a tariff increase the differential market mechanism from climate change involvement is generally irrelevant. In particular, the trade tariff increases the company's emission and decreases the monitoring formality and the emission information sharing from suppliers. This is aligned with the idea that U.S importers at that time are mainly concerned to assess the increase of importing costs that the tariff represents. Information sharing and emission accountability and the coordination regarding these activities are costly for companies to implement, and to assess the import increase from tariff, companies could have reduced those cost among others. Regarding any difference within results of hypotheses 1-3, those might be related to difference in cost, among other factors.

Second, regarding hypotheses 4-6. The results suggest that increasing their base of suppliers and diversifying from China increases companies' emissions and reduce the monitoring formality and the emission information sharing from suppliers. This is aligned with the idea that supplier's willingness to share climate change information is related to both buyer requests prevalence and buyers' commitment to make use of the shared information (Jira and Toffel, 2013). The main purpose of supply base diversification is to enhance robustness and resilience. While this is the company's main concern, information request from suppliers about their climate change assessment are not prevalent and buyers are not committed to use that information in their business decision. This could explain why the trade tariff increases the company's emission and decreases the monitoring formality and the emission information sharing from suppliers.

Third, regarding the hypotheses 7-9. The results suggest that reshoring decreases companies' emissions and increases the monitoring formality and the emission information sharing from suppliers. This is in line with the fact that suppliers in countries with higher regulations share more climate change information (Jira and Toffel, 2013). Comparatively, the U.S. environmental regulation is higher than those found in developing countries. Particularly, the environmental regulation in China. Therefore, companies relying more in U.S. suppliers would show a decreases companies' emissions and increases the monitoring formality and the emission information sharing from suppliers.

This study is particularly relevant for managers aiming for carbon neutrality in their companies and supply chains. By examining the effects of various supply chain restructurings on environmental supply chain management, I offer critical insights on how companies might harmonize their sourcing strategies with their environmental goals. This approach offers management information to enhance their suppliers' commitment to carbon reductions. This work also provides implications for policymakers. Furthermore, expanding the analysis of tariff impacts to encompass Environmental, Social, and Governance (ESG) considerations, specifically greenhouse gas (GHG) emissions.

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