Global Supply Chain Rerouting in Response to the U.S.-China Trade War

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Problem definition: Concerned about rising geopolitical tensions between the U.S. and China, many U.S. firms in recent years have sought to reduce their dependence on China in an attempt to hedge against potential disruptions in Chinese supply chains. U.S. importers have increasingly turned to intermediary countries like Vietnam and Mexico in order to diversify their supplier base. However, can these importers develop supply chains that are independent from China? Or are they still retaining indirect dependence on China by rerouting their supply chains via these third-party countries?

Methodology/results: Utilizing transaction-level customs import-export data, we develop a novel measure to assess firm-product-level indirect dependence of U.S. importers on China via their suppliers in Vietnam and Mexico. Our findings indicate a substantial increase in indirect dependence on China post-Trade War – indirect dependence via Vietnam and Mexico increased by approximately 21% and 5.5% respectively – suggesting that despite efforts to reduce dependence on China, U.S. supply chains remain indirectly dependent on China via third-party nations. We further explore the role of product channels, observing that more downstream products and products for which China has a significant revealed comparative advantage (RCA) experience greater increases in indirect dependence through Vietnam. In contrast, more upstream products exhibit more substantial increases through Mexico. Decomposing indirect dependence into U.S. import share and suppliers' input dependence on China reveals asymmetric growth patterns: for Vietnam, the latter component grows more significantly, while for Mexico, the former shows a slightly more pronounced increase.

Managerial implications: Our results underscore the necessity for firms to reassess indirect dependencies beyond their first-tier suppliers, and also highlight the complex dynamics of global supply chain responses to bilateral trade disputes.

Key words: U.S.-China Trade War, Global Supply Chain Rerouting, Indirect Connections

1. Introduction

The U.S.-China Trade War (Trade War) has brought about significant shifts in global supply chains. Concerned about rising geopolitical tensions between the two countries, many U.S. firms in recent years have sought to reduce their dependence on China in an attempt to hedge against potential disruptions in Chinese supply chains.[1] The impact of this strategic shift is evident in the changing dynamics of U.S. imports. From 2017 to 2022, the share of U.S. imports from China

[1] https://www.washingtonpost.com/business/2023/08/06/us-china-economy-trade-mexico/

fell by nearly five percentage points. By contrast, over the same period, the U.S. saw significant increases in import shares from third-party countries, such as Vietnam and Mexico.

The speed with which these global supply chain shifts have occurred raises several important questions. Namely, do these third-party countries possess the same end-to-end supply chain capabilities as China, or are they merely substituting for China in certain segments of the supply chain while still relying on Chinese inputs? Furthermore, if the latter is the case, does this then suggest that U.S. firms retain an indirect dependence on China via their suppliers in these third-party countries?

Firms looking to hedge against potential disruptions in Chinese supply chains face challenges in the form of the increasing complexity and lack of transparency in global supply chains.[2] For instance, products transported from Southeast Asia or Mexico to the U.S. continue to utilize components, materials, and other inputs from China. Indeed, the quantity of intermediate products shipped from China to these countries has increased significantly.[3] This phenomenon, known as supply chain "rerouting", illustrates how some supply chains connecting the U.S. and China may retain an interdependence between the two, but with the addition of intermediary stages in third-party countries, thereby increasing complexity and costs. The growing complexity and opacity of global supply chain operations may hinder firms' understanding of these dynamics. A survey by McKinsey reported that only 2% of companies had visibility into their supply chain base beyond the second-tier.[4]

As media and public discourse increasingly spotlight global supply chain challenges, researchers are also intensifying their focus on the importance of firms developing global supply chain strategies, particularly when faced with geopolitical risks as well as trade and economic policy uncertainty. Cohen and Lee (2020) discuss the design and management of global supply chains under changes in government policies. Dai et al. (2020) emphasize the economic forces in global supply chain management, such as trade disputes between the U.S. and China. Dong and Kouvelis (2020) highlight the interconnectedness of supply chains, indicating that although tariffs seem to directly impact a single part of the supply chain, firms from multiple stages – from raw materials to final goods – will also make strategic responses to optimize self-interest.

Motivated by the aforementioned observations and studies, this paper aims to quantify the extent of supply chain rerouting from the perspective of U.S. importers, specifically assessing the degree to which their indirect dependence on China through suppliers in third-party countries has intensified after the Trade War. Our analysis focuses on Vietnam and Mexico as the third-party countries

[2] https://www.economist.com/leaders/2023/08/10/joe-bidens-china-strategy-is-not-working

[3] https://www.wsj.com/world/china/u-s-companies-are-finding-it-hard-to-avoid-china-213997b7

[4] https://www.mckinsey.com/capabilities/operations/our-insights/how-covid-19-is-reshaping-supply-chains

of interest. These two countries are frequently mentioned in the academic literature (Alfaro and Chor 2023, Fajgelbaum et al. 2024, Freund et al. 2023) and media reports as being the primary beneficiaries of recent global supply chain rerouting trends.[5][6] Our sample comprises publicly listed manufacturing firms in the U.S. that meet two criteria: (1) they imported from China between 2013 and 2017, prior to the Trade War, and (2) they imported from Vietnam and/or Mexico during our sample period.

A key challenge lies in quantifying U.S. importers' indirect dependence on China through third-party rerouting intermediaries, which occurs when the latter import their own inputs from China. We utilize transaction-level customs data from the U.S., Vietnam, and Mexico, which includes comprehensive supplier and buyer information as well as product shipping details. This granular dataset allows us to precisely identify the imported products and corresponding suppliers of each U.S. importer in our sample. To construct the measure, we link the U.S. import data with Vietnam and Mexico import data, capturing two components for each U.S. importer-supplier-product triad: the import share of products by U.S. importers from suppliers in Vietnam and/or Mexico (termed "U.S. import share"), and the share of inputs for these products that suppliers source from China within the same year-quarter (termed "suppliers' input dependence on China").

To calculate the suppliers' input dependence on China, it is further necessary to identify the inputs for U.S.-imported products. We utilize the Direct Requirement (DR) coefficients from Input-Output Tables, which measure the direct inputs required per unit of output, to understand product vertical relationships. We then calculate suppliers' input dependence on China as a weighted average of all related inputs, using DR coefficients as weights. The firm-product-level indirect dependence on China is finally derived by multiplying U.S. importers' import share from Vietnamese or Mexican suppliers with the suppliers' input dependence on China, aggregated across all suppliers in Vietnam or Mexico. After constructing the measure for indirect dependence on China through Vietnam and Mexico, we examine the dynamics of this dependence following the Trade War.

We find that U.S. importers' indirect dependence on China through Vietnam and Mexico increases by approximately 21% and 5.5% respectively following the commencement of the Trade War. These results suggest that rather than being replacements for Chinese suppliers with equivalent end-to-end supply chain capabilities, the suppliers in Vietnam and Mexico may instead be intermediaries who rely on Chinese inputs for their own production. As a consequence, the post-Trade War supply chain restructurings of U.S. importers likely retained an indirect dependence on China via their suppliers in these third-party countries.

[5] `https://www.ft.com/content/ede919f5-0d3e-43e5-8ef9-407a17551bb9`

[6] `https://www.hinrichfoundation.com/research/article/sustainable/global-supply-chain-reshuffle/`

Operations theory suggests that firms will develop supply chains with varying degrees of cost-efficiency and market-responsiveness capabilities to meet the needs of their products' market demands (see for example Fisher 1997). In the context of the global supply chain, such theory predicts that firms should prefer to source different products from suppliers in different countries, depending on the countries' respective geographical advantages and productive capabilities. In line with these predictions, we find that product characteristics, including upstreamness and the extent of China's comparative advantage for the production of that product, are important factors that influence whether a given product is rerouted through Vietnam or Mexico following the Trade War.

In particular, we show that more downstream products, and products for which China has a greater comparative advantage, demonstrate more substantial growth in indirect dependence on China through Vietnam. This finding suggests that China leverages Vietnam as a bridge to continue exporting products that are more downstream—products that typically involve more labor-intensive final assembly, and for which it retains a significant comparative advantage. These results are further reflected in our industry heterogeneity analysis, which confirms that the growth in indirect dependence through Vietnam is more pronounced in the textile, footwear, and electrical industries. These industries typically utilize more downstream products that require lower-value-added productions and are characterized by China's cost-efficient comparative advantages. As a result, Vietnam's proximity to China and similar productive capability in lower-cost production enable it to more seamlessly integrate into Chinese supply chains.

Conversely, we find that more upstream products—such as those produced in the chemicals, plastics/rubbers, metals, and machinery industries—exhibit more significant growth in indirect dependence through Mexico. These upstream products are typically imported into the U.S. to be further integrated into products that are higher-value-added. These so-called more "innovative products" require greater supply chain responsiveness, for which Mexico's close proximity to the U.S. is a major advantage. Overall, the growth in indirect dependence for products with different characteristics underscores how Vietnam and Mexico have each secured U.S. orders following the Trade War based on their respective geographical and productive advantages. However, they have been unable to fully replace China's end-to-end supply chain, and, as a result, rely on Chinese inputs to a significant degree.

Finally, we decompose the indirect dependence of U.S. importers on China into two components: the share of U.S. imports from Vietnam or Mexico and these suppliers' input dependence on China. By analyzing which component is more influential in driving the growth in indirect dependence through Vietnam and Mexico, we uncover further insights into the distinct roles these countries play within the U.S.-China supply chains following the initiation of the Trade War. Our findings reveal that both components increase significantly post-Trade War, but that their relative importance varies by country. For Vietnam, the increase in suppliers' input dependence on China is more pronounced, highlighting the country's deep integration into Chinese supply chains. In contrast, for Mexico, the rise in the U.S. import share is slightly more substantial than the increase in suppliers' input dependence on China, indicating Mexico's strategic position as a nearshoring destination for U.S. importers seeking to shorten supply chains, while still relying considerably on Chinese inputs.

To illustrate our findings, we explore cases of representative firms from various industries. These include Nike, the leading athletic footwear and apparel manufacturer; Samsung, a multinational electronics corporation specializing in consumer electronics, semiconductors, and mobile devices; 3M, a diversified conglomerate producing a wide range of products including adhesives, materials, and medical supplies; and Eaton, a global power management company offering energy-efficient solutions. We find that their supply chain strategies closely align with our results.

Our empirical findings have several implications for firms and policymakers. For firms, the possibility for indirect dependence on China through suppliers in third-party countries represents a key challenge for those looking to hedge against potential disruptions in Chinese supply chains. To address this challenge, it is crucial for firms to reassess dependencies beyond their first-tier suppliers. Moreover, the dynamics of indirect dependence through Vietnam and Mexico can vary across products with different characteristics. Firms need to carefully review their imported product portfolio from each third-party country, considering not only upstreamness but also the extent of China's comparative advantage for the production of each product.

For policymakers, our study underscores the complexity of global supply chains, particularly the dynamics of their response to bilateral trade disputes. The Trade War may have been intended to reduce dependence on Chinese imports, and did result in a significant reduction in direct trade between the U.S. and China. However, our research shows that the Trade War also resulted in an increase in imports from suppliers in third-party countries who in turn depended on China for their own inputs, thereby representing a growing source of indirect dependence on China.

Our paper contributes to literature on empirical supply chain management. Existing research has utilized various datasets to explore the supply chain dynamics. Some studies employ global shipping data to analyze the impact of global sourcing strategies on inventory performance (Jain et al. 2014, 2022) and stock returns (Jain and Wu 2023).Some studies leverage firm-level supply chain data to examine supply network risks (Wang et al. 2021), credit risk propagation along supply chains (Agca et al. 2022), supply chain restructuring under policy uncertainty (Charoenwong et al. 2023), the bullwhip effect (Osadchiy et al. 2021) and inventory productivity in supply networks (Agrawal and Osadchiy 2024). Beyond the use of secondary data, some research conducts field experiments to investigate price discrimination in global sourcing (Cui et al. 2021). Our paper constructs global supply chains beyond the first-tier for U.S. importers, and examining how they are indirectly exposed to second-tier sourcing country. In addition to U.S. import data, we utilize shipping data from Vietnam and Mexico to provide a nuanced understanding of firms' global supply chain linkages through these intermediary countries.

Our paper also contributes to the research on global supply chain strategies. Some studies have examined firms' global production decisions and facility locations, including the operating policies for production units in different countries (Li et al. 2001), global production design under exchange-rate uncertainty (Kouvelis et al. 2001, Kazaz et al. 2005), global facility network design (Lu and Van Mieghem 2009, Dong et al. 2010). In contrast to previous studies that primarily employ analytical modeling to focus on operational details, our research empirically illustrates the interconnectedness of global supply chains, demonstrating that when tariffs disrupt one node, supply chains may find it too difficult or costly to relocate production in a manner that completely avoids the disrupted node. Rather, they may respond by rerouting through other nodes while maintaining indirect connections with the disrupted node. Within the context of the Trade War, third-party countries like Vietnam and Mexico cannot fully substitute China in an end-to-end capacity, resulting in the maintenance of indirect connections between the U.S. and China through supply chain rerouting.

Furthermore, our paper also contributes to the literature that examines the impact of government policies on global supply chains. Cohen and Lee (2020) point out that the government policy changes include adjustments to tariffs, content requirements, taxes, and investment incentives. Existing research explores the influence of tariffs on the design of global supply chains (Hsu and Zhu 2011, Dong and Kouvelis 2020, Chen et al. 2022), the impact of local content requirement policies on global sourcing decisions (Cui and Lu 2019, Hsu et al. 2022), and the ramifications of tax policies on production choices (Xiao et al. 2015, Lai et al. 2021). Our study contributes to this field by empirically demonstrating the impact of bilateral tariffs on global supply chains, highlighting the ramifications for indirect connections beyond the first tier. While firms affected by tariffs may shift to alternative suppliers who are not directly impacted, these suppliers may themselves continue sourcing from China, thereby representing a potential source of indirect dependence on China.

The remainder of this paper is structured as follows. Section 2 describes the data and sample construction. Section 3 details the methodologies for constructing key variables and reports summary statistics. Section 4 discusses the empirical findings on dynamics of indirect dependence on China. Section 5 examines the channels in shaping indirect dependence dynamics. Section 6 delves into the decomposition of indirect dependence. Finally, Section 7 concludes by summarizing the key findings and discussing the implications.

2. Data and Sample Construction

We construct our sample from four datasets: Panjiva for transaction-level shipping data, Compustat for quarterly firm fundamentals, Orbis for Vietnamese company information, and Input-Output Accounts for product vertical relationships. We discuss the details of the data sources and sample construction below.

2.1. Transaction-level Global Shipping Data

We obtain the transaction-level customs import-export data of the U.S., Vietnam and Mexico from Panjiva, which includes detailed bill of lading (BoL) manifests. The bill of lading serves as a receipt that acknowledges the loading of goods and contains essential information such as the importer's (exporter's) and overseas supplier's (customer's) names and addresses, details about the shipped goods (e.g., Harmonized System (HS) Code, country of origin/destination, goods description, value, weight, quantity, units, and volume in TEUs), as well as carrier and vessel information including names and International Maritime Organization (IMO) numbers. For a sample BoL for U.S. imports, please refer to Figure A1 in Appendix A.

A notable advantage of Panjiva data is that it allows us to link the supplier and buyer entities with identifiers that are shared with S&P's Capital IQ and Compustat databases (Jain and Wu 2023, Hsu et al. 2022). Panjiva assigns a unique ID to each importing and exporting firm and provides a matching table that links the Panjiva ID to a CIQ company ID. This CIQ company ID can then be matched to a publicly listed firm, identified by GVKEY. Through this matching process, we can link U.S. importing firms in the Panjiva dataset with their ultimate parent companies. Finally, we aggregate the matched transactions at the ultimate parent company level.

The variables and data coverage vary across datasets of different countries in Panjiva. The U.S. import dataset in particular has two limitations. Firstly, while Panjiva Vietnam and Mexico datasets contain value of goods observations reported directly from the source, the value of goods for U.S. imports is estimated by Panjiva with approximately 80% of observations missing. Secondly, while the Vietnam and Mexico data cover all modes of transportation, the U.S. import data only covers maritime shipping channels. Since Mexico and the U.S. are neighboring countries and more than 80% of U.S. imports from Mexico are transported via truck and rail,[7] this results in a significant lack of coverage for U.S.-Mexico imports.

To address the two limitations, we adopt the approach used by Hsu et al. (2022). First, we use U.S. import data by port and HS Code from the U.S. Census Bureau to calculate monthly value-to-weight ratios at the product-country level, and then apply the ratio to the corresponding weight in Panjiva to obtain an estimated value of goods. Next, to solve the U.S.-Mexico import coverage

[7] https://www.bts.gov/content/value-us-land-exports-and-imports-canada-and-mexico-mode

limitations, we complement the U.S. import data with Mexico export data, as the latter covers all transportation channels, including truck, rail, maritime, air, and others. To avoid double-counting, we remove transactions from Mexico in the U.S. import dataset and then replace them with transactions from the Mexico export dataset destined for the U.S. The final dataset contains complete US import activity originating from Mexican trade partners. After addressing these limitations, we have a refined US import dataset, where the importing firms are matched to an ultimate parent company identified by GVKEY.

We aggregate U.S. import transactions to the firm-supplier-product-sourcing country-quarter level, identifying all firms and suppliers where the sourcing country is either Vietnam or Mexico. Our key variable, indirect dependence on China, captures the import shares of U.S. importers from Vietnam and Mexico, as well as import shares of Vietnamese and Mexican suppliers from China. To construct this variable, we also process Panjiva Vietnam and Mexico import datasets, which do not share the same limitations of the U.S. data. We aggregate them to the firm-product-sourcing country-quarter level.

To obtain sourcing patterns of U.S. importers' suppliers, we match suppliers in U.S. import data with importers in the Vietnamese and Mexican import data. However, direct matching between the U.S. import data and the Vietnam import data is challenging because the majority of the importer names are written in the Vietnamese language. A key advantage of Panjiva Vietnam import dataset is that it includes a unique tax ID for each importer, allowing us to use the Orbis database (as detailed in Section 2.2) to link supplier names from U.S. import data with their corresponding tax IDs and match them with the tax IDs in the Vietnam import data.

The Panjiva Mexico data also contains a unique tax ID for each Mexican firm. Since we have replaced U.S. import data with Mexican export data to represent imports from Mexico, both Mexican import and export datasets contain unique tax ID information. This allows us to directly match the Mexican import data using the tax IDs. For a detailed description of the data construction process, please refer to Appendix B, where Figure A2 shows the process.

2.2. Firm Characteristics

After cleaning and aggregating global sourcing data to the ultimate owner level, in order to obtain data on these firms' operations and performance, we extract quarterly fundamentals from Compustat. Using the common firm identifier GVKEY, we match these with U.S. importers in the Panjiva data. Based on the North American Industry Classification System (NAICS), we focus on manufacturing firms, specifically those whose first two digits fall within the range of 31 to 33.

To retrieve tax IDs for Vietnamese suppliers in Panjiva U.S. import data, we utilize the Orbis database.[8] Using Orbis's batch search tool, we input the names of Vietnamese suppliers from Panjiva U.S. import data. The search portal subsequently returns the most accurate match for each firm within the Orbis database. We then download the tax ID information for the matched firms and integrate it with the Panjiva Vietnam import data.

2.3. Input-Output Accounts Data

The Input-Output Accounts provide comprehensive tables that illustrate the interdependencies among industries and their interactions with the broader economy. These tables have been employed in academic studies across the fields of supply chain management and finance to capture the materials flows between industries and to construct supply networks (Osadchiy et al. 2016, Anjos and Fracassi 2015, Osadchiy et al. 2021).

After merging U.S. import data with Vietnam and Mexico import data based on supplier information, one issue is that suppliers from Vietnam and Mexico may import various products from China. It is necessary to identify which of these products serve as inputs for the products imported into the U.S., i.e., the vertical relationships between products. Following Conconi et al. (2018), we utilize the Direct Requirement table from the BEA, which summarizes the entire supply chain by tabulating the reliance of production on direct inputs. The Direct Requirement (DR) coefficient between sectors i and j ($DR_{i,j}$) in the Direct Requirement table represents the total inputs from sector i that are directly necessary to generate one dollar of output in sector j. If $DR_{i,j}$ is positive, sector i and j are vertically linked.

The most granular level of the IO tables published by the BEA consists of 402 industries, with updates released every five years. For our study, we collect the most recent Direct Requirement table for 2017, which covers these 402 industries. To capture product-level vertical relationships, we first convert the IO industry codes to NAICS industry codes using the BEA's concordance table. We then match these industries to products at the 4-digit HS Code level using the concordance table provided by Pierce and Schott (2012). In constructing our measure of indirect dependence on China, we incorporate the product pair-level vertical relationships identified using the IO table. A detailed explanation of the construction methodology can be found in Section 3.1.

2.4. Sample Construction

The aim of our study is to investigate the dynamics of indirect supply chain connections between U.S. and China in response to the Trade War. Therefore, our sample initially selects U.S. publicly listed manufacturing firms that imported from China between 2013 and 2017, prior to the Trade War, as these firms are likely to be affected by the Trade War and may adjust their supply chains

[8] Orbis, published by the Bureau van Dijk, is a comprehensive database containing information on private and public companies worldwide. It covers over 400 million companies across more than 200 countries and offers extensive business and financial information on global enterprises.

as a result. From this group, to study the indirect dependence on China through Vietnam and Mexico, we construct two separate samples. The first sample includes firms that, in addition to importing from China during 2013-2017, also imported from Vietnam during our sample period. The second sample is composed of firms that imported from China during 2013-2017 and imported from Mexico during our sample period. Since the Panjiva Vietnam data is available from 2018, our analysis for Vietnam spans from 2018 Q1 to 2022 Q4, while for Mexico, it covers from 2016 Q1 to 2022 Q4. Both samples are analyzed at the firm-product-year quarter level.

From 2013 to 2017, a total of 4,385 U.S. firms imported goods from China. Table A1 in Appendix C illustrates that their import share from China decreased significantly across multiple industries after the Trade War. Among these firms, 2,664 imported from Vietnam and Mexico, with column (1) in Table A2 indicating a significant increase in U.S. import share from these two countries, underscoring their roles as key beneficiaries of the Trade War. Additionally, columns (2)-(4) in Table A2 reveals that the import share from other Southeast Asian countries has risen,[9] whereas the increase in import share from major developed countries remains marginal. Therefore, our sample effectively captures Vietnam and Mexico as representative beneficiaries of the Trade War and examines the indirect supply chain connections through the two countries.

3. Key Variable Construction and Summary Statistics

In this section, we introduce the methodologies for constructing key variables, including indirect dependence on China through Vietnam and Mexico, product upstreamness, and China's revealed comparative advantage (RCA). We also provide summary statistics of these variables.

3.1. Construction of indirect dependence on China

Although U.S. importers have diversified their sourcing away from Chinese suppliers to those in third-party countries such as Vietnam and Mexico to mitigate risks, these suppliers may still rely on inputs from China. Consequently, U.S. importers remain indirectly exposed to Chinese inputs through their sourcing from Vietnamese and Mexican suppliers. To capture and examine this dynamic, we construct a measure of indirect dependence on China through Vietnam and Mexico.

We illustrate the construction process of indirect dependence on China in Figure 1, which contains four steps. First, we utilize Panjiva U.S. import data to calculate U.S. importer i's direct import share of HS4-digit product j from supplier $k(i, j)$ in country c (representing either Vietnam or Mexico) during year-quarter t, as indicated by Equation (1a), where $Imports^{c}_{i,j,k(i,j),t}$ denotes

[9] Some media reports indicate that trade connections between other Southeast Asian countries (such as Thailand) and China are also intensifying, suggesting the existence of rerouting, for instance https://www.wsj.com/world/china/u-s-companies-are-finding-it-hard-to-avoid-china-213997b7.

the imports of product j by firm i from supplier $k(i,j)$ in country c during time t, and $Imports_{i,j,t}$ denotes the total imports of product j by firm i during time t.[10]

$$DirectDepend^{c}_{i,j,k(i,j),t} = \frac{Imports^{c}_{i,j,k(i,j),t}}{Imports_{i,j,t}} \tag{1a}$$

Second, we utilize Panjiva Vietnam and Mexico import data to compute the import share of product m from China by supplier $k(i,j)$ at time t. As shown in Figure 1, during the same year-quarter when firm i imports product j, the supplier may import multiple products from China, denoted as m. This step is formulated in Equation (1b), where $Imports^{c}_{k(i,j),m,CN,t}$ denotes supplier $k(i,j)$'s imports of product m from China during time t, and $Imports^{c}_{k(i,j),m,t}$ denotes supplier $k(i,j)$'s total imports of product m.[11]

$$DirectDepend^{c}_{k(i,j),m,CN,t} = \frac{Imports^{c}_{k(i,j),m,CN,t}}{Imports^{c}_{k(i,j),m,t}} \tag{1b}$$

Third, we analyze the overall dependence of supplier $k(i,j)$ – the supplier of product j for U.S. importer i – on China. It is important to note that the various products m sourced from China by this supplier might not serve as inputs for product j. Therefore, we need to weight the $DirectDepend^{c}_{k(i,j),m,CN,t}$ based on the vertical relationship between product m and j. We use Direct Requirement coefficient ($DR_{m,j}$) in Input-Output Table introduced in Section 2.3 to describe the vertical relationship between product m and j (Conconi et al. 2018). A higher $DR_{m,j}$ indicates that producing one unit of product j requires a greater value of input from product m. In Equation (1c), the ratio $\frac{DR_{m,j}}{\sum_{m \in \mathcal{M}} DR_{m,j}}$ is larger when product m serves as a more important input to product j relative to other products imported from China by supplier $k(i,j)$. This ratio is therefore considered indicative of the weight of supplier $k(i,j)$'s import share of product m from China ($DirectDepend^{c}_{k(i,j),m,CN,t}$).

For example, Samsung U.S. imports telecommunication devices (including telephone and other apparatus, HS code 8517) from a supplier in Vietnam, and in the same year-quarter, this supplier imports electrical capacitors (HS code: 8532) and vacuum cleaners (HS code: 8508) from China. The DR coefficient for electrical capacitors with respect to telecommunication devices is greater than zero, showing that the capacitors are used in the production of these devices. Conversely, the DR coefficient for vacuum cleaners is zero, indicating that they are not inputs for telecommunication devices. Therefore, using our method with DR ratio as the weight, when calculating the supplier's

[10]These imports are measured in terms of value, weight, volume, and number of transactions.

[11]The Vietnam imports are measured in terms of value and number of transactions due to data availability, while Mexico imports are measured in terms of value, weight, volume, and number of transactions.

reliance on China for producing telecommunication devices, the weight for non-relevant product such as vacuum cleaners is zero, while input with greater relevance receives higher weight.

$$DirectDepend^{c}_{k(i,j),CN,t} = \sum_{m\in\mathcal{M}} \frac{DR_{m,j}}{\sum_{m\in\mathcal{M}} DR_{m,j}} DirectDepend^{c}_{k(i,j),m,CN,t} \tag{1c}$$

Finally, we calculate the indirect dependence on China by multiplying the direct dependence of U.S. importer i for product j from supplier $k(i,j)$, denoted as $DirectDepend^{c}_{i,j,k(i,j),t}$, with the direct dependence of supplier $k(i,j)$ to Chinese inputs, denoted as $DirectDepend^{c}_{k(i,j),CN,t}$. We then aggregate these values across all suppliers in country c, as indicated in Equation (1d). The resulting sum, $IndirectDepend^{c}_{i,j,t}$, measures U.S. importer i's indirect dependence on Chinese inputs for HS4-digit product j through country c during year-quarter t.

$$IndirectDepend^{c}_{i,j,t} = \sum_{k(i,j)\in\mathcal{K}(i,j)^{c}} DirectDepend^{c}_{i,j,k(i,j),t} \times DirectDepend^{c}_{k(i,j),CN,t} \tag{1d}$$

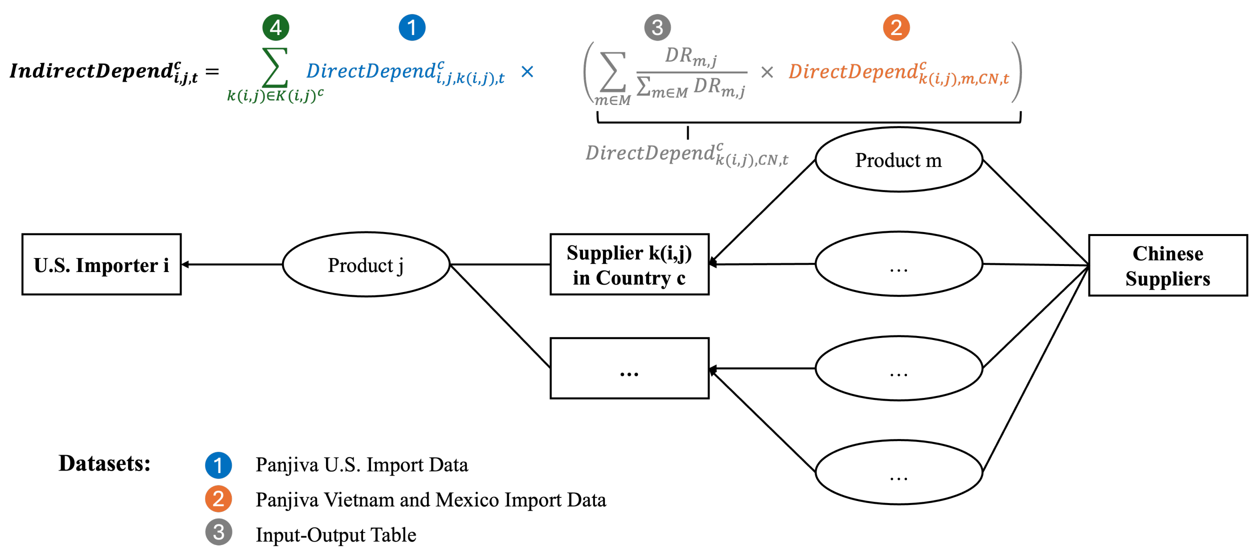

Figure 1 **Construction Process of indirect dependence on China**

3.2. Construction of Upstreamness and Revealed Comparative Advantage

We calculate product upstreamness using the methodology in Antràs et al. (2012). We collect the latest 2017 Input-Output (IO) data from the U.S. Bureau of Economic Analysis (BEA) to construct a measure of upstreamness at the industry level. We then map the industries to 4-digit HS Codes using concordance tables provided by the BEA and Pierce and Schott (2012), thereby deriving a continuous measure for HS4-product-level upstreamness. This measure quantifies the average distance from final use, with higher values indicating a product is positioned at more upstream stages of the production processes.

We also collect product-level data on revealed comparative advantage (RCA). This metric utilizes trade data to identify a country's competitive export strengths and has been widely used in economic research (Dang et al. 2021, Freund et al. 2023). For each country-product-year combination, it is calculated as the proportion of that country's export of the given product in the given year relative to that of the whole world. Economically, RCA indicates the degree to which a country specializes in a particular product compared to the global average, thus highlighting sectors where the country holds a competitive advantage. In our study, we collect data for China's RCA from United Nations Conference on Trade and Development (UNCTAD).

3.3. Summary Statistics

Table 1 presents the variable definitions and their mathematical notations. Table 2 reports summary statistics of key variables, including the mean, standard deviation, 25th percentile, median, and 75th percentile. Panel A presents indirect dependence through Vietnam and components, measured in terms of the value of goods and the number of transactions. Similarly, Panel B includes indirect dependence through Mexico and components, measured in terms of the value of goods, gross weight, volume, and the number of transactions. Panel C and D present product attributes, while Panel E and F present fundamentals of U.S. importers who import from Vietnam and Mexico, respectively. The sample period for the analysis of indirect dependence through Vietnam spans from 2018 Q1 to 2022 Q4, whereas the sample period for the analysis of indirect dependence through Mexico covers 2016 Q1 to 2022 Q4.

In Panels A and B, we present the summary statistics not only for indirect dependence but also for its two components: (1) $USImp^c_{i,j,t}$: the share of U.S. importer i's imports of product j from all suppliers in country c, namely Vietnam or Mexico, and (2) $SupplierImpCN^c_{i,j,t}$: the input dependence of firm i's suppliers on China to produce product j. Equation (2a) presents the first component, where $DirectDepend^c_{i,j,k(i,j),t}$ has been defined in Equation (1a). Equation (2b) displays the second component, where $DirectDepend^c_{k(i,j),CN,t}$ has been introduced in Equation (1c). $Imports^c_{i,j,k(i,j),t}$ indicates the imports of product j by firm i from supplier $k(i,j)$ in country c, and $Imports^c_{i,j,t}$ denote firm i's total imports of product j from all suppliers in country c. Therefore, Equation (2b) effectively captures the weighted average reliance on China of firm i's suppliers in country c to produce product j.

$$USImp^c_{i,j,t} = \sum_{k(i,j)\in\mathcal{K}(i,j)^c} DirectDepend^c_{i,j,k(i,j),t}, \tag{2a}$$

Table 1 Variable Description

Variables	Definition	Source
Indirect Dependence Measures and Components		
$Imports^{c}_{i,j,k(i,j),t}$	U.S. importer i's imports for product j from supplier $k(i,j)$ in country c during year-quarter t	Panjiva
$Imports_{i,j,t}$	U.S. importer i's total imports for product j during year-quarter t	Panjiva
$DirectDepend^{c}_{i,j,k(i,j),t}$	Import share of HS4-digit product j from supplier $k(i,j)$ in country c (Vietnam or Mexico) during year-quarter t by U.S. importer i	Panjiva
$Imports^{c}_{k(i,j),m,CN,t}$	Supplier $k(i,j)$'s imports for product m from China during year-quarter t	Panjiva
$Imports^{c}_{k(i,j),m,t}$	Supplier $k(i,j)$'s total imports for product m during year-quarter t	Panjiva
$DirectDepend^{c}_{k(i,j),m,CN,t}$	Import share of product m from China at time t by supplier $k(i,j)$ in country c	Panjiva
$DR_{m,j}$	Direct requirement coefficient between m and j, which is the inputs m required directly for a dollar of output j	BEA Input-Output Table
$IndirectDepend^{c}_{i,j,t}$	Indirect dependence of U.S. importer i on China for product j through country c during year-quarter t	Panjiva and BEA Input-Output Table
$USImp^{c}_{i,j,t}$	U.S. importer i's share of imports for product j from suppliers in country c	Panjiva
$SupplierImpCN^{c}_{i,j,t}$	Weighted average share of inputs for product j imported from China by suppliers of U.S. importer i	Panjiva and BEA Input-Output Table
Channels: Product and Firm Characteristics		
$Upstreamness_{j}$	Product upstreamness of product j	Antràs et al. (2012) and BEA Input-Output Table
$RCA^{CN}_{j,t}$	Revealed comparative advantage of product j in year t for China	UNCTAD
Control Variables: Firm Attributes		
$Total\ Asset_{i,t}$	Total assets of firm i in quarter t	Compustat
$PPENT_{i,t}$	Property, plant, and equipment of firm i in quarter t normalized by total asset	Compustat
$Inventory_{i,t}$	Inventory of firm i in quarter t normalized by total asset	Compustat
$Sales_{i,t}$	Sales of firm i in quarter t normalized by total asset	Compustat
$ROA_{i,t}$	ROA of firm i in quarter t	Compustat

$$SupplierImpCN^{c}_{i,j,t} = \sum_{k(i,j)\in\mathcal{K}(i,j)^{c}} \frac{Imports^{c}_{i,j,k(i,j),t}}{Imports^{c}_{i,j,t}} \times DirectDepend^{c}_{k(i,j),CN,t}. \tag{2b}$$

We observe that the differences in indirect dependence on China through Vietnam and Mexico are not substantial. The U.S. import shares from Vietnam and Mexico are notably high, particularly for the latter, indicating a significant reliance on Mexican imports at the firm-product level. Regarding the suppliers' input dependence on China, Vietnamese suppliers exhibit higher mean and median import shares from China compared to Mexican suppliers, indicating a greater overall reliance on Chinese inputs. However, the 25th percentile of Vietnamese suppliers' import share from China is 0, while for Mexican suppliers, it is 12.5%. This suggests that despite the higher overall dependence on China among Vietnamese suppliers, a portion of them do not import inputs from China, whereas importing from China is more prevalent among Mexican suppliers.

Regarding product attributes, products in the Mexico sample are more upstream compared to those in the Vietnam sample, whereas China's RCA of products in the Vietnam sample overall exceeds that of the Mexico sample. Regarding firm attributes, U.S. firms with indirect dependence through Vietnam generally have larger total assets, normalized PPE, inventory and sales on average compared to those with indirect dependence through Mexico.

Table 2 Summary Statistics

Variable	Firm-product-year quarter panel					
	N	Mean	Std	P25	Median	P75
Panel A: Indirect dependence through Vietnam and components						
$IndirectDepend^{VN}(value)$	18,195	0.212	0.294	0.000	0.050	0.356
$IndirectDepend^{VN}(transaction)$	18,195	0.205	0.277	0.000	0.076	0.316
$USImp^{VN}(value)$	18,195	0.499	0.405	0.085	0.418	1.000
$USImp^{VN}(transaction)$	18,195	0.485	0.378	0.130	0.385	1.000
$SupplierImpCN^{VN}(value)$	18,195	0.422	0.360	0.000	0.428	0.737
$SupplierImpCN^{VN}(transaction)$	18,195	0.424	0.355	0.000	0.425	0.726
Panel B: Indirect dependence through Mexico and components						
$IndirectDepend^{MX}(value)$	178,612	0.245	0.263	0.008	0.172	0.388
$IndirectDepend^{MX}(weight)$	178,612	0.259	0.267	0.010	0.196	0.409
$IndirectDepend^{MX}(volume)$	178,612	0.248	0.267	0.003	0.179	0.400
$IndirectDepend^{MX}(transaction)$	178,612	0.269	0.242	0.071	0.223	0.394
$USImp^{MX}(value)$	178,612	0.741	0.404	0.367	1.000	1.000
$USImp^{MX}(weight)$	178,612	0.746	0.399	0.415	1.000	1.000
$USImp^{MX}(volume)$	178,612	0.718	0.422	0.203	1.000	1.000
$USImp^{MX}(transaction)$	178,612	0.812	0.316	0.698	1.000	1.000
$SupplierImpCN^{MX}(value)$	178,612	0.334	0.268	0.125	0.288	0.484
$SupplierImpCN^{MX}(weight)$	178,612	0.350	0.270	0.144	0.309	0.503
$SupplierImpCN^{MX}(volume)$	178,612	0.347	0.270	0.141	0.306	0.500
$SupplierImpCN^{MX}(transaction)$	178,612	0.333	0.251	0.154	0.292	0.466
Panel C: Product attributes for sample of indirect dependence through Vietnam						
$Upstreamness$	18,195	1.70	0.75	1.03	1.46	2.25
RCA^{CN}	18,195	1.91	0.86	1.33	2.01	2.47
Panel D: Product attributes for sample of indirect dependence through Mexico						
$Upstreamness$	178,612	2.29	0.66	1.73	2.30	2.81
RCA^{CN}	178,612	1.35	0.74	0.78	1.32	1.74
Panel E: Firm attributes for sample of indirect dependence through Vietnam						
$ln(Total\ Asset)$	16,756	9.837	2.550	7.875	9.154	10.432
$PPENT/Total\ Asset$	16,756	0.214	0.120	0.116	0.195	0.289
$Inventory/Total\ Asset$	16,756	0.166	0.090	0.101	0.147	0.216
$Sales/Total\ Asset$	16,756	0.263	0.125	0.167	0.215	0.292
ROA	16,756	0.032	0.027	0.019	0.029	0.044
Panel F: Firm attributes for sample of indirect dependence through Mexico						
$ln(Total\ Asset)$	153,546	9.484	2.090	8.133	9.475	10.634
$PPENT/Total\ Asset$	152,733	0.207	0.122	0.112	0.185	0.269
$Inventory/Total\ Asset$	152,113	0.135	0.072	0.085	0.120	0.169
$Sales/Total\ Asset$	152,183	0.222	0.110	0.152	0.198	0.276
ROA	149,040	0.032	0.025	0.022	0.030	0.039

Notes. This table presents the summary statistics for key variables. Panel A and Panel B display the indirect dependence on China through Vietnam and Mexico, respectively, as well as components. For Vietnam, since the import data only provides the value of goods for transaction measurement, the related variables for Vietnam are measured in terms of value and number of transactions. In contrast, Mexican import data includes measurements for value, weight, and volume, thus the related variables for Mexico are measured in terms of value, weight, volume, and number of transactions.

4. Dynamics of Firm-product-level indirect dependence on China

In this section, we investigate the dynamics in indirect dependence on China through Vietnam and Mexico following the Trade War and examine the industry heterogeneities.

4.1. Empirical Specification

We provide the institutional background of the U.S.-China Trade War in Appendix D. Following the consensus in the public media (Bown 2023) shown in Figure A3, we define the start of the Trade War to be 2018 Q3.

To test whether U.S. importers' indirect dependence on China through Vietnam and Mexico increases after the Trade War, we estimate the following equation:

$$IndirectDepend^{c}_{i,j,t} = \beta_0 + \beta_1 Post_t + \beta_2^{'} X_{i,t-1} + \lambda_i + \theta_j + \epsilon_{i,j,t}, \tag{3}$$

where i indexes a firm, j indexes a 4-digit HS Code product, t indexes a year-quarter, and c indexes the third-party country, either Vietnam or Mexico. The dependent variable $IndirectDepend^{c}_{i,j,t}$ denotes the indirect dependence on China through country c, as specified by Equation (1d). $Post_t$ serves as an indicator for the onset of the Trade War, set to 1 for periods after 2018 Q3. $X_{i,t-1}$ is a vector of controls consisting of the firm's lagged log total asset ($ln(Total\ Asset)$), 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). λ_i and θ_j denote the firm and product fixed effects, respectively. The coefficient of interest is β_1, representing the magnitude of change in indirect dependence following the onset of the Trade War.

Equation (3) estimates the overall changes in indirect dependence on China after the Trade War. Building upon this, we further examine subsamples of major industries to investigate the growth of indirect dependence across different sectors.

4.2. Unveiling the Post-Trade War indirect dependence Shifts

Table 3 presents the results of a firm-HS4 product-year quarter panel analysis based on Equation (3), examining the changes in firm-product-level indirect dependence on China through Vietnam and Mexico following the Trade War. The results indicate significant post-Trade War increases of approximately 21% for Vietnam and 5.5% for Mexico.[12] These findings underscore that, despite U.S. importers increasingly sourcing from third-party countries such as Vietnam and Mexico after the U.S.-China Trade War, China's well-established supply chains have meant that these countries continue to rely on Chinese inputs. In rerouting their trade via third-party countries, U.S. firms have actually increased their indirect dependence on China as a consequence.

[12] The data indicate that the mean values of indirect dependence through Vietnam and Mexico prior to the Trade War were 0.156 and 0.237 (measured in value of goods), respectively. Table 3 reveals that the *Post* coefficient for Vietnam is 0.032, resulting in a growth rate 0.032/0.156≈ 21%; for Mexico, the *Post* coefficient is 0.013, resulting in a growth rate of 0.013/0.237≈ 5.5%.

To assess the pre-trends and long-term post-trends, we conduct an event study analysis detailed in Appendix E. Figure A4 illustrates that post-Trade War, the indirect dependence via both Vietnam and Mexico exhibits a notable upward trend, indicating that supply chain rerouting is not a short-term phenomenon but a long-term trend that continues to strengthen over time.

Table 3 Changes in indirect dependence Following the Trade War

Dependent variable	$IndirectDepend^{VN}$		$IndirectDepend^{MX}$			
	Value	Transaction	Value	Weight	Volume	Transaction
	(1)	(2)	(3)	(4)	(5)	(6)
$Post$	0.032***	0.040***	0.013***	0.012***	0.011***	0.007***
	(0.006)	(0.006)	(0.002)	(0.002)	(0.002)	(0.002)
$ln(Total\ Asset)$	0.014	0.011	0.004	0.008	0.006	0.003
	(0.012)	(0.011)	(0.005)	(0.005)	(0.005)	(0.004)
$Inventory$	-0.018	-0.015	0.064*	0.056	0.040	0.063*
	(0.093)	(0.091)	(0.034)	(0.035)	(0.036)	(0.032)
$PPENT$	-0.026	0.024	-0.090***	-0.073**	-0.079***	-0.050*
	(0.054)	(0.047)	(0.030)	(0.030)	(0.030)	(0.027)
$Sales$	0.002***	0.001***	-0.005	-0.011	-0.009	-0.016*
	(0.000)	(0.000)	(0.011)	(0.011)	(0.011)	(0.010)
ROA	0.060	0.130	0.036	0.074	0.065	0.112*
	(0.100)	(0.097)	(0.076)	(0.075)	(0.073)	(0.066)
Observations	16,549	16,549	147,888	147,888	147,888	147,888
R-squared	0.424	0.440	0.260	0.264	0.262	0.298
Firm FE	YES	YES	YES	YES	YES	YES
Product FE	YES	YES	YES	YES	YES	YES

Notes. This table presents the change of firm-product-level indirect dependence on China through Vietnam and Mexico following the Trade War. For Vietnam and Mexico, the sample periods are 2018-2022 and 2016-2022, respectively. The dataset for this table is organized at the firm-product(HS4)-year quarter-level. The dependent variable in column (1) and column (2) respectively represents the indirect dependence through Vietnam measured in terms of value and number of transactions. The dependent variable in column (3) - (6) respectively represents the indirect dependence through Mexico measured in terms of value, weight, volume and number of transactions. The independent variable *Post* is an indicator variable marking the period after June 2018. Lagged firm control variables, firm and product(HS4) fixed effects are included. The standard errors are reported in parentheses. Standard errors are clustered at the HS4-product level. The *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Table 4 reveals industry-level heterogeneity in the growth of indirect dependence on China via Vietnam and Mexico. We present results for five major industries: chemicals and plastics/rubbers, textile and footwear, metals, machinery, and electrical equipment, which together account for a significant proportion of our sample.[13] Columns (2) and (5) demonstrate that indirect dependence on China through Vietnam experienced substantial growth in the textile and footwear and electrical equipment industries, indicating an increase in the rerouting of these industries' products via Vietnam in the post-Trade War period. Columns (6) - (9) reveal that the growth in indirect dependence through Mexico was significant for all of the major manufacturing industries, with electrical equipment being the sole exception.

The contrasting industry patterns between Vietnam and Mexico reflect their distinct roles in the global supply chains of U.S. importers. Vietnam possesses a comparative advantage in textile and footwear as well as in electrical equipment exports. By contrast, Mexico's proximity to the

[13]These five industries account for 75% of the Vietnamese sample and 76% of the Mexican sample, respectively.

U.S. has enabled it to attract U.S. orders across a broader range of industries. Nevertheless, the results in Table 4 show that China's advantage in global supply chains endures and maintains a significant impact on both Vietnam and Mexico, spanning multiple industries.

Table 4 Changes in indirect dependence by Industry Group

	Panel A: $IndirectDepend^{VN}$ (in value)				
Dependent variable	Chemicals and Plastics/Rubbers	Textile and Footwear	Metals	Machinery	Electrical Equipment
	(1)	(2)	(3)	(4)	(5)
Post	0.014	0.046***	-0.007	0.007	0.033**
	(0.028)	(0.010)	(0.035)	(0.018)	(0.015)
ln(Total Asset)	0.077	0.049***	-0.207**	0.005	0.044
	(0.065)	(0.016)	(0.079)	(0.028)	(0.350)
Inventory	0.919**	-0.051	0.223	0.326**	-0.176
	(0.444)	(0.120)	(0.408)	(0.153)	(0.267)
PPENT	0.016	-0.134**	-0.719	0.404	-0.150
	(0.327)	(0.055)	(0.570)	(0.245)	(0.310)
Sales	-0.042	0.002***	-0.158	-0.038	-0.174
	(0.365)	(0.001)	(0.380)	(0.212)	(0.170)
ROA	-0.569	0.075	-1.204	0.706	0.071
	(0.814)	(0.112)	(1.277)	(0.726)	(0.503)
Observations	1,227	5,852	1,106	1,697	2,379
R-squared	0.600	0.377	0.532	0.618	0.589
Firm FE	YES	YES	YES	YES	YES
Product FE	YES	YES	YES	YES	YES
	Panel B: $IndirectDepend^{MX}$ (in value)				
Dependent variable	Chemicals and Plastics/Rubbers	Textile and Footwear	Metals	Machinery	Electrical Equipment
	(6)	(7)	(8)	(9)	(10)
Post	0.022***	0.032**	0.011**	0.013***	0.003
	(0.006)	(0.015)	(0.006)	(0.003)	(0.005)
ln(Total Asset)	0.016	-0.048	0.001	-0.002	0.022**
	(0.018)	(0.030)	(0.009)	(0.008)	(0.010)
Inventory	0.107	-0.336**	0.058	0.032	0.193**
	(0.094)	(0.148)	(0.064)	(0.071)	(0.089)
PPENT	-0.203**	0.341***	-0.076	-0.097*	-0.207***
	(0.080)	(0.100)	(0.054)	(0.050)	(0.052)
Sales	-0.007	0.047	-0.157**	0.006	-0.004
	(0.031)	(0.201)	(0.069)	(0.037)	(0.043)
ROA	0.046	-0.848**	0.262	-0.074	-0.138
	(0.22)	(0.402)	(0.197)	(0.150)	(0.133)
Observations	28,883	5,523	26,260	27,344	23,807
R-squared	0.313	0.398	0.315	0.319	0.346
Firm FE	YES	YES	YES	YES	YES
Product FE	YES	YES	YES	YES	YES

Notes. This table presents the change of firm-product-level indirect dependence on China through Vietnam and Mexico following the Trade War, by industry group. For Vietnam and Mexico, the sample periods are 2018-2022 and 2016-2022, respectively. The dataset for this table is organized at the firm-product(HS4)-year quarter-level. The dependent variable in Panel A and Panel B respectively represents the indirect dependence through Vietnam and Mexico measured in value of goods. The independent variable *Post* is an indicator variable marking the period after June 2018. Lagged firm control variables, firm and product(HS4) fixed effects are included. The standard errors are reported in parentheses. Standard errors are clustered at the HS4-product level. The *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

The empirical evidence from our analysis aligns with the actual strategies adopted by firms in response to the U.S.-China Trade War. To illustrate, we present case studies of four representative firms from different industries: Nike, Samsung, 3M, and Eaton. We find that Nike's indirect dependence on China through Vietnam for textile and footwear products surges by 153% after the Trade

War. However, Nike rarely imports these products from Mexico, highlighting the firm's reliance on Vietnam as a key alternative sourcing location. Similarly, Samsung experiences a 5% growth in indirect dependence through Vietnam for electrical products, while experiencing no significant increase through Mexico. Their patterns are in line with our findings in Panel A in Table 4.

In contrast, 3M and Eaton rarely import from Vietnam, with their indirect dependence through the country remaining close to zero both before and after the Trade War. However, 3M experiences a 20% growth in indirect dependence through Mexico for chemicals and plastics/rubbers products and a 47% increase for machinery products. Similarly, Eaton's indirect dependence through Mexico grows by 123% for chemicals and plastics/rubbers products and by 94% for metals products. Their strategies corroborate our results in Panel B of Table 4.

In addition to industry heterogeneities, Section 5 delves deeper into how product characteristics serve as channels for the dynamics of indirect dependence on China, shedding light on the mechanisms driving the restructuring of global supply chain networks after the Trade War.

5. Channels in Shaping Dynamics of indirect dependence on China

In this section, we explore how product characteristics shape the evolution of indirect dependence on China through Vietnam and Mexico following the Trade War, including product upstreamness and China's RCA.

5.1. Empirical Specification

After examining the overall trends in the dynamics of indirect dependence and industry heterogeneities, we further explore how product characteristics serve as channels influencing the dynamics of indirect dependence through Vietnam and Mexico. These two countries possess different geographical characteristics. Firstly, we consider the distances between these two countries and the U.S., the end market, which primarily affects the responsiveness and agility of U.S. importers' supply chains. Vietnam's relative distance from the U.S. end market results in longer shipping times, which may not be suitable for products requiring quick responses to changes in demand. On the other hand, Mexico's proximity to the U.S. enables it to be more responsive to supply chain demands from the U.S. end market, making it an attractive option for products that necessitate higher agility.

This difference in responsiveness is particularly relevant when considering the position of products in the supply chain. Upstream products, such as industrial goods, that are imported into the U.S. are typically further integrated into higher value-added products that often require faster response times due to their shorter life cycle and more volatile demands (Fisher 1997). Thus the upstream products imported into the U.S. are more likely to be rerouted through Mexico due to its proximity to the U.S. Conversely, downstream products like consumer goods, which typically have lower time-sensitivity, may be more suitable for rerouting through Vietnam. Product upstreamness therefore emerges as a significant channel influencing supply chain rerouting in the context of the U.S.-China Trade War. We include it in our analysis, calculating it using the methodology outlined in Section 3.2.

In addition to their distances from the U.S., Vietnam and Mexico's distances to China also play a crucial role in shaping their supply chain dynamics. Bahar et al. (2014) find that a country's exports grow faster in products for which neighboring countries have a comparative advantage. From a supply chain perspective, shorter geographical distances can reduce lead times and lower transportation costs, thereby fostering supply chain integration and improving efficiency.

Vietnam's close geographical location to China facilitates the imports of raw materials and components from China for processing and assembly. For products in which China has a comparative advantage, U.S. importers may find it challenging to completely sever ties with Chinese suppliers. In such cases, Vietnam serves as an ideal rerouting location, as it can integrate with Chinese supply chains, leveraging their geographical proximity and China's well-established supply chain infrastructure. On the other hand, given the significant geographical distance between Mexico and China, the comparative advantage of China may not play a major role in affecting the rerouting of products through Mexico, which means products in which China has a comparative advantage may not be rerouted through Mexico more significantly than products where China lacks such an advantage. In our analysis, we measure it by China's Revealed Comparative Advantage (RCA) index calculated using the methodology outlined in Section 3.2.

To test the effects of product upstreamness and China's RCA on dynamics of indirect dependence, we estimate the following equations:

$$IndirectDepend^{c}_{i,j,t} = \beta_0 + \beta_1 Upstreamness_j \times Post_t + \beta_2 Post_t + \beta_3^{'} X_{i,t-1} + \lambda_i + \theta_j + \epsilon_{i,j,t}, \quad (4a)$$

$$IndirectDepend^{c}_{i,j,t} = \beta_0 + \beta_1 RCA^{CN}_{j,t} \times Post_t + \beta_2 RCA^{CN}_{j,t} + \beta_3 Post_t + \beta_4^{'} X_{i,t-1} + \lambda_i + \theta_j + \epsilon_{i,j,t}. \quad (4b)$$

where i indexes a firm, j indexes a 4-digit HS Code product, t indexes a year-quarter, and c indexes the rerouting country, which is Vietnam or Mexico. The definitions of $IndirectDepend^{c}_{i,j,t}$ and $Post_t$ are the same as Equation (3). The coefficients of interest are those of the interaction terms $Upstreamness_j \times Post_t$ and $RCA^{CN}_{j,t} \times Post_t$, capturing the differential impact of the Trade War on indirect dependence for products with varying levels of product upstreamness and China's RCA.

5.2. Unveiling the Role of Product Upstreamness and China's RCA

Table 5 reveals the differential effect of the Trade War on the indirect dependence of products with varying levels of product upstreamness and China's RCA. Regarding product upstreamness, the results presented in columns (1) and (3) demonstrate that the indirect dependence through Vietnam increases more significantly after the Trade War for downstream products, while the indirect dependence through Mexico grows more prominently for upstream products. These findings align with our hypothesis: downstream goods that are assembled in China pre-Trade War, which need to be relatively high cost-efficient but less time-sensitive, are rerouted more through Vietnam. Conversely, upstream goods imported into the U.S. as intermediate goods for higher value-added finish products that demand higher supply chain responsiveness are rerouted more through Mexico. These results are consistent with the industry heterogeneity results shown in Table 4, in that industries experiencing the most significant growth in indirect dependence through Vietnam, such as textiles, footwear and consumer electronics, typically involve products positioned downstream in the supply chain. By contrast, industries like chemicals, plastics/rubbers, metals, and machinery, which mostly involve upstream products, experience the most notable growth in indirect dependence through Mexico following the Trade War.

Regarding China's RCA, column (2) reveals that products for which China has a higher RCA experience a more pronounced increase in indirect dependence through Vietnam following the Trade War. The coefficient for $Moderator$ suggests that before the Trade War, China's RCA had a significantly negative impact on indirect dependence, indicating that U.S. importers were less inclined to import from Vietnam for products in which China held a comparative advantage. However, the Trade War alters this dynamic, with U.S. importers significantly increasing their Vietnamese rerouting of products with a higher Chinese RCA. This finding is consistent with our earlier hypothesis, which posits that Vietnam's geographical proximity to China facilitates its integration with Chinese supply chains, thereby promoting the rerouting of products in which China has a comparative advantage. This result also aligns with the industry heterogeneity findings presented in Table 4, where industries experiencing growth in Vietnam, such as textiles, footwear, and electrical equipment, are among China's strongest sectors. Column (4) reveals a contrasting pattern for indirect dependence through Mexico: products with a higher Chinese RCA do not exhibit a significantly greater increase in indirect dependence through Mexico after the Trade War. Intuitively, Mexico's proximity to the U.S. makes it an attractive sourcing option for U.S. importers, regardless of China's comparative advantage. Nevertheless, the growth in Mexico's indirect dependence on China even for products where China lacks a comparative advantage suggests that China is attempting to create advantages and maintain connections with the U.S. by exporting through Mexico.

Table 5 Effect of Product Upstreamness and China's RCA on Dynamics of indirect dependence

Dependent variable	$IndirectDepend^{VN}$ (in value)		$IndirectDepend^{MX}$ (in value)	
	Upstreamness	RCA	Upstreamness	RCA
	(1)	(2)	(3)	(4)
$Moderator \times Post$	-0.029***	0.016**	0.012***	-0.001
	(0.009)	(0.007)	(0.003)	(0.003)
$Moderator$		-0.053***		0.013*
		(0.016)		(0.007)
$Post$	0.080***	-0.004	-0.014**	0.013***
	(0.016)	(0.016)	(0.007)	(0.004)
$ln(Total\ Asset)$	0.014	0.014	0.004	0.003
	(0.012)	(0.012)	(0.005)	(0.005)
$Inventory$	-0.017	0.004	0.061*	0.056
	(0.092)	(0.092)	(0.035)	(0.035)
$PPENT$	-0.048	-0.059	-0.082***	-0.085***
	(0.055)	(0.056)	(0.030)	(0.030)
$Sales$	0.002***	0.002***	-0.006	-0.005
	(0.000)	(0.000)	(0.012)	(0.011)
ROA	0.053	0.060	0.040	0.037
	(0.100)	(0.100)	(0.078)	(0.077)
Observations	16,416	16,549	144,918	147,322
R-squared	0.424	0.425	0.249	0.258
Firm FE	YES	YES	YES	YES
Product FE	YES	YES	YES	YES

Notes. This table presents the effect of product upstreamness and China's RCA on the dynamics of indirect dependence on China through Vietnam and Mexico after the Trade War. For Vietnam and Mexico, the sample periods are 2018-2022 and 2016-2022, respectively. The dataset for this table is organized at the firm-product(HS4)-year quarter-level. The dependent variable in column (1)-(2) and column (3)-(4) respectively represents the indirect dependence through Vietnam and Mexico measured in value of goods. The independent variable $Moderator$ in column (1) and column (3) represents product upstreamness, while in columns (2) and column (4) represents China's RCA. $Moderator$, $Post$, lagged firm controls, firm and product(HS4) fixed effect are included. The standard errors are reported in parentheses. Standard errors are clustered at the HS4-product level. The *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

The individual cases of Nike and Samsung serve as illustrative examples of how product characteristics shape the rerouting of supply chains through Vietnam, aligning closely with our empirical findings. Nike, primarily importing downstream textile and footwear products with high China's RCA, sees significant increases in indirect dependence through Vietnam after the Trade War for items such as women's or girls' overcoats (HS code 6102), women's or girls' blouses and shirts (HS code 6106), and footwear with outer soles of rubber, plastics, or leather (HS codes 6403 and 6404). Turning to Samsung, it primarily imports electrical products from Vietnam. Its indirect dependence through Vietnam significantly increases for more downstream products and those with high China's RCA, like telecommunication devices (HS code 8517) as well as monitors and projectors (HS code 8528). However, Samsung's indirect dependence through Vietnam decreases for more upstream goods, such as electrical apparatus for switching or protecting electrical circuits (HS code 8536) and insulated wire, cable, and other insulated electric conductors (HS code 8544). The strategies employed by Nike and Samsung are reflective of our more general findings in columns (1) and (2) of Table 5, and suggest that products which are downstream and/or characterized by high Chinese RCA are more likely to be rerouted through Vietnam by firms.

The experiences of 3M and Eaton offer illustrations of how product characteristics influence the rerouting of supply chains via Mexico, corroborating our empirical results. 3M experiences significant growth in indirect dependence through Mexico for several upstream products, such as prepared binders (HS code 3824) and synthetic rubber and factice (HS code 4002), while seeing a decrease for downstream products like plastic tableware, kitchenware, and sanitary items (HS code 3924). Similarly, Eaton's indirect dependence via Mexico increases for its upstream products, including copper wire (HS code 7408) and ball and roller bearings and components (HS code 8482), but decreases for downstream products such as lifting and handling machinery (HS code 8428). These observations align with the results in column (3) of Table 5, which indicate that more upstream products are likely to be rerouted through Mexico. Regarding China's RCA, 3M sees growth in both high-RCA products in China, like plastic packaging and closures (HS code 3923), and low-RCA products, such as synthetic rubber and factice (HS code 4002). Similarly, Eaton's indirect dependence increases for both high-RCA products in China, like data processing equipment and peripherals (HS code 8471), and low-RCA products, such as lubricating preparations (HS code 3403). These findings are consistent with the results presented in column (4) of Table 5, which suggest that China's RCA does not play a significant role in rerouting of products through Mexico.

6. Extensions: indirect dependence Decomposition

In this section, we decompose indirect dependence into two components: (1) "U.S. import share", which reflects the share of U.S. importers' imports from suppliers in Vietnam or Mexico, and (2) "Suppliers' input dependence on China", which captures the share of inputs sourced from China by Vietnamese or Mexican suppliers. We investigate the changes in these two components through Vietnam and Mexico and examine which component contributes more to the growth of indirect dependence on China.

6.1. Empirical Specification

In Section 3.1, we introduced the calculation method for indirect dependence, as shown in Equation (1), which consists of two main components. The first component is the import share of U.S. importers from Vietnamese or Mexican suppliers, reflecting the extent of their shift towards these countries. The second component is these suppliers' input dependence on China, representing the extent to which they source the relevant inputs from China. In our previous analysis, we focus on the overall changes in indirect dependence. A natural question arises: how much do these two components individually contribute to the overall growth, and do Vietnam and Mexico exhibit differences in the relative contributions of these components to indirect dependence?

In our earlier discussion, we highlighted the importance of geographical location in influencing the indirect dependence dynamics of Vietnam and Mexico. Given Vietnam's proximity to China, it is worth studying whether increases in the second component, Vietnamese suppliers' input dependence on China, contributes more to overall increases in indirect dependence through Vietnam. Conversely, considering Mexico's proximity to the U.S.—and distance from China—it is worth studying whether increases in the first component, U.S. import share from Mexican suppliers, contributes more to overall increases in indirect dependence through Mexico.

We replace the dependent variable in Equation (3) with $USImp^{c}_{i,j,t}$ from Equation (2a) and $SupplierImpCN^{c}_{i,j,t}$ from Equation (2b), both of which are at the firm-HS4 product-year quarter level. The former represents the share of U.S. importer i's imports of product j from suppliers in Vietnam or Mexico, reflecting the extent to which U.S. importers favor sourcing from suppliers in the respective country. The latter represents the weighted average share of product j's inputs sourced from China by firm i's suppliers, capturing the dependence of Vietnamese and Mexican suppliers on Chinese inputs. The equations are as follows:

$$USImp^{c}_{i,j,t} = \beta_0 + \beta_1 Post_t + \beta_2^{'} X_{i,t-1} + \lambda_i + \theta_j + \epsilon_{i,j,t}, \tag{5a}$$

$$SupplierImpCN^{c}_{i,j,t} = \beta_0 + \beta_1 Post_t + \beta_2^{'} X_{i,t-1} + \lambda_i + \theta_j + \epsilon_{i,j,t}. \tag{5b}$$

where i indexes a firm, j indexes a 4-digit HS Code product, t indexes a year-quarter, c indexes the third-party country, either Vietnam or Mexico. We estimate the coefficients of $Post_t$ for Equation (5a) and Equation (5b), reflecting the changes in the two components after the Trade War.

6.2. Unveiling the Post-Trade War Components' Shifts

Table 6 presents the results of a firm-HS4 product-year quarter panel analysis based on Equation (5), examining the changes in the two components of indirect dependence through Vietnam and Mexico following the Trade War. Columns (1) and (2) indicate that, after the Trade War, both the U.S. import share from Vietnamese suppliers and Vietnamese suppliers' input dependence on China increase significantly, with growth rates of 3.8% and 23%, respectively.[14] The magnitude of growth in the second component far exceeds that of the first, suggesting that the increase in indirect dependence through Vietnam is likely due to a notable increase in Vietnamese suppliers' reliance on Chinese inputs. This finding further highlights how Vietnam's geographical proximity to China facilitates its imports from China, leading to a highly significant increase in its dependence on China after the Trade War.

Columns (3) and (4) demonstrate that both the U.S. import share from Mexican suppliers and Mexican suppliers' input dependence on China increase significantly after the Trade War, with

[14]The data indicate that the pre-Trade War averages of the two components for Vietnam were 0.451 and 0.329 (measured in value of goods), respectively. Table 6 reveals that the *Post* coefficient for the two components are 0.017 and 0.076, resulting in a growth rate 0.017/0.451≈ 3.8% and 0.076/0.329≈ 23%.

growth rates of 3.7% and 3.4%, respectively.[15] The similarity in growth magnitudes between the two components suggests that both contribute significantly to the increase in indirect dependence through Mexico. Despite the considerable distance between China and Mexico, China is actively exporting to Mexico to maintain its connections with the U.S. by leveraging Mexico's proximity to the U.S. market.

Table 6 Changes in Components of indirect dependence Following the Trade War

Dependent variable	Components of $IndirectDepend^{VN}$ (in value)		Components of $IndirectDepend^{MX}$ (in value)	
	$USImp^{VN}$	$SupplierImpCN^{VN}$	$USImp^{MX}$	$SupplierImpCN^{MX}$
	(1)	(2)	(3)	(4)
$Post$	0.017*	0.076***	0.027***	0.011***
	(0.009)	(0.009)	(0.003)	(0.002)
$ln(Total\ Asset)$	0.001	0.025	0.015**	0.001
	(0.012)	(0.016)	(0.006)	(0.005)
$Inventory$	-0.008	0.067	0.093*	0.027
	(0.088)	(0.111)	(0.050)	(0.036)
$PPENT$	0.120*	-0.149**	-084**	-0.076**
	(0.066)	(0.070)	(0.038)	(0.031)
$Sales$	0.000	0.002***	0.009	-0.019*
	(0.000)	(0.001)	(0.015)	(0.011)
ROA	0.106	0.210*	-0.061	0.128*
	(0.156)	(0.122)	(0.102)	(0.073)
Observations	16,549	16,549	147,888	147,888
R-squared	0.430	0.450	0.300	0.300
Firm FE	YES	YES	YES	YES
Product FE	YES	YES	YES	YES

Notes. This table presents the changes of components of indirect dependence following the Trade War. For Vietnam and Mexico, the sample periods are 2018-2022 and 2016-2022, respectively. The dataset for this table is organized at the firm-product(HS4)-year quarter-level. The dependent variables for columns (1)-(2) represent components of indirect dependence through Vietnam, including the import share of U.S. importers from Vietnam measured in terms of value, and their Vietnamese suppliers' input dependence on China measured in terms of value. The dependent variables for columns (3)-(4) represent components of indirect dependence through Mexico, including the import share of U.S. importers from Mexico measured in terms of value, and their Mexican suppliers' input dependence on China measured in terms of value. The independent variable *Post* is an indicator variable marking the period after June 2018. Lagged firm control variables, firm and product(HS4) fixed effects are included. The standard errors are reported in parentheses. Standard errors are clustered at the HS4-product level. The *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

To illustrate the real-world implications of our findings, we examine the experiences of Nike and 3M. Nike's import share from Vietnam in textile and footwear goods increases by 52% after the Trade War, while the share of inputs sourced from China by its Vietnamese suppliers increases dramatically by 211%, significantly higher than the increase in the first component, in line with the results in columns (1) and (2) of Table 6. In contrast, 3M's import share from Mexico in chemicals and plastics/rubbers goods increases by 20%, while the share of inputs sourced from China by its Mexican suppliers grows by 6%. Similarly, in the machinery category, 3M's import share from Mexico rises by 22%, and the share of inputs sourced from China by its Mexican suppliers increases by 10%. These firm-level patterns echo the results in columns (3) and (4) of Table 6.

[15] The data indicate that the pre-Trade War averages of the two components for Mexico were 0.728 and 0.326 (measured in value of goods), respectively. Table 6 reveals that the *Post* coefficient for the two components are 0.027 and 0.011, resulting in a growth rate 0.027/0.728≈ 3.7% and 0.011/0.326≈ 3.4%.

7. Conclusion

Amidst the U.S.-China Trade War, U.S. importers have begun to restructure their global supply chains, shifting to third-party countries such as Vietnam and Mexico in an effort to reduce their dependence on China. However, we observe that suppliers in these third-party countries still rely on Chinese inputs, with the share of inputs sourced from China increasing following the Trade War. As a result, we find that U.S. importers have significantly increased their indirect dependence on China through Vietnam and Mexico post-Trade War.

We also explore the impact of product characteristics on this supply chain rerouting. Geography plays a crucial role in shaping supply chains, and Vietnam and Mexico have distinct geographical features: Vietnam is close to China, while Mexico is near the U.S., thereby influencing which products firms prefer to reroute through these countries. We investigate two specific characteristics—product upstreamness and China's revealed comparative advantage (RCA)—and find that their effects differ depending on the country through which the products are being rerouted. More downstream products experience a greater increase in indirect dependence through Vietnam, while more upstream products, which require higher supply chain responsiveness, see a larger increase in indirect dependence through Mexico. Furthermore, products in which China has a comparative advantage are more likely to be rerouted through Vietnam due to its geographical proximity to China, while China's RCA has no significant impact on rerouting through Mexico. Our analysis of industry heterogeneity further corroborates the role of these channels. indirect dependence through Vietnam increases most for sectors that are more downstream and in which China holds an advantage, while indirect dependence through Mexico sees growth mainly in sectors that are more upstream.

After exploring the product channels, we further decompose the indirect dependence into two components: the U.S. importers' import share from Vietnamese or Mexican suppliers, and these suppliers' inputs dependence on China. For Vietnam, which has close ties with China, the second component grows more significantly than the first one. In contrast, for Mexico, the growth rates of the two components are relatively balanced, with the increase in the first component slightly exceeding the growth in the second component.

The findings presented above highlight the importance for U.S. importers to be aware of possible indirect connections with China and their implications for the diversification of their global supply chains. Our research illustrates how firms may see their indirect dependence on China increase even as they seek suppliers from outside of China. Moreover, the dynamics of indirect dependence through Vietnam and Mexico exhibit heterogeneities across products with varying characteristics. Product upstreamness and China's RCA serve as key channels influencing these variations. Therefore, firms redirecting imports to Vietnam should recognize the tendency for products located further downstream and/or products for which China possesses a comparative advantage to feature a more persistent dependence on China. Examples of these include the products of the textile, footwear and electrical industries. Conversely, when shifting imports to Mexico, they need to focus more on upstream goods, notably those in chemicals, plastics/rubbers, metals, and machinery industries. By doing so, firms can make informed decisions about their supply chain diversification strategies, effectively manage risks, and optimize their operations in response to the evolving trade landscape.

In terms of policy implications, our findings highlight the need for policymakers to consider the complexities of global supply chain dynamics when designing and evaluating the effectiveness of trade policies. While tariffs may have led to a decline in the direct trade volume between the U.S. and China, our research shows that third-party countries substituting for China have effectively become intermediaries in the supply chains between the two nations, resulting in a potential increase in indirect interdependence. This suggests that China's supply chains may continue to exert a significant influence on U.S. global supply chains, even in the presence of trade barriers.

Our novel framework, which combines granular customs data with Input-Output Tables to map firm-product-level global supply chains, opens up new avenues for future research. This approach enables a deeper investigation into the indirect connections between various actors during supply chain restructuring in the face of disruptions under geopolitical risks. We also offer a new perspective on global supply chain research under geopolitical risks, highlighting the unintended consequences of policies. Our framework is not limited to Trade war 1.0 in 2018 and can be applied to a broad range of settings where geopolitical risks affect the global supply chains, such as Trump's Trade War 2.0 starting in early 2025. Given the continuously evolving trade policies and geopolitical risks, future research could further explore the long-term impact of geopolitical conflicts and trade frictions on indirect supply chain connections, as well as the new equilibrium of global supply chains.

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Appendix

Appendix A. Data Sample: Bill of Lading

Figure A1 presents a sample of bill of lading data, which provides detailed information on individual transactions. The data include the arrival date of the transaction, names and addresses of the supplier and customer companies, product category classified using the six-digit Harmonized System Code, and importing size measured in terms of cargo volumes, weights, and quantities. Additionally, the data provide logistics information such as the port of lading and unloading, as well as the carrier involved in the transaction.

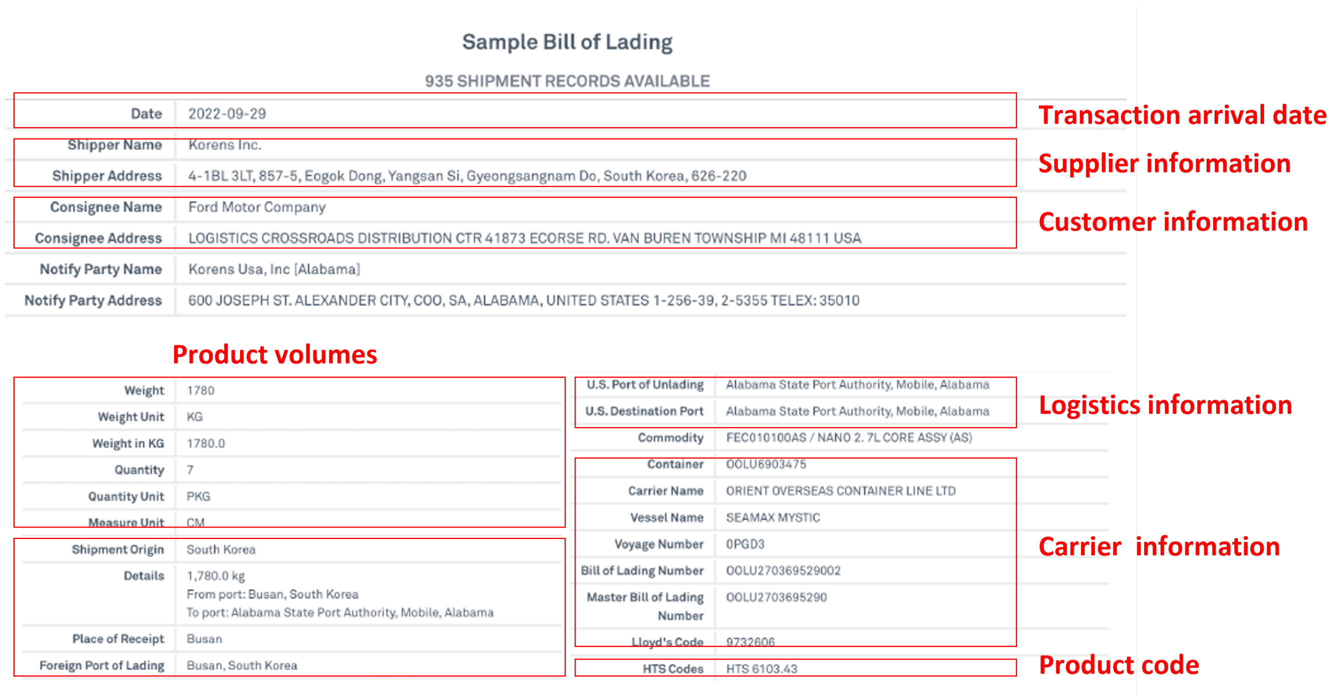


Figure A1 **Sample Bill of Lading for U.S. Imports**

Appendix B. Data Construction Process

Figure A2 shows the key steps in constructing our panel data for regressions, showing how we aggregate and link the data from U.S. Census Bureau, Panjiva, Orbis, Input-Output Table, and Compustat. The method to obtain enhanced U.S. import data references Hsu et al. (2022). Step 5, 6, and 7 illustrate the data processing steps for constructing indirect dependence on China through Vietnam and Mexico. In Section 3.1, we provide a detailed description of the variable construction process.

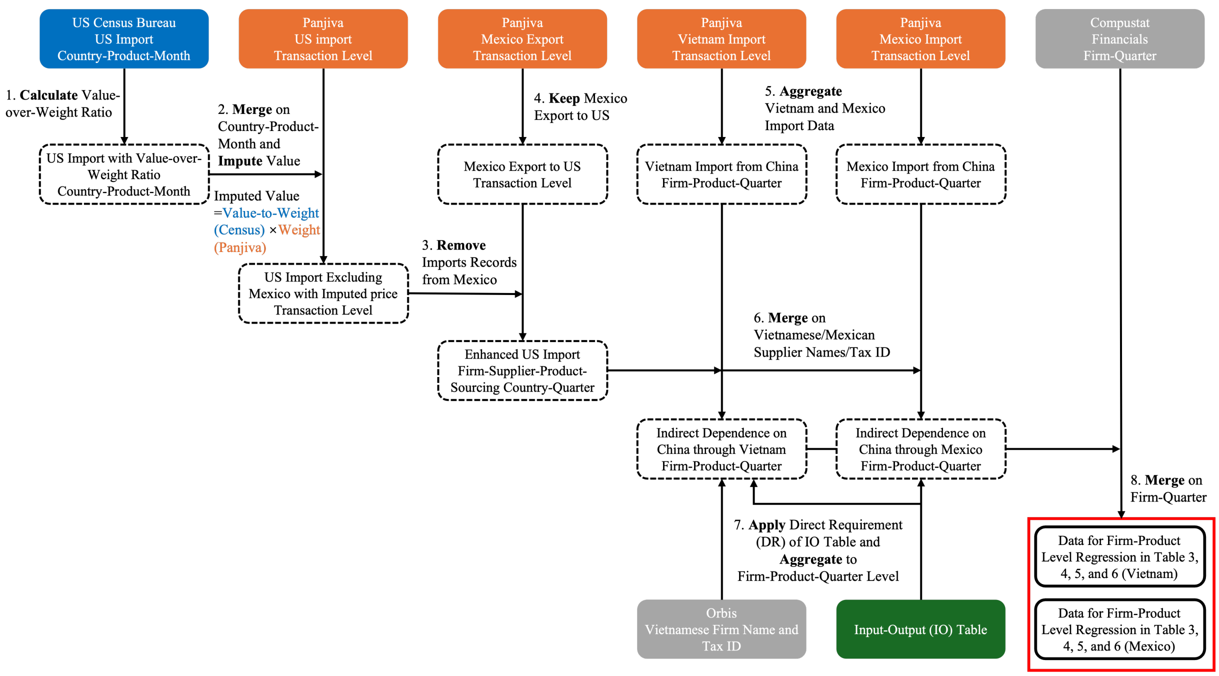


Figure A2 **Data Construction Process**

Appendix C. Analysis of U.S. Import Share from Multiple Countries

Table A1 illustrates the changes in the U.S. import share from China following the Trade War. It shows a significant decline in import share, both across the entire sample and within individual industries, including chemicals and plastics/rubbers, textile and footwear, metals, machinery, and electrical equipment.

Table A1 Changes in U.S. Import Share from China Following the Trade War

	U.S. Import Share from China (in value)					
Dependent variable	All Industries	Chemicals and Plastics/rubbers	Textile and Footwear	Metals	Machinery	Electrical Equipment
	(1)	(2)	(3)	(4)	(5)	(6)
Post	-0.040***	-0.044***	-0.055***	-0.050***	-0.033***	-0.038***
	(0.003)	(0.005)	(0.005)	(0.005)	(0.004)	(0.006)
ln(Total Asset)	0.002*	0.004**	0.001	0.004***	0.004*	0.002
	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Inventory	0.000***	0.000	-0.001	-0.000	0.000	0.000
	(0.000)	(0.001)	(0.000)	(0.001)	(0.000)	(0.000)
PPENT	0.000***	-0.000	0.001**	0.000	0.000***	0.000***
	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)
Sales	0.000***	0.000	-0.000	-0.000	-0.000	0.000*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
ROA	0.002	-0.001**	0.002***	-0.018	0.004***	-0.000
	(0.001)	(0.000)	(0.000)	(0.015)	(0.001)	(0.001)
Observations	721,808	110,446	99,345	84,497	119,551	94,388
R-squared	0.186	0.270	0.356	0.229	0.262	0.261
Firm FE	YES	YES	YES	YES	YES	YES
Product FE	YES	YES	YES	YES	YES	YES

Notes. This table presents the change of firm-product-level U.S. import share from China following the Trade War. The sample period is 2013-2022. The dataset for this table is organized at the firm-product(HS4)-year quarter-level. The dependent variable represents the U.S. import share from China, measured in terms of value. The independent variable *Post* is an indicator variable marking the period after June 2018. Lagged firm control variables, firm and product(HS4) fixed effects are included. The standard errors are reported in parentheses. Standard errors are clustered at the HS4-product level. The *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Table A2 shows the changes in the U.S. import share from countries other than China after the Trade War. The import share from Vietnam and Mexico has significantly increased, as well as other Southeast Asian countries such as Thailand, Malaysia, and Indonesia. However, the import share from major developed countries has not shown significant increase; for example, European countries like Germany, France, and the UK have remained stable, while some Asian countries like Japan, South Korea, and Singapore have even experienced a declining trend.

Table A2 Changes in U.S. Import Share from Other Countries Following the Trade War

	U.S. Import Share from Multiple Countries (in value)			
Dependent variable	Vietnam and Mexico	Thailand, Malaysia and Indonesia	Germany, France and United Kingdom	Japan, South Korea and Singapore
	(1)	(2)	(3)	(4)
Post	0.031***	0.024***	0.007*	-0.008*
	(0.005)	(0.006)	(0.004)	(0.005)
$ln(Total\ Asset)$	0.003	-0.007***	-0.000	-0.005***
	(0.002)	(0.002)	(0.002)	(0.002)
Inventory	-0.000	-0.000	-0.000	0.000
	(0.000)	(0.003)	(0.000)	(0.000)
PPENT	0.000	-0.000	0.000	-0.000
	(0.000)	(0.004)	(0.000)	(0.000)
Sales	-0.000***	-0.000**	-0.000**	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)
ROA	-0.000	0.002***	0.000	-0.001*
	(0.002)	(0.000)	(0.001)	(0.000)
Observations	355,891	113,367	272,794	286,318
R-squared	0.380	0.403	0.308	0.450
Firm FE	YES	YES	YES	YES
Product FE	YES	YES	YES	YES

Notes. This table presents the change of firm-product-level U.S. import share from other countries following the Trade War. The sample period is 2013-2022. The dataset for this table is organized at the firm-product(HS4)-year quarter-level. The dependent variable represents the U.S. import share, measured in terms of value. The independent variable *Post* is an indicator variable marking the period after June 2018. Lagged firm control variables, firm and product(HS4) fixed effects are included. The standard errors are reported in parentheses. Standard errors are clustered at the HS4-product level. The *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Appendix D. Institutional Background

The U.S.-China Trade War represents a marked increase in trade tensions between the world's two largest economies. It commenced on July 6, 2018, when the U.S. imposed tariffs on approximately \$34 billion worth of Chinese imports, with China retaliating immediately. This initiated a series of escalating trade tensions throughout the second half of 2018 and all of 2019, until the Phase One deal in January 2020, as shown in Figure A3.

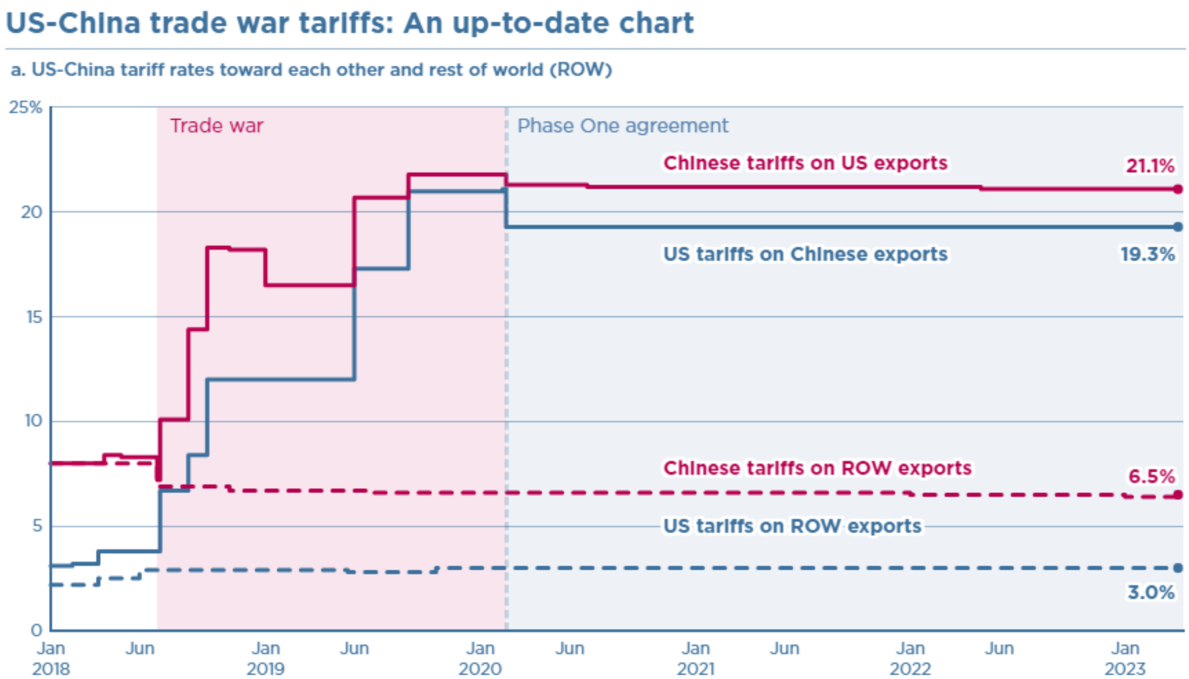
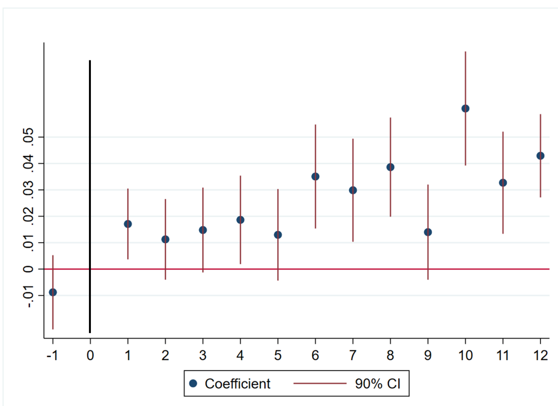


Figure A3 **Timeline of the U.S.-China Trade War**

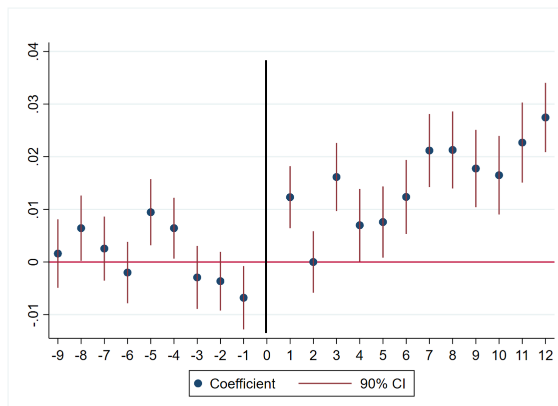
Appendix E. Event Study for the Post-Trade War indirect dependence Shifts

To check for pre-trends for indirect dependence shifts, we conduct analysis of event study. Based on Equation (3), we replace the $PostJune2018_t$ with indicator variables for each year-quarter, and select the quarter before the start of the Trade War (i.e., the second quarter of 2018) as the base period (i.e. period 0).

Figure A4 shows that before the Trade War, the results are generally insignificant. Because the Vietnam import data starts from 2018, there is only one point for the pre-Trade War period. However, following the Trade War, the indirect dependence through both Vietnam and Mexico displays a significant upward trend, indicating the substantial impact of the Trade War on indirect dependence. Additionally, this increase progressively intensifies, reflecting that supply chain rerouting is not a short-term phenomenon but a long-term trend that continues to strengthen over time.



(a) Changes of indirect dependence through Vietnam



(b) Changes of indirect dependence through Mexico

Figure A4 Changes of indirect dependence for Multiple Periods

Note: Points correspond to the change of the indirect dependence through Vietnam and Mexico measured in value of goods post-Trade War, obtained from estimating Equation (3), where $Post_t$ *has been substituted with multiple dummy variables, each representing a distinct quarter. The base period is the second quarter of 2018. Periods beyond the twelfth quarter are aggregated for analysis. The red line represents the 90% confidence interval.*