Transsshipment Hubs, Trade, and Supply Chains*

Anh Do
Michigan State University

Sharat Ganapati
Georgetown University & NBER

Woan Foong Wong
University of Oregon, CEPR & NBER

Oren Ziv
Michigan State University

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Abstract

The majority of global trade moves by sea through hub-and-spoke shipping networks. We investigate the returns to being a hub country by analyzing how transshipment activity shapes trade and supply chains. We show that most US imports—especially from smaller origin countries—are transshipped via key hubs, and transshipment is positively correlated with the hub's product-level trade. Leveraging the indirect shipping network structure to construct an instrument, we find that transshipment increases hubs' imports from origins for which they facilitate trade and exports of downstream goods, highlighting their central role in shaping modern global trade and supply chain dynamics.

Keywords: trade costs, scale, hubs, transport costs, transportation networks, international trade, shipping JEL Classification: F10, F13, F14

*Contact: doanh@msu.edu, sganapati@georgetown.edu, wfwong@uoregon.edu, and orenziv@msu.edu. We thank Davin Chor, Mark Colas, Kerem Coşar, as well as Mariya Brussevich and participants at the 2024 Empirical Investigations in International Trade Conference (Purdue University) for feedback.

1 Introduction

Trade hubs have arisen and flourished along global trading networks for millennia (Seyrig, 1950; Christ, 2017; Graf, 2018; Cameron, 2022). In the modern global trade network, hubs serve as critical nodes connecting global and regional markets via transshipment—the routing of a shipment from its origin through an intermediate country prior to its ultimate destination. Countries invest billions of dollars in port infrastructure, explicitly aiming to capture transshipment traffic and solidify their roles as hubs within this global network.[1] While earlier work has focused on why transshipment occurs (Young, 1999; Feenstra and Hanson, 2004) and a more recent literature has established how hubs benefit global trade as part of a larger network (Heiland et al., 2019; Ganapati, Wong and Ziv, 2024), less attention has been paid to the hubs themselves: What benefits do hubs reap from these investments and transshipment activity?

We study the advantages of being a global hub, showing how transshipment activity drives trade flows and reshapes a country's role within global supply chains. Using bill of lading data for containerized US imports, we document transshipment patterns and examine how transshipment activity relates to trade outcomes. Using the indirect nature of trade networks as an instrument, we estimate the static and dynamic effects of transshipment on trade and find that it significantly boosts hub imports. This link between transshipment and trade is product-specific: firms exporting via a hub are more likely to also sell directly to it, boosting the hub's imports from the origin country, rather than increasing market access across unrelated goods. Importantly, transshipment has supply chain consequences, increasing exports of products positioned downstream of the transshipped goods. We highlight that transshipment, as part of the hub-and-spoke nature of transportation networks, plays a central role in shaping global trade and supply chain dynamics.

We establish three stylized facts on transshipment. Although transshipment plays a central role in the transport network, it is typically omitted from international trade statistics and does not contribute to reported imports or exports at intermediate ports. To document these patterns, we draw on bills of lading data on the universe of US ocean containerized imports from 2008 to 2017. Our first stylized fact shows that the majority—around 70%—of

[1] Saudi Arabia has invested \$7 billion to become a transshipment hub, while India has committed \$4 billion to rival to Sri Lankan ports (Shaw-Smith, 2015; Verma and Das, 2016). Meanwhile, Singapore has investing \$15 billion to maintain their competitive edge (Paris, 2021).

US imports are transshipped via an intermediate country. Smaller trading partners are more heavily dependent on transshipment than larger partners. Second, we show that transshipment activity is highly concentrated, with the top five hub countries accounting for more than half of all transshipment. Third, we show that transshipment activity is positively associated with hub countries' trade outcomes. This relationship is not driven by increased market access but by product-level channels: increased transshipment of a particular good is linked to the hub country also importing that same good directly. A 10% increase in transshipment volumes corresponds to a 2.5% increase in direct imports of the same product, highlighting the role of transshipment in facilitating targeted trade relationships.

Next, we estimate the causal impact of transshipment volumes on bilateral trade. We use transshipment patterns and industry-specific demand shocks to predict good-specific transshipment activity, leveraging the idea that overall increases in US product-level imports makes transshipment more likely through countries historically used as hubs for certain exporters. Using this instrument, we find that increasing transshipment volumes by 10% increases bilateral trade in that product category. We find no contemporaneous effects, but that trade effects only show up several years after transhipment activity intensifies: by 3% over 3 years and 4% over 9 years. These effects are good-specific, without broader impacts at the sector or country-pair level, and we find no evidence that transshipment broadens market access across unrelated product categories. These patterns align with a trade model where fixed shipping costs create economies of scope: firms exporting products through a hub are more likely to also sell directly to that hub, increasing the hub's imports from the origin country. We further explore the potential for dynamic effects using the inter-temporal specification of Jordà (2005).[2] The effect is pronounced at around 20-30% after three years, implying some time passes before the additional trade develops with the transshipment country. Consistent with our reduced-form specification, we find no contemporaneous effect.

Last, we show that transshipment has supply chain implications. Increased transshipment through hubs leads to higher imports into the hub country, but only in product categories that are downstream of the transshipped product. Transshipment has no positive impact on exports in industries where the transshipped goods have no production input role. For every 10% increase in input usage, the elasticity between transshipment and exports increases by roughly 0.03, with this relationship only arising at the full 9-year horizon. These results

[2]See Boehm, Levchenko and Pandalai-Nayar (2023).

suggest that transshipment can shape a country's comparative advantage by improving access to critical inputs needed for downstream production.

Our paper contributes to several strands of literature at the intersection of international trade, transportation, and growth. Using data and methods from a new and growing literature on the global shipping network and the role of hubs in that network, we shed light on the role those hubs play in national outcomes. In doing so, we address a long-hypothesized link between the geography of trade and the development of hubs. We establish evidence for a new mechanism connecting the two: the supply-chain effects of product-level market access.

First, we contribute to a literature on the technology of trade, specifically the role of transshipment in trade. International trade statistics typically exclude transshipment cargoes, which makes it challenging to study effects of transshipment activity via the hub country on its own economic outcomes.[3] Earlier work on transshipment or re-exports have also mostly focused on the motivations behind these activities, particularly in resolving informational frictions, as shown in studies on Hong Kong—a major transshipment hub (Young, 1999; Feenstra and Hanson, 2004).[4] We contribute to this literature by assembling detailed transshipment data for US imports, allowing us to document stylized facts on transshipment activities, key global hub countries that is facilitating these activities, and the link between transshipment and hub-country trade. We identify a novel channel through which transshipment affects hub-country trade and supply chains.[5]

Second, this paper is related to a recent literature focused on the network effects of transportation and their implications for international trade (Brancaccio, Kalouptsidi and Papageorgiou, 2020; Heiland et al., 2019; Wong, 2022; Coşar and Demir, 2018; Bernhofen, El-Sahli and Kneller, 2016; Rua, 2014).[6] The container shipping network is a hub-and-spoke network, driven by the presence of scale economies (Ganapati, Wong and Ziv, 2024). We highlight how the transportation network has evolved over a decade, and highlight a novel

[3] Andriamananjara, Arce and Ferrantino (2004); Talley and Riggs (2018); Kee and Nicita (2022) all consider discrepancies in trade statistics.

[4] Young (1999) shows that transshipments can resolve informational frictions. Feenstra and Hanson (2004) finds that Hong Kong re-exports of Chinese goods were more expensive and had higher markups, consistent with intermediaries helping to overcome informational barriers in exchange.

[5] Focusing on semiconductors, Jones et al. (2020) also find that re-export volumes are higher in sectors with strong global value chain presence. (Xu and Itoh, 2018) studies the impact of rerouted traffic on local activity in Busan.

[6] We do not explore non-transportation reasons for hubs. For example, see Fisman, Moustakerski and Wei (2008) for tariff evasion.

mechanism for how this network can directly impact the hubs within it.

Third, we help bridge the research on transportation and market access to work exploring the relationship between trade and growth. Geographically advantaged locations tend to grow (Barjamovic et al., 2019; Bleakley and Lin, 2012). Both economists and historians have hypothesized this link may be driven by the effects of facilitating trade (Seyrig, 1950; Glaeser, 2005; Bernstein, 2009; Blaydes and Paik, 2021; Ahmad and Chicoine, 2021). Feyrer (2021) and Feyrer (2019) show increased access to international trade, via changes in the transport network, has positive impacts on income.[7] We focus on and find evidence for a specific mechanism linking commercial activity along trade networks with national outcomes: the ability of transhipment to open market access, alter long-run global supply chains, and endogenously increasing exports.

2 Data and Stylized Facts

This section outlines the data and three key stylized facts on transshipment in global trade.

2.1 Data

Bills of Lading We use US Customs bills of lading data for all containerized imports into the US from 2008-2017.[8] The data is at the shipment level. For each shipment, we observe three locations: the origin country, the port where the shipment is loaded onto a containership bound for the US (port of lading), and the US destination port where the shipment is unloaded. When the port of lading's country differs from the origin country, we define this shipment as being transshipped and the port of lading's country as the *transship country*. Colloquially, the definition of transshipment encompasses any event in the transportation of an import where a change of vessel or mode occurs.[9] Our definition narrows this to observed vessel or mode changes at third countries. Our transshipment activity measure is an underestimate.[10] Additionally, we observe the shipment's container volume (TEUs)

[7]Specifically, the introduction of containerization has also induced population growth (Brooks, Gendron-Carrier and Rua, 2021), although gains are offset by development costs (Ducruet et al., 2024). Brancaccio, Kalouptsidi and Papageorgiou (2024) shows efficiency gains from port investments.

[8]Sourced through Panjiva. Similar data is used by Flaaen et al. (2021) and Ganapati, Wong and Ziv (2024).

[9]This results in a multimodal transport network (Fuchs and Wong, 2022).

[10]The port of lasing is the port at which the shipment was loaded onto the vessel which delivers it to the port of unlading. This is the final vessel in its journey. Transshipment activity within the origin country or

and product information for the primary good at the 6-digit Harmonized System (HS-6) level. Over this decade, we see US imports from 224 origin countries which are loaded onto US-bound containerships in 123 intermediate hub countries.

International Trade Flows To establish the link between transshipment activities and trade, we match the origin and transshipment countries in our bills of lading data to their international trade flows data from CEPII BACI (Gaulier and Zignago, 2010). We match trade between an origin country and transshipment country using HS-6 product-level details in the bills of lading.

Supply Chains We use input-output tables from the World Input-Output Database (WIOD) to calculate for each sector, the share of intermediate inputs sourced from each sector (Timmer et al., 2015). This allows us to study the link between transshipment and trade along the supply chain. Since trade flows and transshipment activities are recorded at the HS 6-digit level while input-output data consist of 2-digit sectors according to the International Standard Industrial Classification Rev. 3 (ISIC-3), we map HS-6 commodities to ISIC-3 sectors. In our baseline supply-chain specification, we only include manufacturing sectors. We check for robustness to their inclusion in our appendix.

2.2 Stylized Facts

We first calculate the share of imports into the United States that was transshipped for each origin country in our data. Figure 1a shows distribution of transshipment shares over the period. Around a third of the 224 origin countries tranship all of their exports to the US.[11] The median transshipment share (indicated by horizontal black line) hovers around 96-98% with a slight decrease to 94% in 2017. The average transshipment share (indicated by diamonds) is also relatively stable at around 70%. However, the box plot shows a wide distribution, with the 25th percentile shares around 30-35%. The trade-weighted average of transshipment shares hovers around 40%-45%, suggesting that transshipment activity is especially prevalent for imports from smaller trading partners.

in third countries before the port of lading is missed.

[11] These include landlocked countries like Switzerland, Austria, and Bolivia, as well as smaller countries like Brunei, Papua New Guinea, and Ethiopia.

[Figure 1]

Dividing origin countries into four quartiles based on their 2008 trade values with the US shows clear differences in transshipment shares across quartiles. Countries in the lower three quartiles rely heavily on transshipment, while the largest traders in the top quartile more often ship directly. The bottom two quartiles of countries have mean transshipment shares ranging from 74-79%, while the third-quartile countries have slightly lower means around 70-75%. By contrast, fourth-quartile countries have the lowest mean share of around 61% (See Appendix Figure A.1 for further details). This allows us to establish our first stylized fact:

Stylized Fact 1. *The majority of trade into the US is transshipped (70%). This share is relatively stable from 2008 to 2017. Smaller US trading partners consistently transship a higher proportion of exports relative to larger countries.*

Next, we consider countries that conduct transshipment activities and show that these global transshipment activities are highly concentrated in a small number of countries. We define the percent of transshipment activities as the total of transshipped containers at these countries divided by the total of transshipped containers that year and multiplied by 100. Figure 1b reports the cumulative sum of transshipment activity for years 2008 and 2017. In 2008, the top five largest intermediate hub countries were responsible for more than 50% of global transshipment activity. In rank order, they are China, Hong Kong, South Korea, Taiwan, and Singapore. The top-10 largest hub countries are responsible for more than two-thirds of transshipment activity. Concentration is similar in 2017 (Figure 1b).

Despite the relative stability of both the share of goods that are transshipped and the concentration of transshipment activity, this list has experienced moderate churn related to regional competition. For example, a roughly 3.5 percentage-point uptick in transshipment share in Panama and Colombia corresponds to a nearly identical drop in that of Jamaica and the Bahamas in the same period; an almost 1 percentage-point decline in Costa Rica's share coincides with a 1.2% increase in Guatemala's. A four percentage-point decline in China's share corresponds to a nearly 3 percentage-point increase in South Korea.[12] Our second stylized fact summarizes:

[12] Table A.1 shows the the countries with the most transshipment activity in 2008 and 2017.

Stylized Fact 2. *Global transshipment activity is concentrated in a small number of countries and has stayed concentrated over a decade. The top five countries account for more than half of global transshipment activity while the top ten hub countries account for more than 70%.*

These stylized facts echo Ganapati, Wong and Ziv (2024) over a time series using a different way of capturing indirect trade.[13] Hub countries help smaller trading partners better access global markets, by allowing these partners to access large ships that are extremely cheap on a per-unit level. But what are the benefits to hubs themselves?

We next examine the correlation between total trade levels and transshipment volumes for these hub countries. We include the hub country's annual GDP to control for time-varying changes in these countries' openness and access to trade outcomes, as well as country-level fixed effects to control for time-invariant country-level characteristics and year fixed effects to control for aggregate changes over time. To capture potential longer-run effects, we examine the correlation between trade and transshipment changes over our sample. Figure 1c shows a statistically significant and positive correlation of 0.091. Appendix B further explores this link for aggregate trade outcomes and additional measures of transshipment activity, demonstrating that it is largely driven by exports.

Two mechanisms could potentially explain this observed aggregate positive relationship. One possibility is that transshipping through a hub country enhances overall market access to that hub, regardless of product composition. In this view, transshipment activity lowers trade costs for hubs where economies of scope external to the firm arise from shared shipping infrastructure. Alternatively, the relationship may be driven by a product-specific channel, where increased transshipment of a particular good is linked to firms also exporting that same good directly to the hub. Under this view, transshipment enables *internal* economies of scope in shipping. To distinguish between these channels, we examine whether the correlation between transshipment and trade flows persists within product categories, rather than being driven by aggregate trade expansion.

[Table 1]

[13]Focusing on the number of stops between its origin and destination, Ganapati, Wong and Ziv (2024) finds that the goods from smaller countries tend make more stops and these stops take place at entrepôts. Stops allows the ships to pick up more goods and better utilize their capacity. Smaller countries, when shipping via hub countries, utilize larger ships that are similar in size to larger countries.

Table 1 explores how transshipment activity to the United States corresponds to a hub country's trade flows within product categories (HS2) over the entire time period. We include hub–year fixed effects to control for time-varying shocks that are specific to each hub country, such as changes in infrastructure, policy, or demand. We also include product–year fixed effects to capture global shocks by product and year. Additionally, we include hub–product fixed effects to absorb time-invariant, persistent hub–product relationships like specialization patterns.

The results confirm that the relationship is mostly driven by the product-specific channel. Specifically, Table 1 Panel (a) Column (4) shows a statistically significant relationship between the number of transshipped containers and imports of transshipped goods by the hub country. A 10% increase in transshipment volume of a given product corresponds to a 2.8% increase in direct imports of that same product by the hub. This statistically significant result is robust and even stronger using alternative measures of transshipment activity: a 10% increase in the count of transshipped HS6 products within a broader HS2 category corresponds to a 12.5% increase in direct imports of that same product by the hub (Panel (b) Column (4), Table 1), and a 10% increase in the the number of transshipped trading partners is associated with a 11.3% increase in direct imports of that same product (Panel (c) Column (4), Table 1).

In contrast, the relationship between transshipment and aggregate trade outcomes—including total trade, exports, and imports—are small and statistically insignificant (Columns (1) to (3), Table 1). We also find similarly weak patterns when using alternative measures of transshipment activity. These findings support the view that transshipment facilitates trade at the product level, suggesting that firms are not simply gaining general market access to hub markets through transshipment, but are engaging in targeted trade relationships around specific goods. This leads to our third stylized fact:

Stylized Fact 3. *Transshipment activity is positively correlated with the hub country's trade. This relationship is driven by product-level relationship between transshipments and imports.*

3 Impact of Transshipment on Trade

We show our main results using two research designs. The first is a simple empirical specification that looks at short, medium, and long run variation under assumptions about shock timing and persistence, primarily when the transshipment starts and the resulting trade occurs must be within a specified window. We use an instrumental variable to control for omitted variables, reverse causation and attenuation bias. In a second research design, we extend this to a dynamic setting which allows transshipment activities to dynamically affect subsequent trade flows over time. This not only allows us to look at dynamic effects over time, but lets us to better control for potential reverse causation.

3.1 Static Research Design

We outline an empirical strategy when an exogenous transshipment contemporaneously affects trade flows. Due to incomplete data and instruments, we account for attenuation bias, omitted variable bias, and reverse causation.

A regression relating transshipment volumes to trade considers:

$$\log X_{o\to d,k,t} = \alpha_1 \log \sum_{f\in\mathcal{F}} T_{o\to d\to f,k,t} + \delta_{o\to,k,t} + \delta_{\to d,k,t} + \delta_{o\to j,k} + \epsilon_{o\to d,k,t}, \tag{1}$$

where the outcome variable $X_{o\to d,k,t}$ are the exports from origin o to destination d, in product category k (at the HS-6 level) in year t. In this specification, the parameter of interest is the coefficient α_1 on $\sum_{f\in\mathcal{F}} T_{o\to d\to f,k,t}$, the volume of product k transshipped at location d from origin o to any final destination f in the set $\mathcal{F}$. This is the empirical analog of Proposition 2 in the theory model in Appendix A.

3.1.1 Empirical Implementation

While we observe the export date of transshipments, we do not observe the timing of trade. So we aggregate our transshipment data to the yearly level. Taking first differences between t and t_0:

$$\Delta_{t-t_0} \log X_{o\to d,k,t} = \alpha_1 \Delta_{t-t_0} \log \sum_{f\in\mathcal{F}} T_{o\to d\to f,k,t} + \delta_{o\to,k_{HS_2},t} + \delta_{\to d,k_{HS_2},t} + \delta_{o\to d,k_{HS_2}} + \epsilon_{o\to d,k_{HS_2},t}, \tag{2}$$

where the $\delta_{o\to d,k}$ fixed effect in Equation (1) is differenced out, and origin-product-time and destination-product-time fixed effects now flexibly control for time variation in trends within sectors (2-digit HS codes) and at the bilateral-sector level. The first differences take out an origin-destination-HS 6-digit fixed effect for every time pair between t and t_0. We next consider three major econometric issues.

Omitted Variables and Timing Assumptions A standard concern is omitted variables, which confound the observed relationship between transshipment and trade. For example, demand shocks in the transshipment country or supply shocks from the origin country could generate increased transshipment and trade at the same time. In general, we have no prediction for the direction of bias for unspecified omitted variables.

Reverse Causation and Autocorrelation A related endogeneity problem is reverse causation. In our model, this takes the form of a simplified traveling salesman problem: conditional on selling to B, the benefits of trade with A make transshipment more attractive relative to direct shipping to B. Exporters servicing the US who begin servicing a second destination may switch shippers to one transshipping through the second destination. An important feature of this mechanism is that it should occur contemporaneously to an observed change in trade, while the causal impact of transshipment may be delayed as exporters search for markets.

Attenuation Bias The principal issue with our data is our measurement of transshipment, which will result in attenuation bias. Our transshipments data is not universal, we only observe if a location is used as a transshipment point for voyages transporting US imports. On these US voyages, we only observe the final transshipment activity. Furthermore, because bill of lading data is not customs data, HS code misclassification generates measurement error.[14] In our results, we will find significant scope for bias resulting from these measurement difficulties.

With these issues in mind, we run the regression using $\Delta_{t-t_0} T_{o \to d \to US,k,t}$ to denote the change in transshipment volumes for the US between time periods t and t_0. We run these regressions in non-overlapping time periods to account for issues with staggered-difference research designs. Our short run estimation will use one-year variation, our medium run will look at three years, and our long-run will look over our entire data set over 9 years. We

[14] Our transaction level data is only a partial list of the various HS codes in each shipment. For a substantial portion of these shipments, multiple HS codes are listed. In these cases, we assign the first HS code to the entire shipment.

run additional specifications as robustness checks, with origin-destination-product-time fixed effects and HS 4-digit level fixed effects.

While all three threats to identification are partially addressed by first differences and robust fixed effects—the specific supply or demand shocks posited above as omitted variables are absorbed at the k_{HS_2} level—ultimately, these strategies are insufficient—even in a simple setting where transshipment is a one-time shock. We turn to an instrument to predict transshipment that plausibly satisfies the conditions of an instrumental variable, one that affects transshipment directly, but after accounting for the fixed effects—has no direct effect on industry-level trade flows.

3.1.2 Instrumental Approach

Our instrumentation strategy echoes Ganapati, Wong and Ziv (2024), which exploits the geographic nature of global trade. We leverage historic patterns to predict transshipment geography by interacting changes in shipments to the US in a particular product category from all countries excluding the origin o with the share of shipments from origin o that are transshipped to the US through d in the base year, excluding transshipments from good k's sector.

The intuition behind our instrument is that increased exports from o due to demand shifts in the US will make transshipment more likely overall, but differentially more so for countries historically used as a transshipment location for o's US exports.[15] Leaving out US imports from the origin omits the possibility of capturing supply shocks, which would induce exports to both the US and the transshipment country.

Formally, we create a instrumental variable $z_{o,d,k,t}$:

$$z_{o,d,k,t} = \ln \underbrace{\sum_{o' \in \mathcal{N} \setminus \{o\}} (X_{o',k,t} - X_{o',k,t_0})}_{\substack{\text{Total change in US imports of} \\ \text{good } k \text{ not from } o \text{ over time}}} \times \underbrace{\frac{\sum_{k' \in \mathcal{K} \setminus \{k\}} T_{o \to d \to US,k',t_0}}{\sum_{d \in \mathcal{N}} \sum_{k' \in \mathcal{K} \setminus \{k\}} T_{o \to d \to US,k',t_0}}}_{\substack{\text{Historic share of transshipment of} \\ \text{all goods } k' \text{ from } o \text{ to US via } d \text{ at period } t_0}} \tag{3}$$

where $X_{o',k,t}$ are US imports of good k from origin o' in period t. This instrument is similar to predicted tax instruments or shift-shares, though, crucially, unlike a shift-share, this predicted transshipment instrument does not sum aggregate changes with shares across product

[15] Results are robust to omitting historic bilateral transshipment in product categories.

categories.

[Table 2]

Table 2 presents our results using stacked differences. Columns (1)-(3) present OLS results. Column (3) presents our main specification, while columns (1) and (2) present robustness specifications, with four-way (origin, destination, sector and time) fixed effects, and origin-product and destination product fixed effects at the four digit level, respectively. Panel (A) presents results for 1-year differences. The OLS displays a modest, marginally relationship: doubling the volume of transshipment of a given product is associated with a 0.1-0.2% increase in product imports from the transshipment's origin country.

In columns (3)-(6), we employ our instrument. Coupled with the correct direction of the first stage (Appendix Table A.4 shows our first stage results), our instrument appears to be strong. The instrumental variable results display much larger relationships. While the one-year relationship in Panel A remains insignificant, Panel B shows that a 10% increase in transshipment results in a 2.9-3.3% increase in imports in the 3-year window. This identified "micro" elasticity nearly exactly matches the aggregated "macro' elasticity of our stylized fact. As such, this upward revision in magnitude is consistent with the instrument rectifying the significant measurement error resulting from missed transshipment and misclassified shipments.

The bottom panel displays results from our longest lags, 9 years difference. Despite the mechanical reduction in our sample size, Columns (1)-(3) demonstrate larger, now more significant correlations. In the OLS, doubling transshipment is related to roughly a 1% increase in trade. Our instrument also generates a larger magnitude: a 10% increase in transshipment results in a 4% increase in trade. The effect of transshipment increasing over time is consistent with the notion—not captured by a static model—that transshipment effects take time to materialize. Speculatively, firms revisit export decisions slowly after they learn about the lower transport cost, paying export costs at the transshipment location.

We report first stage results, and extensive margin results in Appendix C. We run "placebo" regressions where we compare transshipment in one industry to imports in others. Transshipment in one product category should not predict imports in another. In Appendix C, we find no evidence.

3.2 Dynamic Responses

Our initial research design finds statistically zero effects in the very short run (within the year), but large and growing effects at the medium and long-run. With this in mind, we now move to a dynamic estimating research design. Specifically, we consider the effect of transshipment at different horizons in a dynamic framework, in the spirit of Jordà (2005), allowing the process of transshipment to affect trade over a variable time horizon. Our dynamic regression specification is similar to that used in the exchange rate and tariff pass through literature (Boehm, Levchenko and Pandalai-Nayar, 2023).

We follow the literature's notation, using the time difference operator Δ_h to denote the difference between $t-1$ and $t+h$ for any given variable. As before, due to limited information on transshipment, we are unable to fully saturate fixed effects. As such, we aggregate up to the 2-digit HS code for the local projection fixed effect. Furthermore to alleviate issues with attenuation bias, endogeneity, and reverse causation, we use an instrument for the the low horizon transshipment. Our baseline specification takes the form:

$$\Delta_h \ln X_{i,j,p,t} = \beta^h \Delta_h \ln T_{i,j,US,p,t} + \delta^{1,X,h}_{i,p,t} + \delta^{2,X,h}_{j,p,t} + \delta^{3,X,h}_{i,j,p} + u^{X,h}_{i,j,p,t} \tag{4}$$

where β^h is the h-horizon effect of transshipment T from i to the US via j for product p at time t on trade flows X between i and j.

[Figure 2]

In this specification, the OLS specifications at the 1, 3, and 9 year horizons are identical to those in our previous results. Figure 2a plots the OLS results. The general pattern in our previous results holds more clearly here: the OLS effect is growing over time to an 8-period peak of 10 times the initial effect.

However, in addition to the identification threats isolated above, an increased secondary threat is autocorrelation: resulting changes at any horizon may be a product of transshipment changes at that horizon, or more or less recent changes to transshipment. To isolate the horizon-specific effects, our instruments now must be orthogonal to prior and future period shocks. We follow the literature by using base-period shocks for each time difference. Specifically, Figure 2a uses the initial transshipment changes as an instrument for h-horizon changes. As in Jordà (2005) and Boehm, Flaaen and Pandalai-Nayar (2019), the fixed effects of our main specification remove correlation between shock periods. Here, the general upward trend is more pronounced, increasing to a maximum six-period effect of 2%.

As Boehm, Flaaen and Pandalai-Nayar (2019) write, the initial period instrument should be considered in the spirit of OLS, and will not address the main threats to identification listed above. As such, we employ a initial version of our shift-share instrument. Here, we use our initial shift share instrument from t_0 to t_3 to instrument for h-horizon changes, (precisely the one used in Table 2b, Specification 5). Figure 2b plots these dynamic effects. We confirm the zero short-run effect, and gradually increasing effect size levels off at around a 20-30% effect, lower than our 9-period lag, which would be expected if the 9-period lag absorbs correlated shorter-horizon shocks.[16]

Appendix D considers robustness, looking at alternative fixed effects and initial time period instruments. Results are all consistent.

4 Supply Chains Effects

In the previous sections, we established a link between transshipment and imports at the product level: transshipping a product through a country increases the probability of export to it. However, the country-level relationship between trade and transshipment is driven by *exports*. In this section, we show that transshipment activity increases export activity in downstream industries.[17]

We consider the effect of transshipment in one industry on *exports* in other industries, and how that relationship is mediated by the input-output relationship between the industries. We use the World Input-Ouput Tables (WIOT) to link industries (aggregated into 35 ISIC3 sectors) according to their input expenditure share, and merge these with product-level exports and product-level transshipments. The resulting dataset is transshipment product (k) by origin (o) by hub (d) by export (k') by year(t). We then consider how transshipment in one industry differentially affects exports in other industries, that use that industry's products more in production.

[16] We also use our shift share from the change from t_0 to t_1, as well as from t_0 to t_2 in the Appendix. Results are broadly similar, though less precise.

[17] The model in Appendix A highlights the fact that when imports are intermediates, transshipment generate comparative advantage effects, lowering the country's costs of production downstream and increasing downstream exports. The same mechanism has been highlighted by government agencies interested in transshipment activity (Government of Malta, 2019; Government of Jamaica, 2022).

We consider the following specification:

$$\begin{aligned}\Delta_{t-t_0} \log \sum_{o' \in I \setminus o} X_{d,o,k',t} =& \beta_1 \Delta_{t-t_0} \log T_{o \to d \to US,k,t} \times Pct\_Input_{k,k'} \\ &+ \beta_2 \Delta_{t-t_0} \log T_{o \to d \to US,k',t} + \beta_3 Pct\_Input_{k,k'} \\ &+ \gamma_{d,t} + \gamma_{o,t} + \gamma_{k,t} + \epsilon_{o,d,k,k',t}\end{aligned} \tag{5}$$

where $\sum_{o' \in I \setminus o} X_{d,o,k',t}$ is the sum of exports from d to all other countries o', leaving out the transshipment's origin country o. In other words, the LHS variable measures the total amount of exports in WIOT category k' by hub country d to the rest of the world, minus exports to o in the same category. Transshipment of k is measured at the HS-6 level. $Pct\_Input_{k,k'}$ is the percentage of industry k''s total input expenditures coming from industry k, across all countries in 2008, calculated using the World Input-Output Database 2013 Release. Note that because we have aggregated data to the 35-WIOT industry level in order to capture the input-output relationships between industries (and because the bilateral, bi-industry specification explodes the size of our dataset), our baseline specification drops our industry fixed effects.[18] To address endogeneity as in Section 3.1.1, we instrument for Transshipment using the same IVs constructed through Equation 3 in Section 3.1.2, and interacted with $Pct\_Input_{k,k'}$.

[Table 3]

Table 3 presents our OLS results (columns 1-3) and IV results (columns 4-6). In Panel A and B, we find precise zero effects for both transshipments and the transshipment-supply chain interaction in the first three (OLS) specifications. Transshipment appears to have no effect on exports or on downstream exports. This might be expected since the dynamic effects explored in the prior section show transshipped goods only fully penetrate as imports (and hence intermediate inputs only arrive at the economy) at the 3- and 9-year period. Across columns 3-6, the IV results are positive but noisy. These results are consistent with zero short- and medium-run supply chain effects.

Panel C explores the long-run effects (9-year differences). In columns 1-3, the effect of transshipment on exports is zero, while the interaction effect is positive and significant. Transshipped goods have no effect on exports in unrelated industries, but do increase exports

[18] We include country-industry-time FEs as well, although they remove the bulk of our variation.

in downstream industries. In the IV, the effect of unrelated industries is slightly negative, though not significant with industry-time effects. Transshipment may slightly lower exports in unrelated industries. This may be plausible and consistent with comparative advantage-driven export shifts. Here, the interaction term is again positive: for each 10 percentage point increase in intermediate input usage between the industry of the transshipped good (k) and the export industry (k'), the elasticity between transshipment and export increases by 2 percentage points.

In Appendix E we consider robustness, investigating specifications with all WIOT industries, alternative functional forms, extensive-margin effects, and a placebo on downstream imports.

5 Conclusion

In this paper, we study the returns from being a hub country—the impact of global transshipment activity by these hubs on their own international trade flows and supply chains over a decade. We demonstrate that enabling global trade through transshipment not only benefits partner countries but also yields important and substantial gains for the hub itself, benefiting its own trade flows and downstream industries. However, this effect does not work through increasing one's own general market access, but through particular product-specific channels. These findings open up potential research using either firm-level or multi-country shipping data to look into how exactly the costs of finding and shipping to downstream users is paid, while also revealing trade statistics understate overall transportation usage (Ganapati and Wong, 2023). This could open up the black box into useful policy recommendations for developing and newly industrialized countries to enter into global value chains. In a world of interconnected trade flows and networks, transshipment is another way in which countries can harness global trade to their own advantage.

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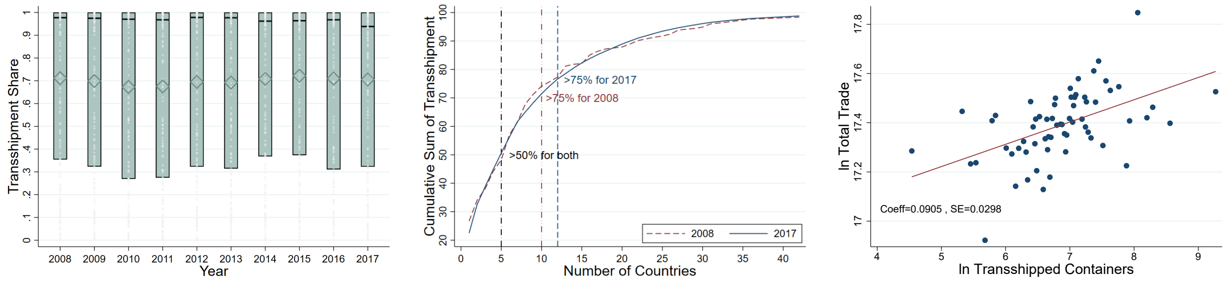
Figures and Tables

Figure 1: Stylized Facts on Transshipment Trends: 2008-2017

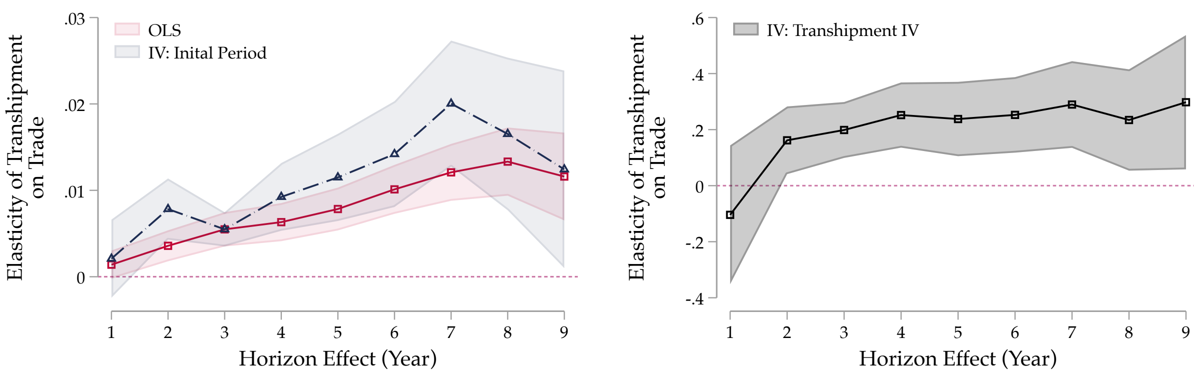


(a) Average Transshipment Share (b) Sum of Transshipment (c) Trade and Transshipment

Notes: Panel 1a plots the distribution of transshipment shares for the 224 origin countries in our data from 2008 to 2017. The 50th, 25th and 27th percentiles are indicated by a box plot. The mean is indicated by a diamond. The light gray dots are a scatter plot of the values for each year. Panel 1b plots the cumulative sum of transshipment activity for first 40 of the 123 intermediate hub countries in our data for years 2008 and 2017, in dashed red lines and solid blue lines respectively. The number of countries when the cumulative sum is more than 50% is 5 countries for both years (in dashed-dot black line). The number of countries when the cumulative sum is more than 75% is 10 for 2008 (dash-dot-dot red line) and 12 for 2017 (dashed blue line). Panel 1c plots the binned scatterplot at the country-level between total trade and transshipment volumes in TEUs, controlling for the hub country's annual GDP, to control for time-varying changes in these countries' openness and access to trade outcomes, as well as country-level fixed effects to control for fixed country-level characteristics and year fixed effects to control for aggregate changes over time. These results correspond to the regression results in Panel (a) Column (2) in Table A.2. Source: Panjiva bills of lading and authors' calculations.

Figure 2: Dynamic Horizon Effect - Local Projections

(a) Baseline OLS and t_1 IV (b) Transhipment IV



Notes: These figure plots the coefficients β^h that look at the effect transshipment over different horizons. The estimation is done in first differences at the HS 6-digit level (netting out origin-destination-product (HS-6)-pair effects) and includes origin-year-product(HS-2), destination-year-product (HS-2), and origin-destination-time fixed effect.

Table 1: Long-Run, Product-Level, International Trade and Transshipment Activity at Hubs, 2008 and 2017

(a) Total Transshipped Containers (TEU)

	(1) Total Trade	(2) Total Exports	(3) Total Imports	(4) Imports of Transshipped Goods
Transshipped Containers	0.0003	0.011	0.004	0.282
	(0.006)	(0.011)	(0.010)	(0.043)
R^2	0.99	0.98	0.99	0.92

(b) Count of Transshipped HS6 Products

	(1) Total Trade	(2) Total Exports	(3) Total Imports	(4) Im of Transshipped Goods
Transshipped Products	-0.009	0.064	-0.015	1.250
	(0.015)	(0.034)	(0.020)	(0.133)
R^2	0.99	0.98	0.99	0.92

(c) Count of Transshipped Trading Partners

	(1) Total Trade	(2) Total Exports	(3) Total Imports	(4) Im of Transshipped Goods
Transshipped Countries	-0.005	0.062	-0.007	1.134
	(0.020)	(0.037)	(0.023)	(0.156)
R^2	0.99	0.98	0.99	0.92
Hub-Year FE	✓	✓	✓	✓
Product-Year FE	✓	✓	✓	✓
Product-Hub FE	✓	✓	✓	✓
Observations	6,812	6,812	6,904	5,398

Notes: This table reports coefficients from regression: $Y_{dkt} = \alpha_0 + \alpha \text{Transshipment Measure}_{dkt} + \delta_{dt} + \gamma_{kt} + \rho_{dk} + \epsilon_{dkt}$ where Y_{dkt} is the trade outcome for hub country d's HS2 product k in year t. We include hub–year fixed effects (δ_{dt}) to control for time-varying shocks specific to each hub, product–year fixed effects (γ_{kt}) to capture global shocks by product and year, and hub–product fixed effects (ρ_{dk}) to absorb time-invariant persistent hub–product relationships. Standard errors are clustered at the hub country d level. All variables are in logs, trade variables are in thousands of current USD, and the sample covers 2008 and 2017. We study three transshipment measures: (a) Total Transshipped Containers is the total transshipment volumes (measured in TEUs) for a given HS2 product category k through country d in year t, (b) Count of Transshipped HS6 Products is the total number of HS6 products transshipped through country d for a given HS2 product category k in year t, (c) Count of Transshipped Trading Partners is the total number of countries that transship through hub country d. Column (1) reports results for total trade, Column (2) for total exports while Column (3) for total imports of country d for a given HS2 product category k in year t. Column (4) reports results for country d's total HS2-level imports (k) that were also transshipped through d in year t. Source: Panjiva bills of lading, CEPII BACI, Penn World Tables (Feenstra, Inklaar and Timmer, 2015), and authors' calculations.

Table 2: Impact of Transshipment on Imports: Short, Medium, and Long Term

	(1)	(2)	(3)	(4)	(5)	(6)
	$\Delta X_{o,d,k}$	$\Delta X_{o,d,k}$	$\Delta X_{o,d,k}$	$\Delta X_{o,d,k}$	$\Delta X_{o,d,k}$	$\Delta X_{o,d,k}$
Panel A: Short-Run 1-Year Differences						
$\Delta_1 \log Transshipped_{o,d,k}$	0.001	0.002	0.001	0.155	0.115	0.132
	(0.001)	(0.001)	(0.001)	(0.113)	(0.086)	(0.105)
Observations	889,373	889,373	889,373	889,373	889,373	889,373
Adj. R-Square	0.13	0.05	0.08	-0.37	-0.12	-0.15
First Stage F				77.62	125.63	88.89
Panel B: Medium-Run 3-Year Differences						
$\Delta_3 \log Transshipped_{o,d,k}$	0.004	0.003	0.004	0.288	0.312	0.329
	(0.002)	(0.002)	(0.002)	(0.180)	(0.162)	(0.171)
Observations	229,147	229,147	229,147	229,147	229,147	229,147
Adj. R-Square	0.15	0.09	0.11	-0.50	-0.44	-0.33
First Stage F				26.45	32.55	29.74
Panel C: Longer-Run 9-Year Differences						
$\Delta_9 \log Transshipped_{o,d,k}$	0.016	0.010	0.012	0.384	0.574	0.408
	(0.004)	(0.005)	(0.004)	(0.129)	(0.196)	(0.119)
Observations	64,053	64,053	64,053	64,053	64,053	64,053
Adj. R-Square	0.23	0.30	0.20	-0.56	-1.42	-0.37
First Stage F				67.16	33.00	80.46
Fixed Effects						
o, d, k_{HS2}, t	✓			✓		
o, k_{HS4} and d, k_{HS4}		✓			✓	
o, k_{HS2}, t and d, k_{HS2}, t			✓			✓
o, d, t		✓	✓		✓	✓

Notes: The dependent variable, $\Delta_3 \log X_{o,d,kt}$ is the 3-year change in the log of trade flow, in current USD, from exporter o to importer d in HS-6 product category k in year t. $\Delta_3 T_{o,d,k}$ is the 3-year change in the amount of goods transshipped from exporter o to the US via hub country d in k as defined in Equation (2). We look at stacked 3 year differences, to avoid overlapping differences. Panels (1)-(3) are run using ordinary least squares. Panels (4)-(6) use the geographic instrumentation strategy outlined in Equation (3). In addition to the first difference across o, d, and k (as the 6-digit harmonized system classification level), we run three different fixed effect specification. Columns (1) and (3) allow for time variation at the o and d pair within 2 digit-HS codes. Columns (2) and (5) allow for o, d, t time variation with trends in o-HS-4 and d-HS-4 digit levels. Column (3) and (6) replace the last fixed effects with those that absorb time-variation at the origin-HS-2 and destination HS-2 product levels. ■

Table 3: The Effects of Transshipping on Downstream Exports

Panel A: Short-Run 1-Year Differences						
	(1) OLS	(2) OLS	(3) OLS	(4) IV	(5) IV	(6) IV
$\Delta_1 \log T_{o,d,k,t}$	-0.0001	-0.0001	-0.0000†	-0.010	-0.002	-0.004
	(0.0000)†	(0.0000)†	(0.0000)†	(0.004)	(0.003)	(0.003)
$\Delta_1 \log T_{o,d,k,t} * Pct\ Input_{k,k'}$	0.001	0.001	0.001	0.063	0.082	0.076
	(0.001)	(0.001)	(0.001)	(0.043)	(0.051)	(0.051)
Observations (thousands)	12,126	12,126	12,126	12,126	12,126	12,126
First-stage F-stat				44.75	22.84	22.81
Panel B: Medium-Run 3-Year Differences						
$\Delta_3 \log T_{o,d,k,t}$	-0.0002	-0.0002	-0.0001	-0.020	0.004	-0.004
	(0.0001)	(0.0001)	(0.0001)	(0.008)	(0.003)	(0.003)
$\Delta_3 \log T_{o,d,k,t} * Pct\ Input_{k,k'}$	0.001	0.001	0.001	0.047	0.077	0.064
	(0.001)	(0.001)	(0.001)	(0.041)	(0.048)	(0.047)
Observations (thousands)	3,430	3,430	3,430	3,430	3,430	3,430
First-stage F-stat				11.49	12.47	12.45
Panel C: Long-Run 9-Year Differences						
$\Delta_9 \log T_{o,d,k,t}$	-0.001	-0.001	-0.001	-0.020	-0.015	-0.019
	(0.0003)	(0.0003)	(0.0002)	(0.004)	(0.005)	(0.004)
$\Delta_9 \log T_{o,d,k,t} * Pct\ Input_{k,k'}$	0.013	0.013	0.014	0.318	0.366	0.356
	(0.004)	(0.004)	(0.004)	(0.064)	(0.076)	(0.076)
Observations (thousands)	1,014	1,014	1,014	1,014	1,014	1,014
First-stage F-stat				22.11	14.77	14.78
Fixed Effects						
o, t	✓	✓		✓	✓	
d, t	✓	✓		✓	✓	
k, t		✓	✓		✓	✓
o, d, t			✓			✓

Notes: $X_{d,k',t}$ is the total export, in current USD, from country d to the rest of the world, leaving out transshipment origin country o, in industry k' in year t. $T_{o,d,k,t}$ is the volume of goods, in TEU, in industry k being transshipped from country o to the US via country d in year t. Δ_1, Δ_3, and Δ_9 denote one, three, and nine-period differences. $Pct\_Input_{k,k'}$ is the percentage of industry k''s total input expenditures coming from industry k, across all countries in 2008, calculated using the World Input-Output Database 2013 Release. Standard errors are clustered by origin-destination country pair. †First significant digit is hundred-thousandths place. ■

Transshipment Hubs, Trade, and Supply Chains

Part I

Supplemental Appendix:

Table of Contents

A Theory Model Of Transshipment and Supply Chains

In this section, we describe our trade model with roundabout production and transshipment. Fixed and variable transport costs in shipping give rise both to entrepôt usage and link export decisions across destinations.

A.1 Setup

Our model has three countries: Home (H) and two foreign destinations (A and B). Firms pay to enter, hire workers, produce domestically, and then choose to sell domestically or abroad. If they export, they further choose to export to A and/or B, as well as how to send their goods to the foreign destination(s)—shipping either directly or indirectly through the other country. In exporting, there are three types of trade costs involved. First, there are idiosyncratic fixed export costs that guarantee not all firms export to all destinations (even when firms ship through these destinations, using it as an indirect shipping location). Second, there are deterministic iceberg transport costs that make some routes more attractive than others on average. Third, there are idiosyncratic fixed transport costs which firms pay to use particular shipping routes. These fixed transport costs accomplish two goals: they link export decisions across export destinations via shipping on the same route, and guarantee heterogeneity in firms' shipping decisions. Production is roundabout, so that access to more imported varieties makes exports more competitively priced.

A.2 Demand

There are K industries in each country i, and a continuum of products within each industry. Production of product ω_l in each industry l uses labor and intermediates from other industries in a Cobb-Douglass production function with Constant Elasticity of Substitution (CES) nests:

$$q_{i,l}(\omega_l) = \prod_{k=1}^{K-1} \left[\int_{\Omega_{i,k}} q_{i,\omega}^{\frac{\sigma}{\sigma-1}} d\omega \right]^{\frac{\beta_{l,k}(\sigma-1)}{\sigma}} \cdot b(\omega_l)^{1-\sum_l \beta_{l,k}},$$

where $\Omega_{i,k}$ is the set of available goods or inputs in country i in industry k, $\beta_{l,k}$ is the Cobb-Douglas parameter governing industry l's usage of industry k's inputs, $b(\omega_l)$ is a product's labor demand, and σ is elasticity of substitution which (for convenience) is constant across industries and consumption.

The final good industry is industry $k = K$, which is consumed locally only and its demand from consumers follows a CES demand function:

$$U_i = \left[\int_{\Omega_{i,k}} q_{i,\omega_k}^{\frac{\sigma}{\sigma-1}} d\omega_k \right]^{\frac{(\sigma-1)}{\sigma}},$$

For all other industries $k = 1, ..., K-1$, demand is both domestic and foreign. Servicing foreign markets incur both shipping and non-shipping related trade costs (as explained further in Section A.4).

A.3 Firms

In order to enter and sell to the domestic market, firms pay a fixed cost of entry. Exporting firms further choose whether to export to one or both destination countries, and how to ship their goods to those countries. There are three types of trade costs incurred when exporting: (1) fixed export costs to the destinations, (2) bilateral iceberg transport costs between Home and the destinations, and (3) fixed transport costs to access shipping routes.

The (variable) profit of a firm making product ω_l in industry l selling either domestically or to the two foreign destinations ($n \in H, A, B$), before the export-related trade costs, is:

$$v\pi(\omega_l, n) \equiv \sum_k \beta_{k,l} X_n \left(\frac{p(\omega_l)}{P_{nk}}\right)^{1-\sigma}.$$

where X_n is the total expenditure in country n, $p(\omega_l)$ is the price of product ω_l, and P_{nk} is the price index of industry k in country n.

For a firm selling domestically, this equation above is their variable profit from domestic sales where $n = H$ since there is no cost incurred in shipping to their home market. To export to foreign destinations A or B, seller ω_l in any industry l pays a fixed cost $f_n^e(\omega_l)$ where $n = A, B$. For simplicity all fixed export and transport costs in the model will be drawn from the same positive, continuous distribution with a known mean and standard deviation $G(x)$.

A.4 Trade Costs of Exporting and Shipping

To export their goods to the foreign destinations, firms must pay (competitive) shipping companies to transport their goods along one or both shipping routes. Contracting with shipping companies and to send a quantity of $q(\omega_l)$ exports incurs two types of costs: a deterministic bilateral iceberg component that is variable, $\{\tau_{HA}, \tau_{AB}, \tau_{HB}\}$ where all of them are larger than 1, and a fixed stochastic transport cost component for each shipping route r ($f_r(\omega_l)$, where $r \in \{HAB, HBA\}$), which we discuss below. For simplicity, we assume that the bilateral iceberg costs are symmetric ($\tau_{AB} = \tau_{BA}$). Firms can choose to ship their goods directly or indirectly, and the resulting variable and fixed transport costs will be different based on their choice.

Variable iceberg transport costs If firms export to A or B directly, then the export profits they receive *before the fixed transport costs*, are respectively

$$\underbrace{\frac{v\pi(\omega_l, A)}{\tau_{HA}} - f_A^e(\omega_l)}_{\substack{\text{Export profits to A} \\ \text{when shipping to A directly}}}, \quad \underbrace{\frac{v\pi(\omega_l, B)}{\tau_{HB}} - f_B^e(\omega_l)}_{\substack{\text{Export profits to B} \\ \text{when shipping to B directly}}}$$

If they export to A or B indirectly through B, *net of fixed shipping costs*, then they receive, respectively

$$\underbrace{\frac{\upsilon\pi(\omega_l, A)}{\tau_{HB}\tau_{AB}} - f_A^e(\omega_l)}_{\substack{\text{Export profits to A} \\ \text{when shipping indirectly via B}}} \quad , \quad \underbrace{\frac{\upsilon\pi(\omega_l, B)}{\tau_{HA}\tau_{AB}} - f_B^e(\omega_l)}_{\substack{\text{Export profits to B} \\ \text{when shipping indirectly via A}}} \quad .$$

note that due to our symmetry assumption for the bilateral iceberg transport costs, the cost is the same for transporting between A and B ($\tau_{AB} = \tau_{BA}$).

Without fixed transport costs and with the imposition of triangle inequality in iceberg costs, both of the export profits for indirect shipping will be dominated by the profits for direct shipping. Furthermore, without fixed transport costs, exporting to A and exporting to B will be separable decisions. However, since both indirect and direct shipping behaviors are present in our data, we include fixed transport costs in order to match our empirical observations.

Fixed transport costs In order to ship their goods to final destinations, firms have to pay a fixed cost to book the shipping routes that are offered by shipping countries. There are (for simplicity) two shipping routes Route one moves ships in a specific order from Home, to A, and then to B (termed route $r = HAB$). Route two instead moves ships from Home, to B, and then to A (termed route $r = HBA$).[1]

The total shipping cost of moving $q(\omega_l)$ from Home (H) to A directly would require booking on route HAB which in turn incurs the bilateral iceberg cost τ_{HA} and the fixed cost $f_{HAB}(\omega_l)$.

$$q(\omega_l)\tau_{HA} + f_{HAB}(\omega_l)$$

On the other hand, moving the same goods from H to B directly would require paying for the iceberg cost τ_{HB} and the fixed cost $f_{HBA}(\omega_l)$. booking route HBA.

$$q(\omega_l)\tau_{HB} + f_{HBA}(\omega_l)$$

For indirect shipping, the cost to move the same goods from H to A via B would require booking on route HBA which in turn incurs two bilateral iceberg costs, τ_{HB} and $\tau_{BA} = \tau_{AB}$, and the fixed cost $f_{HBA}(\omega_l)$.

$$q(\omega_l)\tau_{H,B}\tau_{AB} + f_{HBA}(\omega_l)$$

Similarly, the cost to move the same goods from H to B via A would require booking route HAB which in turn incurs two bilateral iceberg costs, τ_{HA} and $\tau_{BA} = \tau_{AB}$, and the fixed cost $f_{HAB}(\omega_l)$.

$$q(\omega_l)\tau_{HA}\tau_{AB} + f_{HAB}(\omega_l)$$

Consider a firm exporting to both A and B. Shipping to both countries directly would result in some savings on iceberg transport costs. However, to ship to both directly, firms have to pay the fixed transport costs twice, once to book route HAB, (i.e. f_{HAB} to ship directly from H to A), and again to book route HBA (i.e. f_{HBA} to ship directly from H to B). The scale economy mechanism here is that once one of the fixed costs (either f_{HBA} or

[1]We can easily expand this to include a larger variety.

f_{HAB}) is paid, shipping to one country indirectly through the other reduces the amount of fixed costs firms have to pay.

A.5 Export and Shipping decisions

Because of the fixed transport costs associated with shipping, the export decisions to A and B from Home are linked.

With lower fixed costs of export to a country (all else equal), a firm will be more likely to export to it. With low enough fixed transport costs on a route (all else equal), a firm will be more likely to take it, either to ship directly or indirectly. When all fixed cost draws are low (and the triangle inequality is imposed) firms export to both countries and do so directly to economize on iceberg transport costs.

We explore the firm decision by first examining the export decision for a given shipping decision, then examine the shipping decision. There are four possible shipping decisions:

Case I: No Contract In this case, the firm does not export. Export profits are zero: $\pi(\omega_l, n) = 0$ for $n = A, B$.

Case II: Booking on HAB Route In this case, the firm has paid the fixed transport cost of booking route HAB ($f_{HAB}(\omega_l)$). It will export to A directly if its fixed export draw to A is low enough. It will export to B using A as an entrepôt if its fixed costs to export to B are low enough. Exporting profits will be

$$\pi(\omega_l) = \underbrace{\max\{\frac{v\pi(\omega_l, A)}{\tau_{HA}} - f^e_A(\omega_l), 0\}}_{\text{Direct export to A}} + \underbrace{\max\{\frac{v\pi(\omega_l, B)}{\tau_{HA}\tau_{AB}} - f^e_B(\omega_l), 0\}}_{\text{Indirect export to B via A}} - \underbrace{f_{HAB}(\omega_l)}_{\text{Fixed cost to book route } HAB}.$$

Note that in this case, the firm ships to A only when the fixed export cost to A is low enough. If the fixed export costs to B is low enough to merit export to B, but the fixed export costs to A is too high, then the firm will use A as an entrepôt to B without exporting to A. If the reverse is true (fixed export cost to B is too high, fixed export costs to A are low), then the firm will simply export directly to A. If both the fixed export costs are too high to merit exporting, this option is dominated by Case I.

Case III: Booking of HBA Route In this case, the firm has paid $f_{HBA}(\omega_l)$ which is the fixed transport cost for route HBA. It will export to B directly if its fixed export draw to A is low enough. It will export to A using B as an entrepôt if its fixed costs to export to A are low enough. In this case, profits are

$$\pi(\omega_l) = \underbrace{\max\{\frac{v\pi(\omega_l, B)}{\tau_{HB}} - f^e_B(\omega_l), 0\}}_{\text{Direct export to B}} + \underbrace{\max\{\frac{v\pi(\omega_l, A)}{\tau_{HB}\tau_{AB}} - f^e_A(\omega_l), 0\}}_{\text{Indirect export to A via B}} - \underbrace{f_{HBA}(\omega_l)}_{\text{Fixed cost to book route } HBA}.$$

The analysis is symmetric to that in Case II.

Case IV: Contract With Both In this case, the firm has paid both $f_{HAB}(\omega_l)$ and $f_{HBA}(\omega_l)$. It will export to both A and B and do so directly. If the fixed export costs to either do not justify doing so, this option is dominated by the other cases. Profits in this case are

$$\pi(\omega_l) = \underbrace{\max\{\frac{\upsilon\pi(\omega_l, B)}{\tau_{HB}} - f_B^e(\omega_l), 0\}}_{\text{Direct export to B}} + \underbrace{\max\{\frac{\upsilon\pi(\omega_l, A)}{\tau_{HA}} - f_A^e(\omega_l), 0\}}_{\text{Direct export to A}} - \underbrace{f_{HAB}(\omega_l) - f_{HBA}(\omega_l)}_{\text{Fixed cost to book both routes}}.$$

Knowing their fixed export costs, firms can determine their profits in each of these cases. Working backwards, firms choose which fixed transport costs to pay based on their fixed export costs and the subsequent outcomes.

A.6 Equilibrium

The four idiosyncratic fixed costs in the model smooth the shipping and exporting decisions, resulting in the following proposition

Proposition 1. *In equilibrium, each of the following behaviors are exhibited by a positive mass of operating firms:*

1. *Domestic sales only.*
2. *Direct sales to A only.*
3. *Direct sales to B only.*
4. *Indirect sales to A through B, only.*
5. *Indirect sales to B through A, only.*
6. *Direct sales to A in conjunction with indirect sales to B through A.*
7. *Direct sales to B in conjunction with indirect sales to A through B.*

Proof Outline. The idiosyncratic draws combined with the fixed-variable cost trade-offs ensure each of these occur for some region of the 4-dimensional joint distribution of fixed cost draws.

Proposition 2. *A reduction in the distribution of fixed export costs f_B^e, or an increase in demand at B increases the likelihood that a firm exports to A.*

Proof Outline. The increase in firms exporting to B can come from one of 2 margins: (1) firms who are not exporters or (2) firms already exporting to A. Of those in the 2nd margin, direct export to A was profitable already, and therefore export to B, whether it happens through using A as an entrepôt, or directly through paying a second fixed shipping cost, will not reduce the number of A exporters (see Case III). More interestingly, the first margin can be decomposed into two groups, those who elect to pay $f_{HBA}(\omega_l)$, who ship directly to

B, and those who elect to pay $f_{HAB}(\omega_l)$, who use A as an entrepôt to B. For the latter, since they were not exporters previously, the combined fixed costs $f_{HAB}(\omega_l) + f_A^e(\omega_l)$ were previously prohibitive. However, the marginal fixed cost of exporting to A conditional on paying $f_{HAB}(\omega_l)$ is only $f_A^e(\omega_l)$. This effectively lowers the fixed cost of export to A by $f_{HAB}(\omega_l)$, inducing some of those firms to export.

A more subtle point is that of those electing to pay $f_{HAB}(\omega_l)$ to export to B, the profitability of additionally selling at A induced export to B; intuitively, the new larger market at B might not be enough to induce entry for some on its own, but the bonus of now also being able to sell to A makes the fixed shipping cost worth paying.

Finally, an increase in transshipment in a particular industry k reduces costs through the price index differentially for industries using k's products more intensively. This, in turn, increases exports.

Proposition 3. *Given industries l, l' and k, an increase in demand at B for goods in industry k results in a differential increase X_{AH} in l where $\beta_{kl} > \beta_{kl'}$.*

Proof Outline. By Proposition 2, an increase in demand from B increases exports from H to A in industry k. That differentially reduces the price index in industries to which k contributes a larger share of the price index. That in turn differentially reduces costs and increases the margin of profitable exporters from A to H in industry l. So long as there are no general equilibrium reversals of these forces, the increased transshipment due to the increased demand at B has downstream supply chain effects on A's exports.

B Stylized Facts: Additional Tables and Figures

This section presents additional tables and figures from the Section 2 on data and stylized facts.

Transshipment Share by Trade Quartiles From Stylized Fact 1, we divide origin countries into four quartiles based on their 2008 trade value with the US. Figure A.1 shows that lower-quartile countries have higher transshipment shares, as top-quartile countries are large enough to ship directly by fully utilizing vessel capacity.

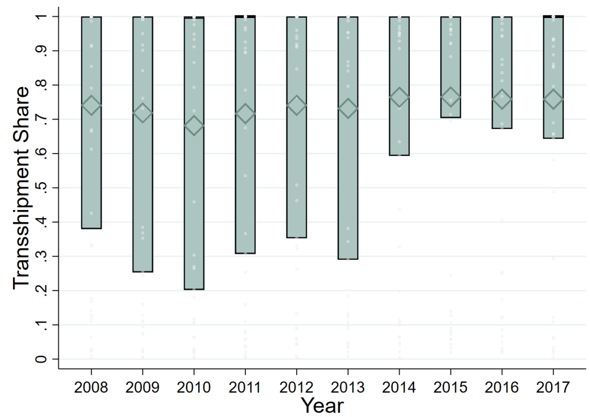
By dividing the origin countries into four quartiles by their trade values with the US in the first year of our data (year 2008), Figure A.1 shows that there are significant differences in the transshipment share distribution by quartiles. The lower three quartiles of countries have relatively high transshipment shares compared to the highest quartile countries, since larger countries trade enough with the US so they can better utilize the capacity of entire ships and send their goods directly. The lowest (first) quartile countries have a median transshipment share of one for all ten years, with an average share of 79% in 2008 and decreases marginally to 74% in 2017 (Figure A.1a). The second quartile countries also have a median transshipment share of one for all ten years, but with a slight increase in mean transshipment shares from 74% in 2008 to 76% in 2017 (Figure A.1b). The third quartile countries have a median transshipment share that is very high (95-98 %), and a mean share that hovers around 70% to 75% (Figure A.1c). The fourth quartile countries have the lowest transshipment shares, which may be unsurprising since they trade directly. Here the median shares increase from 59% to 64% in 2017, dipping down to 49% in 2011 (Figure A.1d). The average shares stayed around 61%, with a similar dip in 2011 to 57%. All in all, the different changes in transshipment shares across the countries in different trade quartiles have resulted in a relatively stable 70% average over the last ten years.

Transshipment Activity - Top 30 Countries From Stylized Fact 2, Table A.1 shows the top 30 countries with the highest percent of transshipment activity in 2017, comparing them to their rankings in year 2008.

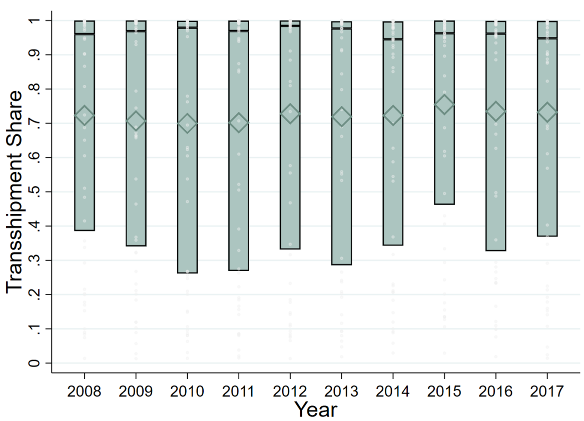
International Trade Values and Transshipment Activity Is transshipment activity linked with hub countries' other aggregate trade flow? Table A.2 presents our correlation results, highlighting the positive relationship between trade and transshipment changes over the ten-year sample. Table A.3 presents similar positive correlations using trade quantities, measured in metric tons.

Figure A.1: Transshipment Share by Trade Quartiles from 2008 to 2017

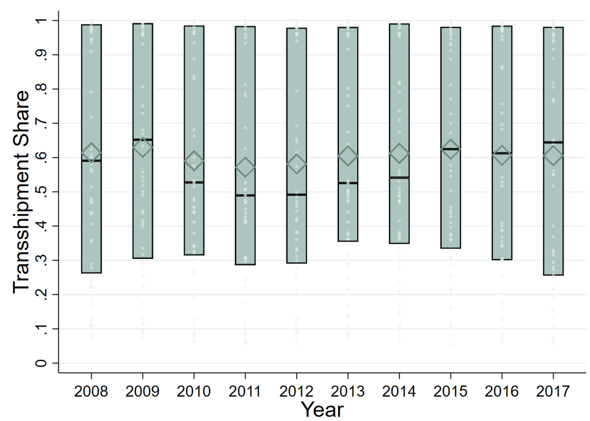
(a) Lowest Quartile (First)



(b) Second Quartile



(c) Third Quartile



(d) Highest Quartile (Fourth)

Notes: This figure plots the distribution of transshipment shares for the 224 origin countries in our data from 2008 to 2017, broken down by four quartiles using their export value to the US in year 2008. Each panel indicates each trade quartile as labelled. For all panels, the 50th, 25th and 27th percentiles are indicated by a box plot. The mean is indicated by a diamond. The light gray dots are a scatterplot of the values for each year. For all years in Panel (a) and most years in Panel (b), the median is one which is why the black horizontal line within the box plot is hard to see. Source: Panjiva bills of lading and authors' calculations.

Table A.1: Transshipment Activity - Top 30 Countries, 2017 compared to 2008

(1)	(2)	(3)	(4)	(5)
Country	2017 Hub Rank	2017 Transship. (%)	2008 Hub Rank	2008 Transship. (%)
China	1	22.49	1	26.71
South Korea	2	10.06	3	7.35
Panama	3	6.24	8	3.97
Singapore	4	6.05	5	6.13
Belgium	5	5.81	7	4.09
Hong Kong	6	5.50	2	8.76
Germany	7	5.50	6	4.47
Taiwan	8	3.45	4	6.41
Netherlands	9	3.29	10	3.45
Spain	10	3.06	12	2.79
Guatemala	11	2.74	14	1.54
Mexico	12	2.46	13	1.65
Bahamas	13	1.94	9	3.84
Colombia	14	1.94	22	0.65
Portugal	15	1.78	34	0.24
Jamaica	16	1.52	11	3.05
Italy	17	1.41	16	1.28
Oman	18	1.25	20	0.84
Vietnam	19	1.25	51	0.04
Canada	20	1.18	25	0.59
Sri Lanka	21	1.07	19	1.10
Honduras	22	1.04	17	1.18
Malaysia	23	0.81	24	0.59
Dominican Republic	24	0.80	26	0.56
France	25	0.79	28	0.45
United Kingdom	26	0.62	23	0.65
Costa Rica	27	0.61	15	1.47
Netherlands Antilles	28	0.49	33	0.26
Chile	29	0.49	32	0.27
New Zealand	30	0.47	27	0.46

***Notes*:** This table lists the top 30 countries by percent of transshipment activity in year 2017 and compares the same list of countries to their rank ten years ago in 2008. The percent of transshipment activity is defined as the total of transshipped containers in these countries divided by the worldwide total of transshipped containers that year and multiplied by 100. Column (1) lists the country names while Column (2) lists the rank of these countries in 2017. Column (3) reports the percent of transshipment activity in 2017. Columns (4) and (5) report the rank of the same countries as well as their transshipment activity in 2008 respectively.

Table A.2: International Trade Values and Transshipment Activity at Hubs over the Long Run, between 2008 and 2017

(a) Total Transshipped Containers (TEU)

	(1) Total Trade	(2) Total Trade	(3) Exports	(4) Imports
Transshipped Containers	0.113	0.091	0.109	0.061
	(0.034)	(0.030)	(0.045)	(0.030)
GDP per Capita		0.406	0.377	0.441
		(0.124)	(0.150)	(0.076)
Hub Country FE	✓	✓	✓	✓
Year FE	✓	✓	✓	✓
Observations	204	204	204	204
R^2	0.99	0.99	0.99	0.99
F	10.99	10.61	5.77	21.43

(b) Count of Transshipped HS6 Products

	(1) Total Trade	(2) Total Trade	(3) Exports	(4) Imports
Transshipped Products	0.117	0.087	0.066	0.071
	(0.050)	(0.041)	(0.050)	(0.044)
GDP per Capita		0.433	0.426	0.454
		(0.137)	(0.170)	(0.083)
Hub Country FE	✓	✓	✓	✓
Year FE	✓	✓	✓	✓
Observations	204	204	204	204
R^2	0.99	0.99	0.98	0.99
F	5.46	7.37	4.33	17.63

(c) Count of Transshipped Trading Partners

	(1) Total Trade	(2) Total Trade	(3) Exports	(4) Imports
Transshipped Countries	0.139	0.100	0.075	0.078
	(0.057)	(0.047)	(0.053)	(0.053)
GDP per Capita		0.429	0.423	0.453
		(0.135)	(0.168)	(0.082)
Hub Country FE	✓	✓	✓	✓
Year FE	✓	✓	✓	✓
Observations	204	204	204	204
R^2	0.99	0.99	0.98	0.99
F	5.87	7.49	4.36	17.98

Notes: This table reports coefficients from regression: $Y_{dt} = \beta_0 + \beta\text{Transshipment Measure}_{dt} + \text{GDP per Capita}_{dt} + \delta_d + \gamma_t + \epsilon_{ht}$, where Y_{dt} is log trade outcomes for hub country d in year t, and Transshipment Measure_{dt} is the log of our measures of transshipment activities en-route to the US in the same year t. We include GDP per Capita_{dt}, the hub country's GDP in year t, to control for time-varying changes in these countries' openness and access to trade outcomes, as well as country-level fixed effects δ_d to control for fixed country-level characteristics and year fixed effects γ_t to control for aggregate changes over time. Standard errors are clustered at the country level. All variables are in logs, trade variables are in thousands of current USD, and the sample covers 2008 and 2017. We study three transshipment measures: (a) Total Transshipped Containers is the total transshipment volumes (measured in TEUs) through country d in year t, (b) Count of Transshipped HS6 Products is the total number of HS6 products transshipped through country d in year t, (c) Count of Transshipped Trading Partners is the total number of countries that transship through hub country d. Columns (1) and (2) present results for total trade, where Column (1) excludes the GDP control. Column (3) reports results for exports, while Column (4) focuses on imports. Source: Panjiva bills of lading, CEPII BACI, Penn World Tables (Feenstra, Inklaar and Timmer, 2015), and authors' calculations.

Table A.3: International Trade Quantities and Transshipment Activity at Hubs over the Long Run, between 2008 and 2017 - By Weight

(a) Total Transshipped Containers (TEU)

	(1) Total Trade	(2) Total Trade	(3) Exports	(4) Imports
Transshipped Containers	0.103	0.090	0.136	0.054
	(0.032)	(0.032)	(0.051)	(0.031)
GDP per Capita		0.234	0.168	0.267
		(0.131)	(0.119)	(0.121)
Hub Country FE	✓	✓	✓	✓
Year FE	✓	✓	✓	✓
Observations	204	204	204	204
R^2	0.98	0.98	0.97	0.97
F	10.33	7.11	4.32	5.32

(b) Count of Transshipped HS6 Products

	(1) Total Trade	(2) Total Trade	(3) Exports	(4) Imports
Transshipped Products	0.111	0.092	0.081	0.072
	(0.039)	(0.038)	(0.054)	(0.042)
GDP per Capita		0.259	0.229	0.274
		(0.144)	(0.149)	(0.127)
Hub Country FE	✓	✓	✓	✓
Year FE	✓	✓	✓	✓
Observations	204	204	204	204
R^2	0.98	0.98	0.97	0.97
F	8.26	5.88	4.08	4.66

(c) Count of Transshipped Trading Partners

	(1) Total Trade	(2) Total Trade	(3) Exports	(4) Imports
Transshipped Countries	0.147	0.125	0.099	0.099
	(0.045)	(0.045)	(0.057)	(0.052)
GDP per Capita		0.247	0.223	0.264
		(0.143)	(0.147)	(0.126)
Hub Country FE	✓	✓	✓	✓
Year FE	✓	✓	✓	✓
Observations	204	204	204	204
R^2	0.98	0.98	0.97	0.97
F	10.44	6.73	4.39	5.00

Notes: This table reports coefficients from regression: $Y_{dt} = \beta_0 + \beta \text{Transshipment Measure}_{dt} + \text{GDP per Capta}_{dt} + \delta_d + \gamma_t + \epsilon_{ht}$, where Y_{dt} is log trade outcomes for hub country d in year t, and Transshipment Measure$_{dt}$ is the log of our measures of transshipment activities en-route to the US in the same year t. We include GDP per Capita$_{dt}$, the hub country's GDP in year t, to control for time-varying changes in these countries' openness and access to trade outcomes, as well as country-level fixed effects δ_d to control for fixed country-level characteristics and year fixed effects γ_t to control for aggregate changes over time. Standard errors are clustered at the country level. All variables are in logs, trade variables are measured in metric tons, and the sample covers 2008 and 2017. We study three transshipment measures: (a) Total Transshipped Containers is the total transshipment volumes (measured in TEUs) through country d in year t, (b) Count of Transshipped HS6 Products is the total number of HS6 products transshipped through country d in year t, (c) Count of Transshipped Trading Partners is the total number of countries that transship through hub country d. Columns (1) and (2) present results for total trade, where Column (1) excludes the GDP control. Column (3) reports results for exports, while Column (4) focuses on imports. Source: Panjiva bills of lading, CEPII BACI, Penn World Tables (Feenstra, Inklaar and Timmer, 2015), and authors' calculations.

C Static Estimation: Additional Tables

Main Estimation In Appendix Table A.4, we present first stage results for our main specifications.

Robustness Checks We conduct a number of robustness checks to test the strength of ours results. First, we re-run out main specification on the extensive margin of transshipment on trade flows, replication of Table 2 but using an indicator variable for transhipping a good from o to the US via d over a three year horizon. We find large effects. But we note that identification in the IV case is highly limited due to the limited number of switchers and caution extrapolation from these results. See table A.5 for the baseline 3-period results.

Placebo Tests We consider a set of "placebo" correlations where we compare transshipment in one industry to imports in others. To the extent that our product-level regressions are picking up coefficients that are effects based on the mechanism outlined in our model, transshipment in one product category should not predict imports in any other.

If our placebo tests do return positive results, and transshipment in one product category increases imports in another, a likely mechanism driving this result would be that transshipment increases market access more broadly. If increased transshipment brings larger or more frequent boats, this could lower trade costs for all imports from the transshipment's origin country. For this reason, our placebos will double as tests for broader market access effects of transshipment.

In particular, we will adjust our main specifications to examine the effect of transshipment of all products in k's 4-digit HS code (industry) except for the 6-digit product code itself:

$$\Delta_{t-t_0} \log X_{i,j,k',t} = \alpha_1 \Delta_{t-t_0} \log \left(\sum_{k' \in K_{HS_4} \setminus k} \widetilde{T}_{i \to j \to US,k,t} \right) + \gamma_{i,j,t} + \gamma_{j,k_{HS_2},t} + \gamma_{i,k_{HS_2},t} + \epsilon_{i,j,k,t}.$$

We use this specification as our preferred for both OLS and our instrumental variable's second stage, in conjunction with our alternative robustness specifications with fixed effects as in Tables 3 through 5.

Table A.6 reports our results for 3-year lags. In Column (3), our preferred specification, our coefficients drop by two thirds in magnitude – conforming to the zero effect we find in 1-year lags, and our IV results in column (6) are similarly indistinguishable from zero. Results with alternative fixed effects have OLS and instrumental results are indistinguishable from zero.

In Table A.7, we modify our fixed effects: removing industry controls. If market access effects exist but affect all import categories evenly, time-varying fixed effects at the HS2 level will absorb the effect. Removing these, we allow for broad market effects in the medium run. Here, the OLS and instrument for our main specifications are negative but indistinguishable from zero as well.

Table A.4: First Stage: Instrumental Variable Regressions: 3-year Horizon

	(1) $\Delta_3 \log Transshipped_{o,d,k}$	(2) $\Delta_3 \log Transshipped_{o,d,k}$	(3) $\Delta_3 \log Transshipped_{o,d,k}$
$IV_{o,d,k}$	0.146	0.166	0.143
	(0.0266)	(0.0289)	(0.0259)
Observations	229,147	229,147	229,147
Adj. R-Square	0.09	0.03	0.07
F-Stat	26.45	32.55	29.74
Fixed Effects			
o, d, k_{HS2}, t	✓		
o, k_{HS4} and d, k_{HS4}		✓	
o, k_{HS2}, t and d, k_{HS2}, t			✓
o, d, t		✓	✓

Notes: Results here are the first stage results for regression in Table 2. See main text and Table 2 for details. ■

Table A.5: The Medium-Run Effects of Transshipment on Imports: Extensive Margin

	(1) $\Delta_3 \log X_{o,d,k}$	(2) $\Delta_3 \log X_{o,d,k}$	(3) $\Delta_3 \log X_{o,d,k}$	(4) $\Delta_3 \log X_{o,d,k}$	(5) $\Delta_3 \log X_{o,d,k}$	(6) $\Delta_3 \log X_{o,d,k}$
$\Delta_3 \mathbb{I}^{Transshipped}_{o,d,k}$	0.0184	0.0151	0.0184	4.141	3.522	4.038
	(0.00370)	(0.00363)	(0.00362)	(0.974)	(1.044)	(0.916)
Observations	10,501,194	10,712,372	10,734,814	10,501,194	10,712,372	10,734,814
Adj. R-Square	0.06	0.04	0.03			
First Stage F				160.05	136.85	185.34
Fixed Effects						
o, d, k_{HS2}, t	✓			✓		
o, k_{HS4} and d, k_{HS4}		✓			✓	
o, k_{HS2}, t and d, k_{HS2}, t			✓			✓
o, d, t		✓	✓		✓	✓

Notes: Results here replicate regression in Table 2, except with the extensive margin of trade (a binary variable) as the outcome variable. See main text and Table 2 for details. ■

Table A.6: Placebo for Within-Pair Market Access: Medium Run

	(1) $\Delta_3 X_{o,d,k}$	(2) $\Delta_3 X_{o,d,k}$	(3) $\Delta_3 X_{o,d,k}$	(4) $\Delta_3 X_{o,d,k}$	(5) $\Delta_3 X_{o,d,k}$	(6) $\Delta_3 X_{o,d,k}$
$\Delta_3 \log \widetilde{T}_{o,d,k}$	0.00140	-0.00172	0.00102	0.673	1.374	0.889
	(0.00293)	(0.00292)	(0.00275)	(0.614)	(1.224)	(0.705)
Observations	137,574	139,777	140,390	137,492	139,690	140,309
Adj. R-Square	0.11	0.06	0.09	-0.70	-2.55	-1.06
First Stage F				6.87	2.63	5.76
Fixed Effects						
o, d, k_{HS2}, t	✓			✓		
o, k_{HS4} and d, k_{HS4}		✓			✓	
o, k_{HS2}, t and d, k_{HS2}, t			✓			✓
o, d, t		✓	✓		✓	✓

Notes: The dependent variable, $\Delta_3 \log X_{odkt}$ is the 3-year change in the log of trade flow, in current USD, from exporter o to importer d in HS-6 product category k in year t. $\widetilde{T}_{o,d,k}$ is the amount of goods transshipped from o to the US via country d in a HS-4 digit sector, but excluding the six digit HS-6 code k. We look at stacked, non-overlapping 3 year differences here over the entire time period. Panels (1)-(3) are run using ordinary least squares. Panels (4)-(6) use the geographic instrumentation strategy outlined in Equation (3). In addition to the first difference across o, d, and k (as the 6-digit harmonized system classification level), we run three different fixed effect specification. Columns (1) and (3) allow for time variation at the o and d pair within 2 digit-HS codes. Columns (2) and (5) allow for o, d, t time variation with trends in o-HS-4 and d-HS-4 digit levels. Column (3) and (6) replace the last fixed effects with those that absorb time-variation at the origin-HS-2 and destination HS-2 product levels. ■

Table A.7: Placebo for Broad Market Access: Medium Run

	(1) $\Delta_3 \widetilde{X}_{o,d,k}$	(2) $\Delta_3 \widetilde{X}_{o,d,k}$	(3) $\Delta_3 \widetilde{X}_{o,d,k}$	(4) $\Delta_3 \widetilde{X}_{o,d,k}$	(5) $\Delta_3 \widetilde{X}_{o,d,k}$	(6) $\Delta_3 \widetilde{X}_{o,d,k}$
$\Delta_3 \log transhipment_{o,d,k}$	0.00187	0.00138	-0.00345	0.122	2.352	-0.193
	(0.00276)	(0.00267)	(0.00339)	(0.0649)	(3.326)	(0.299)
Observations	140,079	140,692	136,015	140,079	140,692	136,015
Adj. R-Square	0.03	0.08	0.12	-0.14	-7.01	-0.35
First Stage F				400.49	0.68	38.43
Fixed Effects						
o, k_{HS4} and d, k_{HS4}	✓			✓		
o, k_{HS2}, t and d, k_{HS2}, t		✓			✓	
o, k_{HS4}, t and d, k_{HS4}, t			✓			✓

Notes: The dependent variable, $\Delta_3 \log X_{odkt}$ is the 3-year change in the log of trade flow, in current USD, from exporter o to importer d in HS-6 product category k in year t. $Transshipment_{o,d,k}$ is the amount of goods transshipped from o to the US via country d in a HS-4 digit sector, but excluding the six digit HS-6 code k. We look at stacked, non-overlapping 3 year differences here over the entire time period. Panels (1)-(3) are run using ordinary least squares. Panels (4)-(6) use the geographic instrumentation strategy outlined in Equation (3). We use a weaker set of fixed effects than in Table A.6and omit origin-destination fixed effects of any kind. ■

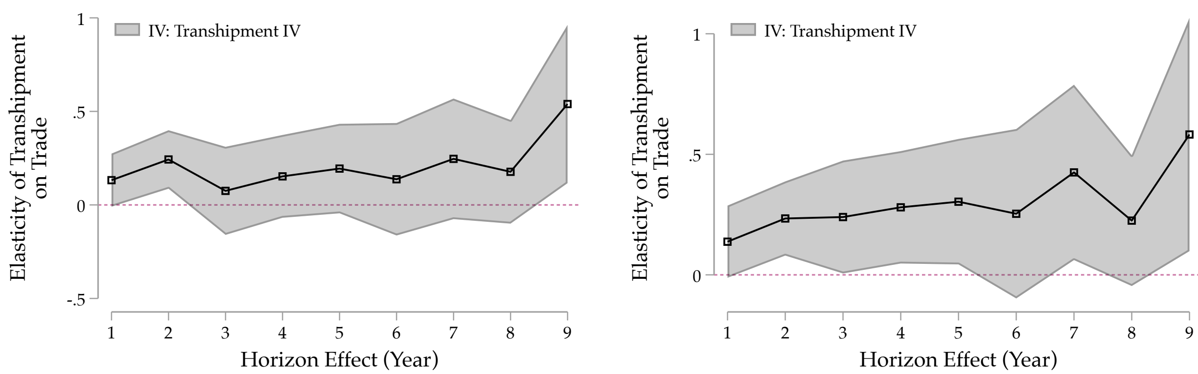
D Dynamic Estimation: Additional Figures

In this section, we show robustness for Section 3.2. Figure A.2 shows robustness for Figure 2 with different initial event windows. Similarly, Figure A.3 and A.4 show robustness for Figure 2 using differnt fixed effect specification.

Figure A.2: Dynamic Horizon Effect - Local Projections - IV Robustness (for appendix, or swap with fig 2b)

(a) Baseline OLS and t_1 IV

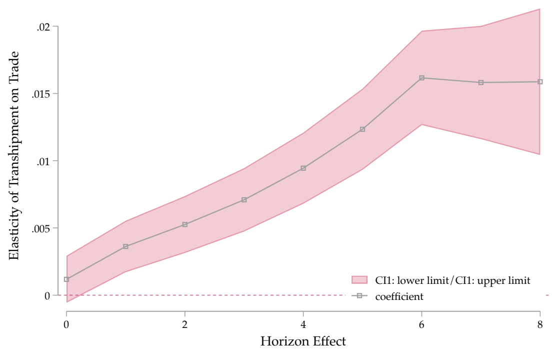
(b) Transhipment IV



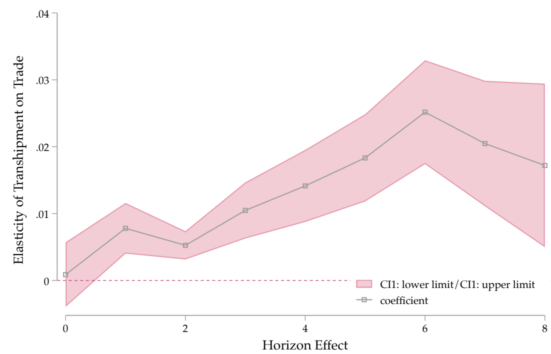
Notes: These figure plots the coefficients β^h that look at the effect transshipment over different horizons. The estimation is done in first differences at the HS 6-digit level (netting out origin-destination-product (HS-6)-pair effects) and includes origin-year-product(HS-2), destination-year-product (HS-2), and origin-destination-time fixed effect.

Figure A.3: Dynamics - Alternative Fixed Effects

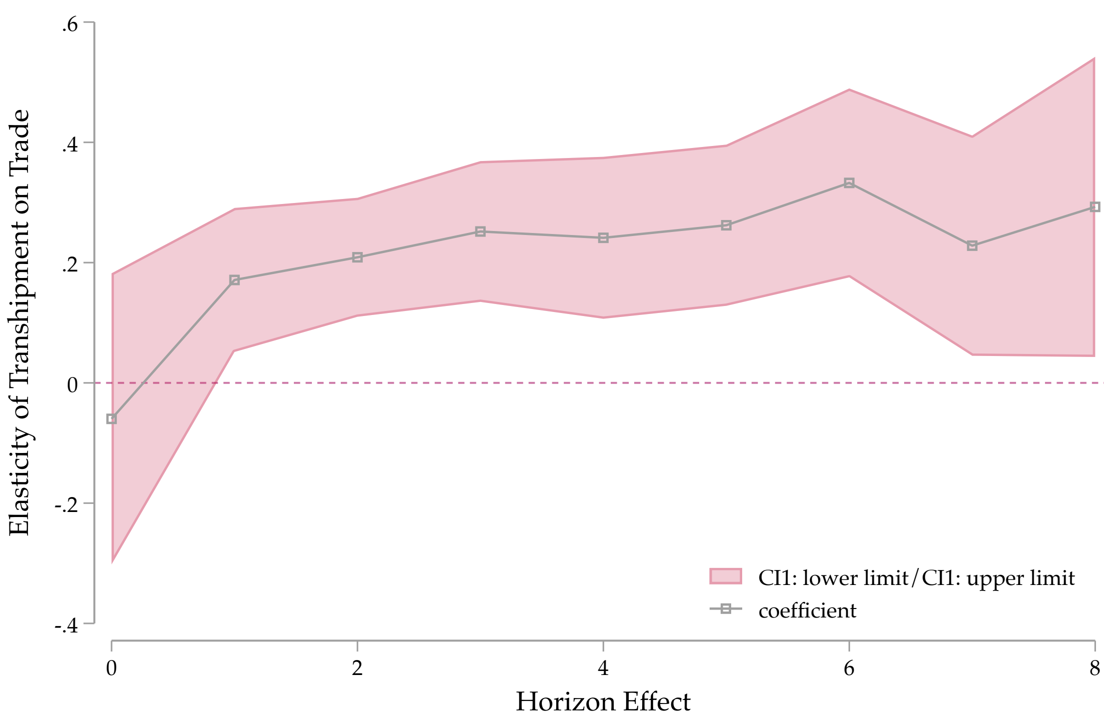
(a) Local Projection: OLS



(b) Local Projection: First Period IV



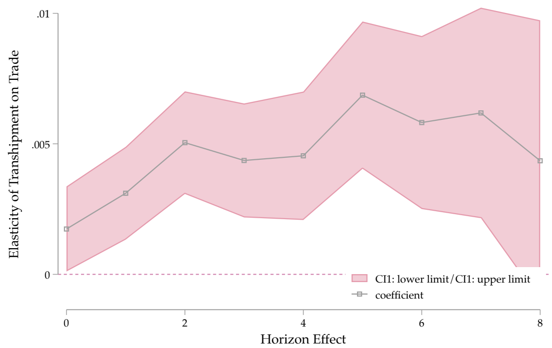
(c) Local Projection: First Period Geographic IV



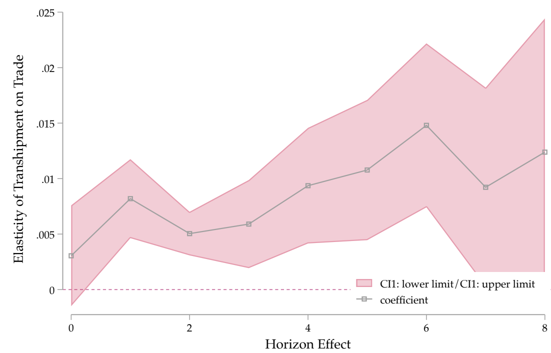
Notes: This replicates the figures in the text, but with origin-destination-HS 2-digit-year fixed effects. Panel (a) includes OLS results, panel (b) uses the initial period as an IV for all periods, panel (c) uses our initial IV for all periods.

Figure A.4: Dynamics - Alternative Fixed Effects

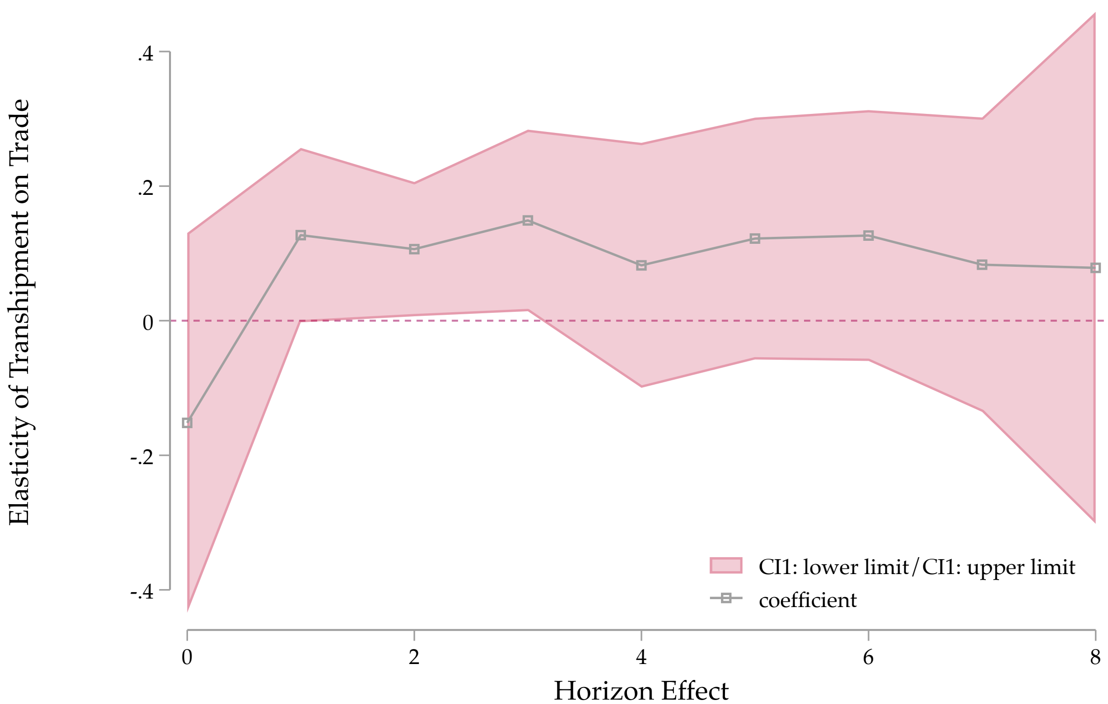
(a) Local Projection: OLS



(b) Local Projection: First Period IV



(c) Local Projection: First Period Geographic IV



Notes: This replicates the figures in the text, but with origin-HS 4-digit, destination-HS 4-digit, and origin-destination-year fixed effects. Panel (a) includes OLS results, panel (b) uses the initial period as an IV for all periods, panel (c) uses our initial IV for all periods.

E Supply Chain Estimation: Additional Tables

We conduct a number of robustness checks to test the strength of ours results. In A.8 we replicate our baseline results in Table 3 using all WIOT sectors (including raw materials and agricultural products). Although the one and three year results are noisier, and the 9-year difference is slightly more modest, the table largely replicates the results of the manufactured product sample. Next, in Table A.9, we explore extensive margin changes and alternative functional forms. Column (1) uses an indicator for whether transshipment occurred in the relevant industry in a given year, and interacts this indicator with the log of the *PCT Input* variable. In Column 2, we use the original *PCT Input* functional form. Columns 3 and 4 do the same but measure transshipment as the sum of varieties of HS6 goods in the industry transshipped. Columns 5 and 6 use the log of the sum. Across all columns, the result is consistent with our intensive-margin results. Finally, in Table A.10, we replicate A.9 with imports as a placebo test. In all specifications, we find precise zeros.

Table A.8: The Effects of Transshipping on Downstream Exports: All Sectors

Panel A: Short-Run 1-Year Differences						
	(1) OLS	(2) OLS	(3) OLS	(4) IV	(5) IV	(6) IV
$\Delta_1 \log T_{o,d,k,t}$	-0.000†	-0.000†	-0.000†	-0.022	-0.004	-0.009
	(0.000)†	(0.000)†	(0.000)†	(0.014)	(0.004)	(0.004)
$\Delta_1 \log T_{o,d,k,t} * Pct\ Input_{k,k'}$	0.001	0.001	0.001	0.158	0.189	0.181
	(0.001)	(0.001)	(0.001)	(0.066)	(0.081)	(0.078)
Observations (thousands)	16,160	16,160	16,160	16,160	16,160	16,160
First-stage F-stat				51.64	24.59	24.53
Panel B: Medium-Run 3-Year Differences						
$\Delta_3 \log T_{o,d,k,t}$	-0.000†	-0.000†	-0.000†	-0.044	0.011	-0.006
	(0.000)†	(0.000)†	(0.000)†	(0.015)	(0.005)	(0.005)
$\Delta_3 \log T_{o,d,k,t} * Pct\ Input_{k,k'}$	0.001	0.001	0.001	0.102	0.151	0.125
	(0.002)	(0.002)	(0.002)	(0.088)	(0.108)	(0.103)
Observations (thousands)	4,573	4,573	4,573	4,573	4,573	4,573
First-stage F-stat				14.69	18.82	18.78
Panel C: Long-Run 9-Year Differences						
$\Delta_9 \log T_{o,d,k,t}$	-0.000†	-0.000†	-0.000†	-0.022	-0.006	-0.011
	(0.000)†	(0.000)†	(0.000)†	(0.004)	(0.004)	(0.004)
$\Delta_9 \log T_{o,d,k,t} * Pct\ Input_{k,k'}$	0.011	0.011	0.011	0.216	0.238	0.232
	(0.005)	(0.005)	(0.005)	(0.062)	(0.071)	(0.073)
Observations (thousands)	1,344	1,344	1,344	1,344	1,344	1,344
First-stage F-stat				23.33	20.30	20.30
Fixed Effects						
o, t	✓	✓		✓	✓	
d, t	✓	✓		✓	✓	
k, t		✓	✓		✓	✓
o, d, t			✓			✓

Notes: Table replicates Table 3 using all 35 WIOT sectors. $X_{d,k',t}$ is the total export, in current USD, from country d to the rest of the world, leaving out transshipment origin country o, in industry k' in year t. $T_{o,d,k,t}$ is the volume of goods, in TEU, in industry k being transshipped from country o to the US via country d in year t. Δ_1, Δ_3, and Δ_9 denote one, three, and nine-period differences. $Pct\_Input_{k,k'}$ is the percentage of industry k''s total input expenditures coming from industry k, across all countries in 2008, calculated using the World Input-Output Database 2013 Release. Standard errors are clustered by origin-destination country pair. †First significant digit is hundred-thousandths place. ■

Table A.9: The Effects of Transshipping on Downstream Exports: Extensive Margins

VARIABLES	(1) $x_{jk't}$	(2) $x_{jk't}$	(3) $x_{jk't}$	(4) $x_{jk't}$	(5) $x_{jk't}$	(6) $x_{jk't}$
$\mathbb{I}_{trans,ijkt}$	0.00420	-0.000437				
	(0.00149)	(0.000450)				
$\mathbb{I}_{trans,ijkt}$#log(Pct Input)	0.000919					
	(0.000322)					
$\mathbb{I}_{trans,ijkt}$#Pct Input		0.0116				
		(0.00560)				
$\sum_{hs6} \mathbb{I}_{trans,ijkt}$			0.000655	-3.57e-05		
			(0.000277)	(8.36e-05)		
$\sum_{hs6} \mathbb{I}_{trans,ijkt}$#log(Pct Input)			0.000151			
			(6.47e-05)			
$\sum_{hs6} \mathbb{I}_{trans,ijkt}$#Pct Input				0.00120		
				(0.000663)		
$\log \sum_{hs6} \mathbb{I}_{trans,ijkt}$					0.00562	-0.000723
					(0.00207)	(0.000578)
$\log \sum_{hs6} \mathbb{I}_{trans,ijkt}$#log(Pct Input)					0.00127	
					(0.000468)	
$\log \sum_{hs6} \mathbb{I}_{trans,ijkt}$#Pct Input						0.0152
						(0.00612)
O-D-Org. Ind.-Dest. Ind. FEs	Yes	Yes	Yes	Yes	Yes	Yes
O-Year FEs	Yes	Yes	Yes	Yes	Yes	Yes
D-Year FEs	Yes	Yes	Yes	Yes	Yes	Yes
Observations (thousands)	29,025	29,025	29,025	29,025	29,025	29,025

Notes: The outcome is an indicator for exports in industry k' by country j in year t. Standard errors are clustered two-way by origin country and transshipping country. Pct Input is the proportion of inputs used by industry k' coming from k, omitted due to perfect collinearity after partialling out the FEs. ■

Table A.10: Supply-Chain Placebo: The Effects of Transshipping on Downstream *Imports*

VARIABLES	(1) $x_{jk't}$	(2) $x_{jk't}$	(3) $x_{jk't}$	(4) $x_{jk't}$	(5) $x_{jk't}$	(6) $x_{jk't}$
$\mathbb{I}_{trans,ijkt}$	-0.000576	8.82e-05				
	(0.00114)	(0.000122)				
log(Pct Input)	-4.73e-05		-6.47e-05		-3.94e-05	
	(8.27e-05)		(6.51e-05)		(8.75e-05)	
$\mathbb{I}_{trans,ijkt}$#log(Pct Input)	-0.000135					
	(0.000253)					
Pct Input		-0.000574		-0.000646		-0.000365
		(0.000657)		(0.000576)		(0.000748)
$\mathbb{I}_{trans,ijkt}$#Pct Input		-0.00139				
		(0.00207)				
$\sum_{hs6} \mathbb{I}_{trans,ijkt}$			1.39e-05	1.11e-05		
			(8.39e-05)	(1.14e-05)		
$\sum_{hs6} \mathbb{I}_{trans,ijkt}$#log(Pct Input)			1.81e-06			
			(2.14e-05)			
$\sum_{hs6} \mathbb{I}_{trans,ijkt}$#Pct Input				-8.02e-05		
				(0.000202)		
$\log \sum_{hs6} \mathbb{I}_{trans,ijkt}$					-0.000458	0.000214
					(0.000888)	(0.000112)
$\log \sum_{hs6} \mathbb{I}_{trans,ijkt}$#log(Pct Input)					-0.000134	
					(0.000202)	
$\log \sum_{hs6} \mathbb{I}_{trans,ijkt}$#Pct Input						-0.00219
						(0.00195)
O-Org.Ind.-Yr FEs	Yes	Yes	Yes	Yes	Yes	Yes
D-Dest.Ind.-Year FEs	Yes	Yes	Yes	Yes	Yes	Yes
O-D FEs	Yes	Yes	Yes	Yes	Yes	Yes
Observations (thousands)	33,786	33,786	33,786	33,786	33,786	33,786

Notes: $x_{jk't}$ is the log of imports of products in industry k' by country j in year t. Standard errors are clustered two-way by origin country and transshipping country. Pct Input is the proportion of inputs used by industry k' coming from k. ■