Trade Disruptions and the Organization of Supply Chains*

Sebastian Heise † Justin R. Pierce ‡ Georg Schaur §
Peter K. Schott ¶

September 17, 2025

Abstract

We show that the cost of using relational agreements to solve a buyer's quality-control problem rises with the probability of trade disruption. Empirically, we introduce a method for distinguishing such agreements from spot market purchasing in transaction-level trade data, show that their use varies intuitively across US trading partners and industries, and find that relational importing from China increased after a change in US policy promoting trade stability. We show quantitatively that an increase in the possibility of trade disruption across all trading partners raises consumer prices and induces a reallocation of trade towards countries for which relational agreements are *ex ante* less attractive, even if tariffs do not change. (JEL Codes: F13, F14, F15, F23)
(Keywords: Supply Chain, Uncertainty, Trade War, Procurement)

*Earlier versions of this paper circulated under the titles "Trade Policy Uncertainty and the Structure of Supply Chains" and "Tariff Rate Uncertainty and the Structure of Supply Chains." Schott and Heise thank the National Science Foundation (SES-1427027) for research support. We thank George Alessandria, Davin Chor, Kerem Cosar, Teresa Fort, Virgiliu Midrigan, Adam Szeidl, Dan Trefler, and seminar participants at the Bank of Canada, the Barcelona Summer Forum, ERWIT, Indiana, the Inter-American Development Bank, Mannheim, the NBER Fall ITI Meeting, the NBER Japan Conference, Oregon, Toronto, the US International Trade Commission, and the Yale Cowles Conference for helpful comments. The views and opinions expressed in this work do not necessarily represent the views of the Federal Reserve Bank of New York, the Census Bureau, the Board of Governors, or its research staff. The Census Bureau has reviewed this data product to ensure appropriate access, use, and disclosure avoidance protection of the confidential source data used to produce this product. This research was performed at a Federal Statistical Research Data Center under FSRDC Project Number 1883 (CBDRB-FY21-P1883-R9019, CBDRB-FY22-P1883-R9643, CBDRB-FY25-P1883-R12609).

†Federal Reserve Bank of New York; sebastian.heise@ny.frb.org.
‡Board of Governors of the Federal Reserve System; justin.r.pierce@frb.gov
§University of Tennessee; gschaur@utk.edu
¶Yale School of Management & CEPR & NBER; peter.schott@yale.edu

1 Introduction

The rapid expansion of global value chains has promoted a substantial increase in world trade, boosted aggregate productivity, and supported an unprecedented convergence in rich and poor country incomes (Johnson, 2018; World Bank, 2020; Antras and Chor, 2022). While the spread of these international production networks was bolstered by decades of trade liberalization and policy stability, more recently, rising risks of protectionism and geoeconomic fragmentation have threatened this progress.[1] Yet, despite the central role of cross-border supply chains in the global economy, relatively little is known about how firms structure international procurement strategies or how these strategies affect economic outcomes.

In this paper, we employ theory, empirical analysis and quantification methods to characterize how importers arrange their purchases in a procurement system to assure receipt of high-quality inputs from their foreign suppliers. We show that mere changes in the probability of a trade war or other disruption to trade can affect a buyer's choice of procurement system. A key insight emerging from our analysis is that an increase in the likelihood of disruption across all US trading partners raises prices and tilts trade towards countries for which relational agreements are *ex ante* less attractive – such as China – even if tariffs do not change.

In the first part of the paper, we construct a model in the spirit of Taylor and Wiggins (1997) (hereafter TW) that has buyers minimizing costs across two procurement strategies. The first approach, referred to as "Japanese" by TW (hereafter J), motivates a seller to maintain high input quality by paying an incentive premium above production costs and by committing to smaller, more frequent, and repeated transactions as part of a relationship with a single seller. The opposing system, which TW label "American" (hereafter A), relies on costly inspections, enforceable contracts, and sporadic spot transactions with many potential sellers to enforce quality standards. We modify and extend TW to show that policy tensions that raise the likelihood of trade disruption increase the cost of J relative to A procurement.

Our extended framework provides several predictions. First, import spells relying on the J system (relational agreements) are characterized by smaller, more frequent, and higher-priced transactions compared to the A system. Second, greater trade stability – in our setting, a lower probability of trade disruptions such as a trade war

[1] See, for example, Amiti et al. (2019), Fajgelbaum et al. (2019), Flaaen and Pierce (2019), Flaaen et al. (2020), Bown et al. (2021), and Alfaro and Chor (2023).

– can induce firms to switch to the J system, with the result that shipping frequencies increase, shipment sizes decrease, and import prices rise.

The challenge in bringing these predictions to the data is that standard sources do not include information on buyer-seller contracts. In the second part of the paper, we address this problem by constructing an indicator for relational agreements with standard, transaction-level trade data, which we have for all US import transactions from 1992 to 2016.[2] Guided by our model, we classify an importer purchasing a given product from a given origin country via a given mode of transportation as being A or J depending on the number of foreign sellers from which it buys relative to its total number of shipments. A low value of this ratio – few sellers per shipment – is indicative of the J system, while a high value signals the A system.

With our new sellers-per-shipment (SPS) measure in hand, we provide the first systematic empirical evidence in support of the TW framework. Importers classified as J report higher shipping frequencies, smaller shipment sizes, and higher import prices. Product-country-mode-of-transportation fixed effects and additional controls capture effects of other factors that can affect importers' shipping choices, isolating the novel relationships associated with procurement systems. Reassuringly, J importer-exporter relationships last longer, importer spells for differentiated products are more likely to be J, and importers purchasing according to the J procurement system hold smaller inventories.[3] Moreover, J trade is more prevalent with Japan than China, and more evident in transportation equipment (e.g. autos) than textiles.

In the third part of the paper, we provide direct empirical evidence that changes in the probability of trade disruptions induce firms to switch procurement systems. Specifically, using a triple difference-in-differences empirical strategy, we find that imports of products most affected by a substantial decrease in the possibility of a China-US trade war in 2001 exhibit increases in shipment frequency, higher import prices, and lower SPS after the policy is implemented. This finding suggests that a full understanding of the consequences of trade risk reduction requires consideration of firms' procurement strategies, which we address in our quantitative exercise.

In the final part of the paper, motivated by our empirical evidence, we embed our procurement framework in a more general trade model with firm- and country-level

[2] Citing an earlier version of this paper, Cajal-Grossi et al. (2023a) and Cajal-Grossi et al. (2023b) use our measure to study relational agreements in the garment sector of a select group of developing economies including Bangladesh, Ethiopia, India, Indonesia, Pakistan, and Vietnam.

[3] Consistent with just-in-time sourcing (Evans and Harrigan, 2005; Matsui, 2007).

heterogeneity in productivity to illustrate the relevance of procurement mechanisms for trade patterns and consumer prices. For example, when a trade war with all countries becomes more likely, the model shows that the share of US imports from China increases and the US price level rises. The model highlights the mechanism: the higher probability of trade disruption increases the cost of sourcing under the J system, shifting US firms' sourcing towards countries with which it mostly uses A procurement, such as China. While import prices decline with the shift to the A system as firms save the incentive premium, overall procurement costs – and therefore US consumer prices – rise as firms now incur inspection costs. This finding demonstrates that even seemingly non-discriminatory trade policies can affect relative trade patterns across countries, as well as import and consumer prices.

Our analysis contributes to greater understanding of the organization of global value chains and incomplete contracts (Antràs et al., 2017; Antràs and Chor, 2018; Antras and Chor, 2022; Antràs, 2003; Antràs, 2005; Grossman and Helpman, 2004; Spencer, 2005; Feenstra and Hanson, 2005; Nunn, 2007; Antràs and Helpman, 2008; Kukharskyy and Pflüger, 2010; Kukharskyy, 2016; Defever et al., 2016; Alfaro et al., 2019). In contrast to much of the research in this area, we consider a choice between procurement systems rather than firm integration as a solution to firms' quality-control problem and show that this choice can have economically meaningful consequences. We provide and empirically verify a theory-consistent procurement indicator based on importers' number of suppliers and transactions to distinguish between procurement systems. Our evidence implies that our procurement indicator is policy relevant and useful to anticipate the effect of global trade tensions on procurement strategies, trade patterns, and consumer prices.[4]

Our finding of a relationship between procurement systems and unit values highlights a novel source of price variation associated with firms' incentive to maintain product quality beyond the quality premiums and markups studied in the existing literature (Schott, 2004; Verhoogen, 2008; Khandelwal, 2010; Hallak and Schott, 2011; Kugler and Verhoogen, 2012; Antoniades, 2015; Manova and Yu, 2017; Demir et al., 2024). Indeed, recent complementary research relying on our SPS measure finds that sellers earn higher markups on otherwise identical orders produced for relational ver-

[4]Broader work examining relationships in international trade (Monarch and Schmidt-Eisenlohr, 2023; Heise, 2024) has focused on differences in behavior across relationships of varying ages and how relationship age might affect the transmission of shocks across borders.

sus spot buyers (Cajal-Grossi et al., 2023b) consistent with the presence of incentive premia to motivate product quality.

We also add to the growing body of research on trade wars and policy uncertainty (Grossman et al., 2024; Ossa, 2014; Handley, 2014; Handley and Limão, 2017; Alessandria et al., 2024; Handley and Limão, 2022; Ahir et al., 2022). We provide direct empirical evidence that firms' procurement strategies are relevant to determine the effect of trade tensions on firms' organization of global value chains. We examine the mechanisms highlighted in our model and their effects on trade patterns and prices in a quantifiable equilibrium model. For example, our results show that policies that reduce fixed per-shipment costs, such as the 2013 WTO Agreement on trade facilitation, complement the J procurement system, and may have the unintended consequence of facilitating supply chains that are more sensitive to trade tensions and potential trade disruptions.

We examine firms' choice of procurement system theoretically and empirically in Sections 2 through 4. Sections 5 through 7 extend our model to general equilibrium and perform counterfactuals. Section 8 concludes.

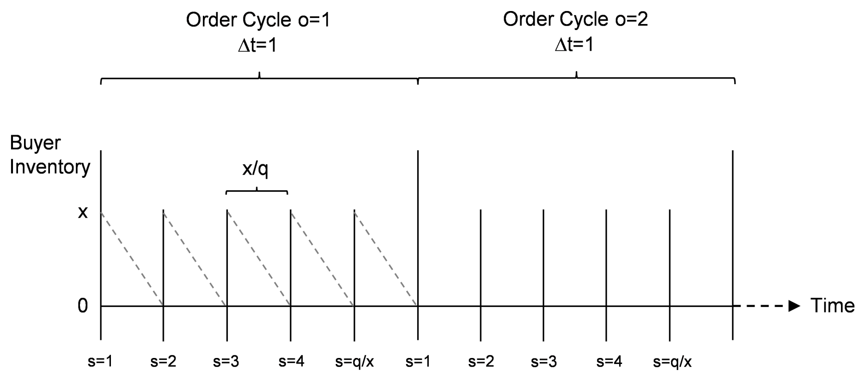
2 Extending Taylor and Wiggins, 1997

Taylor and Wiggins (1997) develop a procurement framework that focuses on an arm's-length solution to quality control challenges when contracts are incomplete.[5] In their theory, a buyer repeatedly seeks to obtain high-quality inputs from a supplier whose effort is unobservable.[6] Their solution to this problem is one of two procurement systems. Under the A system, buyers use competitive bidding to select the lowest-cost supplier for each shipment of inputs, and use the threat of inspection to deter provision of low-quality goods. Under the J system (relational agreements), by contrast, buyers offer sellers a price premium over a long-term relationship as an incentive to deter cheating. The Taylor and Wiggins (1997) framework is particularly suitable to our context because it broadly characterizes typical procurement strategies (Helper and Sako, 1995) and, linking incentive premia to potential trade wars, allows

[5] Firm integration is another potential means of addressing these issues (Antràs, 2003; Antràs, 2005; Antràs and Helpman, 2008), but may face policy-based restrictions. China, for example, requires foreign ventures to include a domestic partner, while the United States (and other developed countries) mandate national security reviews.

[6] This problem falls into the class of repeated games with incomplete information (Kandori, 2002).

Figure 1: Timing



Notes: The total quantity shipped over an order cycle is q. Order cycles repeat indefinitely and are indexed by $o = \{1, 2, ...\}$. There are $s = \{1, 2, ..., q/x\}$ shipments during an order cycle, arriving every x/q units of time apart.

us to examine the effect of trade policy stability on international shipping patterns and welfare.

2.1 The Procurement Problem

The Seller's Problem: There is a country populated by a continuum of homogeneous sellers able to produce the same good.[7] To complete a production run (i.e., produce one shipment) a seller hires labor l at wage $w = 1$ to produce and deliver output $x = \frac{\Upsilon}{\theta} l$, where Υ is a seller's productivity and θ represents her product's level of quality. The unit input requirement, $\frac{\theta}{\Upsilon}$, allows for variation in quality, giving rise to a "quality control" problem.[8] Sellers choose between discrete quality levels, $\theta \in \left\{\underline{\theta}, \overline{\theta}\right\}$, where lower quality is less costly to produce. To complete the shipment, the seller absorbs f units of labor for per-shipment logistics services, including transport costs.[9] The seller's total costs for each production and delivery cycle are therefore $x\frac{\theta}{\Upsilon} + f$.

The Buyer's Problem: Homogeneous buyers with complete bargaining power procure a seller's output and distribute it to consumers. Conditional on desired quality, $\overline{\theta}$, consumer demand arrives continuously. Let t denote continuous time and consider

[7] We extend the model to multiple products and sellers in multiple countries in Section 5.

[8] See, for example, "Poorly Made," The Economist, May 14th, 2009.

[9] Recent evidence emphasizes per-unit and -shipment specific delivery costs (Hummels and Skiba, 2004; Martin, 2012; Kropf and Sauré, 2014; Hornok and Koren, 2015a; Hornok and Koren, 2015b; Békés et al., 2017).

time periods $\Delta t = \int_0^1 1dt = 1$, e.g., 1 year. To supply the consumer market over one time period, a buyer procures total quantity, q, in a series of discrete, equally sized, symmetric shipments of size x. We take q as fixed in this section, but solve for it in equilibrium in Section 5. Consequently, there are q/x shipments during each period. Figure 1 summarizes the shipment and consumption pattern. If quality is less than desirable, then no demand arrives and buyers must dispose of the obsolete shipment without recompense. Following Taylor and Wiggins (1997), the buyer seeks to ensure the desired level of quality using either an A or a J procurement system.

In the A system, buyers inspect each shipment, and inspections reveal product quality with certainty.[10] Inspection costs m_A for each shipment are fixed.[11] Given an order of size x_A placed with a seller, the buyer sets the per shipment price $v_A(x_A, \overline{\theta})/x_A$ to allow the seller to exactly break even and participate, where

$$v_A(x_A, \overline{\theta}) = f + \frac{\overline{\theta}}{\Upsilon} x_A. \tag{1}$$

Since the sellers are homogeneous and all willing to supply at the same price, we assume that for a given buyer the winning seller is chosen randomly for each order. Thus, A procurement is characterized by many different suppliers. Inclusive of inspection costs, the buyer's total procurement expense equals $v_A(x_A, \theta) + m_A$.

J procurement motivates the production of high quality via an incentive premium and the value of a long-term relationship. This value depends, in part, upon the relationship's longevity. Let trade disruption shocks that break buyer-seller relationships, e.g. tariff escalation to prohibitive levels, arrive at a constant rate, ρ.[12] Then, relationships survive over a shipment cycle with probability $e^{-\frac{\rho x}{q}}$.[13] Our focus is on trade policy but other shocks including natural disasters and more general supply chain disruptions may have similar consequences (Boehm et al., 2019; Bai et al., 2024).

If $e^{-\frac{\rho x}{q}} < 1$, then firms are uncertain about whether future trade policy will sustain relationships and a greater arrival rate of trade wars, ρ, increases the separation

[10] Taylor and Wiggins (1997) allow for probabilistic inspections and derive limit theorems for small discount rates. Our simplification facilitates analytical tractability when we extend discount rates for the possibility of trade wars.

[11] "[I]t costs the same to have 20 pallets inspected as it does just one." See "What a Year of Brexit Brought UK Companies: Higher Costs and Endless Forms," New York Times, December 29, 2021.

[12] In a potential trade war average tariffs are estimated at 63 percent worldwide (Ossa, 2014).

[13] Relationships thus break with probability $F(t) = 1 - e^{-\rho t}$ over interval t (Wooldridge, 2002, p. 688). At the product level, ρ reflects both the probability of a trade war (which is the same for all products) and the magnitude of the subsequent rise in tariffs (which might vary across products).

probability.[14] Let r be the per-period interest rate and $v_J(x_J, \theta)$ be the payment the buyer sets under the J system for each shipment. With continuous compounding, the expected discounted value of the relationship is then $\frac{v_J(x_J,\bar{\theta})}{1-e^{-(r+\rho)x_s/q}}$.[15]

If the buyer does not observe product quality until the shipment is received and the payment is made, then, to guarantee desired quality, she sets a per-shipment payment such that the seller's net present value of the continued relationship exceeds the one-time profit from cheating on quality, $\frac{v_J(x_J,\bar{\theta})-f-\frac{\bar{\theta}}{\Upsilon}x_J}{1-e^{-(r+\rho)x_J/q}} \geq v_J(x_J,\bar{\theta}) - f - \frac{\underline{\theta}}{\Upsilon}x_J$. Rearranging, buyers under the J system set the per-shipment payment

$$v_J(x_J,\bar{\theta}) = f + \bar{\theta}\frac{1}{\Upsilon}x_J + \left[e^{(r+\rho)x_J/q} - 1\right](\bar{\theta} - \underline{\theta})\frac{1}{\Upsilon}x_J. \tag{2}$$

The per-unit premium $\left[e^{(r+\rho)x_J/q} - 1\right](\bar{\theta} - \underline{\theta})\frac{1}{\Upsilon}$ incentivizes quality. A key feature of the J system is that more stable trade relationships (i.e., a lower ρ) with repeated smaller shipments, x_J, sent more frequently reduce the premium necessary to guarantee desired quality. Long-term relationships are optimal in the Japanese system because they increase the incentive to provide quality.[16]

Buyers choose between the A and J system by comparing long-term expected revenues and costs. At a given market price p, long-term expected buyer profits in the two procurement systems are then given by

$$\pi_s^b = \left[\int_0^{x_s/q} e^{-rt}pq\,dt - v_s(x_s,\overline{\theta}) - m_s\right] / \left[1 - e^{-(r+\rho)x_s/q}\right] \quad \text{s}\in\{\text{J,A}\} \tag{3}$$

where discounted revenues per shipment cycle are $\int_0^{x_s/q} e^{-rt}pq\,dt$ and $m_J = 0$.

2.2 Market Equilibrium and Optimal Procurement Choice

We now determine the optimal procurement system. In equilibrium, buyers' profits equal zero, as we show in Section 5. Therefore, the market price must equal average costs, $AC_s(x_s, q)$, and employing (3) set equal to zero we obtain

[14] Handley and Limão (2017) consider trade policy where tariffs may either go up or down. In our case, the uncertainty is w.r.t. greater tariffs that break relationships.

[15] The discount rate over a shipping cycle is $\lim_{N\to\infty}\left(\frac{1}{1+\frac{rx}{q}/N}\right)^N = e^{-\frac{rx}{q}}$.

[16] While ρ may, in principle, have effects on aspects of firms' trading behavior in either procurement system, the model's key point is that the incentive premium payment boosts procurement costs for the J system *relative* to the A system as ρ increases.

$$p_s = AC_s\left(x_s, q\right) = \left(\frac{r}{q}\right) \frac{v_s(x_s, \bar{\theta}) + m_s}{\left[1 - e^{-rx_s/q}\right]} \quad \text{s}\in\{\text{J,A}\}. \tag{4}$$

Buyers choose a shipment size, x_s, to minimize average procurement costs within each procurement system. Taking first order conditions (FOC_s) for each system and setting them to zero we obtain,

$$\frac{v_s'(x_s, \bar{\theta})}{1 - e^{-rx_s/q}} = \frac{\left[v_s(x_s, \bar{\theta}) + m_s\right] \frac{r}{q} e^{-rx_s/q}}{\left(1 - e^{-rx_s/q}\right)^2} \quad \text{s}\in\{\text{J,A}\}. \tag{5}$$

The firm optimally procures x_s^* such that the discounted value of higher costs associated with a small increase in order size (left-hand side) equals the savings from an increased discount factor due to spacing these larger orders further apart in time (right-hand side).[17]

The buyer compares average procurement costs evaluated at the optimum, $AC_s\left(x_s^*, q\right)$, to determine the cost-minimizing procurement system. If $\bar{\theta} - \underline{\theta} = 0$ and with $m_A = 0$, then there is no incentive problem and costs in both systems are identical. Compared to this benchmark case, differentiating equation (4) under the J system with respect to $\underline{\theta}$ and ρ using the envelope theorem shows that average procurement costs in the J system increase with the arrival rate of trade wars, ρ, and with the range of potential qualities, $\bar{\theta} - \underline{\theta}$, due to the greater incentive premia they necessitate, $\frac{\partial AC_J\left(x_J^*, q\right)}{\partial \underline{\theta}} \leq 0$ and $\frac{\partial AC_J\left(x_J^*, q\right)}{\partial \rho} \geq 0$.[18] In the A system, differentiating (4) with respect to m shows that average costs increase with inspection costs m. Importantly, as $m \to \infty$, we have $AC_A\left(x_A^*, q\right) \to \infty$ because average costs grow without bound, $\frac{\partial AC_A\left(x_A^*, q\right)}{\partial m} = \frac{1}{1 - e^{-\frac{rx_A^*}{q}}} > 1$. We obtain the following proposition.

Proposition 2.1. *For $\bar{\theta} - \underline{\theta} > 0$ and $\rho > 0$, there is always a threshold value $m^* \in (0, \infty)$ for inspection costs such that average procurement costs in both systems are the same. This point is the cut-off at which the buyer switches systems: the American system is chosen for $m < m^*$, and the J system is chosen for $m > m^*$.*

Proof. See Appendix A.3. □

This proposition defines the threshold at which a change in the arrival rate of trade wars—and therefore a change in procurement costs under the J system—leads

[17] Appendix A.1 shows that an interior solution to the first order condition is a unique cost minimizer for $0 < rx/q < 1$.

[18] See Appendix Section A.2 for the proof.

to a change in buyers' endogenous choice of procurement system. Starting at a level of inspection cost m slightly below m^*, a reduction in ρ lowers average costs under the J system and reduces the threshold inspection cost m^* at which procurement costs under both systems are the same, causing the buyer to switch from the A to the J system if m^* falls below m.[19]

To map the choice of procurement system into observable trade flows, we examine how order size, frequency, and unit values differ across the two systems. We restrict our attention to a setting where buyers make a purchase at least once per period, $x^* \leq q$, and where discount rates are bounded, i.e., $0 < \frac{rx_s}{q} < 1$.

Proposition 2.2. *An increase in the probability of a trade war, which increases ρ, raises the unit value per shipment and reduces the size of shipments (i.e., raises shipment frequency) in the J system. An increase in the inspection cost m lowers the unit value per shipment and raises the size of shipments (i.e, reduces shipment frequency) in the A system.*

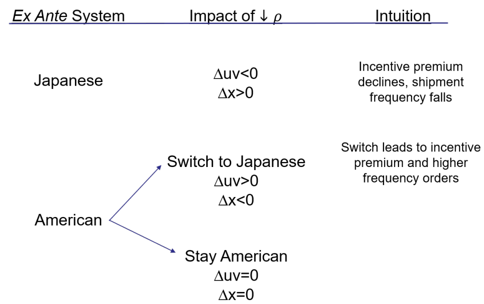
Proof. See Appendix A.4. □

Under the J procurement system an increase in ρ raises the incentive premium. As a result, variable procurement costs increase and buyers re-optimize by lowering shipment sizes (i.e., raising shipping frequency). Unit values increase because fixed per-shipment costs are spread over smaller shipment sizes. Instead, an increase in the inspection cost m raises fixed per-shipment costs under the A system, and buyers re-optimize by increasing per-shipment quantities (i.e., decreasing shipping frequency). The unit value paid to the seller must decrease in the A system since the fixed cost f is spread over more units.

We can now rank shipping frequencies and unit values across the two systems. If $\bar{\theta} - \underline{\theta} = 0$ and $m_A = 0$, then the A and J procurement systems are identical. An increase in $\bar{\theta} - \underline{\theta}$ raises variable shipment costs under the J system, leading buyers to increase their shipping frequency by lowering the shipment size. Unit values increase because fixed costs are spread over fewer units. Under the A system, Proposition 2.2 shows that an increase in inspection costs raises the shipment size, and hence shipping

[19] Existing theories of relational agreements in trade rely on exogenous heterogeneity in discount rates to determine relationship-based transactions (Kamal and Tang, 2015; Defever et al., 2016; Kukharskyy, 2016). In our framework, buyers endogenously determine the effective discount rate of rx_s/q by choosing the optimal procurement system and order size in response to inspection costs and the probability of a future trade conflict.

Figure 2: Impact of A Decline in the Probability of Trade Conflict (ρ)



Notes: Figure illustrates the impact of a change in the arrival rate of a trade war, ρ on shipment unit values (uv) and quantities (x) under both systems where, e.g., $\Delta uv < 0$ indicates a decline in unit value.

frequency and unit values decrease. Therefore, if $\bar{\theta} - \underline{\theta} > 0$ and $m \geq 0$, then shipping sizes are greater in the A system and unit values are greater in the J system. This reasoning forms the basis of our third proposition.

Proposition 2.3. *Batch sizes in the A system are greater than in the J system, $x_A^* > x_J^*$, and therefore time between shipments is greater under the A system, $x_A^*/q > x_J^*/q$. Unit values in the J system are greater than in the A system, $v_J(x_J^*, \bar{\theta})/x_J^* > v_A(x_A^*, \bar{\theta})/x_A^*$.*

Proof. See Appendix A.5. □

Figure 2 illustrates the predictions of a lower likelihood of trade war (a decrease in ρ) according to Proposition 2.2 and 2.3. The effect depends on whether the adjustment takes place within the J system or via a switch from the A to the J system. Within the J system, unit values fall, shipment sizes increase, and shipping frequency declines. Within the A system we expect no impact on prices, quantities, or frequencies. If a lower trade war arrival rate triggers a switch from A to J procurement, then we predict a decrease in shipment sizes and an increase in the unit value.

Based on our propositions, in Sections 3 and 4 we develop an empirical strategy that provides evidence of J and A procurement in US import transactions, and then examine the effect of reducing the probability of trade disruption on US importers' procurement strategies.

3 Data on J Importers

We use the US Census Bureau's Longitudinal Foreign Trade Transaction Database (LFTTD) to identify J (relational) importers and to examine the predictions of the model introduced above. Our dataset tracks every US import transaction from 1992 to 2016 and includes: the dates the shipment left the exporting country and arrived in the United States; identifiers for the US and foreign firm conducting the trade; the shipment's value and quantity; a ten-digit Harmonized System (HS10) code classifying the product traded; the country of origin of the exporter; and the mode of transport.[20] We perform standard data cleaning and use the concordance developed by Pierce and Schott (2012) to create time-consistent HS codes. Given our focus on arm's-length trade, we drop all related-party transactions. Since shipments of the same product between the same buyer and seller spread over multiple containers are recorded as separate transactions, we aggregate the dataset to the weekly level. For more detail on our data preparation, see Appendix Section B.1.

Our analysis below focuses on "buyer quadruples" that group shipments of a ten-digit HS product (h) imported by a US importer (m) from origin country (c) shipped via mode of transportation (z).[21] Since our theory requires that we observe repeated shipments to learn about the procurement system, we exclude buyer quadruples with fewer than five shipments in our analysis.[22] Our sample represents more than 80 percent of all arm's length trade and contains almost 3 million $mhcz$ quadruples between 1992 and 2016. There are nearly 22 million "buyer-seller relationships" associated with these bins, i.e., the number of $mxhcz$ quintuples, where x denotes the exporter. Table A.1 in Appendix B.2 provides an overview.[23]

[20] We focus on vessel, rail, road, and air, dropping the small fraction of transactions that are transported by other means, e.g., hand-carried. See Bernard et al. (2009) for further information on the LFTTD and Kamal and Monarch (2018) for more detail on the foreign firm identifier.

[21] Including mode of transport in these bins mitigates the influence of spurious sources of variation like product quality that might differ across product varieties shipped using different methods.

[22] This restriction eliminates importers trying out a new product or other idiosyncrasies. In Appendix B.2, we compare our sample against the sample of all arm's-length quadruples with at least two transactions. Two transactions are necessary to compute variables such as weeks between shipments (WBS_{mhcz}). As expected, the excluded quadruples with fewer than five transactions tend to be relatively small and trade more rarely.

[23] Referring to "$mhcz$ quadruples" and "$mxhcz$ quintuples" is awkward but precise. In the data, a given seller (i.e., exporter) may supply a particular HS code to multiple buyers (i.e., importers). We interpret this behavior as sellers producing different varieties within HS codes for each buyer. Moreover, A buyers can procure their variety from different sellers over time, and different buyers may procure the same product from the same seller using different procurement systems due to, for

Table 1: Attributes of $mhcz$ Quadruples

	Mean	*Standard Deviation*
Total Value Traded ($)	1,914,000	36,300,000
Length Between Buyer's First and Last Shipment (Weeks)	304.3	266
Total Shipments	38.6	157.9
Number of Sellers (x)	7.3	25.5
Value per Shipment (VPS), ($)	35,910	386,100
Weeks Between Shipments (WBS)	23.5	28.5
Average Relationship Length in Weeks ($length$)	180.8	154.7
Ratio of Sellers to Shipments (SPS)	0.334	0.241

Source: LFTTD and authors' calculations. Table reports the mean and standard deviation across importer (m) by country (c) by ten-digit Harmonized System category (h) by mode of transport (z) quadruples during our 1992 to 2016 sample period. Import values are in real 2009 dollars. Observations are restricted to quadruples with at least five transactions. Observation counts are rounded to the nearest thousand per US Census Bureau disclosure guidelines.

Table 1 summarizes the $mhcz$ quadruples, which are the focus of our study in the next section. The first four rows of the table reveal that from 1992 to 2016, the average $mhcz$ bin traded 1.9 million dollars (in 2009 dollars), lasted for 304 weeks and encompassed 39 shipments across 7 sellers. Rows 5 through 7 highlight "procurement patterns," showing that average value per shipment (VPS_{mhcz}), weeks between shipments (WBS_{mhcz}), and buyer-seller relationship length across the relationships within a quadruple ($length_{mhcz}$) averaged 36 thousand dollars, 24 weeks and 181 weeks, respectively.[24]

3.1 Sellers per Shipment (SPS_{mhcz})

A key characteristic of relational J buyers in the model developed in Section 2 is that they trade with just one seller. Guided by this insight, we develop a novel, observable metric of J sourcing: the ratio of the number of sellers to the number of shipments (SPS) within importer-product-country-mode ($mhcz$) quadruples,

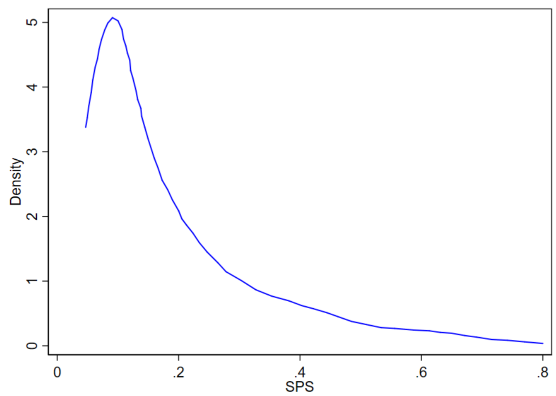
$$SPS_{mhcz} = \frac{Sellers_{mhcz}}{Shipments_{mhcz}}. \tag{6}$$

This variable has an upper bound of one, i.e., a different supplier for every shipment,

example, variation in inspection costs.

[24]Appendix C provides more details on how all variables are constructed. While below we also analyze quantity per shipment (QPS_{mhcz}) and unit value per shipment (UV_{mhcz}), they are not summarized here due to differences in quantity units across products. Relationship lengths can be subject to both left and right censoring at the beginning and end of our 1992 to 2016 sample period.

Figure 3: Sellers Per Shipment (SPS) Across Relationships, 1992 to 2016



Source: LFTTD and author's calculations. Figure displays the distribution of sellers per shipment (SPS_{mhcz}) across all buyer quadruples with at least five transactions between 1992 and 2016. The figure was created according to Census Bureau guidelines and omits observations below the 5th percentile and above the 95th percentile.

and approaches a lower bound of zero in the case of many transactions sourced from a single seller. It therefore offers an empirical generalization of the stylized binary definition of J buyers from the model: Buyers that use fewer sellers relative to the number of shipments (i.e., those with lower values of SPS_{mhcz}) are more likely to be engaged in repeated transactions, and hence in J procurement. While A buyers might in theory also transact with few sellers if they repeatedly offer the lowest price, introducing noise into our measure, we find below that SPS_{mhcz} is indeed correlated with procurement patterns in a manner consistent with the model.

The distribution of SPS_{mhcz} across buyer quadruples with at least five transactions from 1992 to 2016 is displayed in the kernel density reported in Figure 3. As indicated in the figure, most buyer quadruples have a relatively small ratio of sellers to shipments. Observations in the right tail approach a value of 1, i.e., a different seller for each shipment. As reported in the final row of Table 1, the mean ratio of sellers to shipments across buyer quadruples is 0.33, with standard deviation 0.24.

The first two columns of Table 2 report the weighted average of SPS_{mhcz} for buyer quadruples trading with the noted countries, using the quadruples' total imports as weights. These means are reported for the two five-year time periods used in our regression analysis in Section 4. For the first time period, we find that the average SPS_{mhcz} is lowest for US imports from Mexico and Japan, consistent with the prevalence of J sourcing in the automobile industry—a key industry in US trade with these countries—including among large Japanese multinationals like Toyota (Boehm et al., 2020). Results in the second column reveal that, over time, average SPS_{mhcz} generally falls. The largest decreases exhibited, both in levels and percent growth, are for Mexico, China and Brazil. The relatively large drop for Mexico may be related to increasingly close supply-chain integration with US producers as a result of NAFTA. In Section 4, we examine whether the decline in SPS_{mhcz} for China is related to the US granting Permanent Normal Trade Relations (PNTR) in 2001.

Table 2: J Relationships by Country

	Mean SPS		$J^{hz}_{mhcz} = 1$ Share of Import Value	
	(1)	(2)	(3)	(4)
Country	1995-2000	2002-2007	1995-2000	2002-2007
Mexico	0.095	0.068	0.750	0.869
Japan	0.107	0.123	0.756	0.725
Taiwan	0.132	0.114	0.711	0.743
Canada	0.141	0.120	0.602	0.667
United Kingdom	0.146	0.225	0.717	0.519
South Korea	0.156	0.135	0.656	0.724
France	0.177	0.158	0.627	0.667
Rest of the World	*0.180*	*0.156*	*0.625*	*0.678*
Germany	0.184	0.163	0.582	0.606
China	0.185	0.147	0.582	0.693
Brazil	0.190	0.151	0.576	0.706

Source: LFTTD and authors' calculations. Columns (1) and (2) report the weighted average sellers per shipment (SPS_{mhcz}) across buyer quadruples with at least five transactions by country and period, where import values are used as weights. Columns (3) and (4) report the share of the value of US imports accounted for by quadruples with SPS_{mhcz} in the first quartile of the distribution of SPS_{mhcz} within product-mode in the first period. Rows of the table are sorted by column (1).

In subsequent analysis, we will also consider an indicator variable for J importers that takes the value 1 when SPS_{mhcz} falls in the first quartile of its distribution computed within a given bin k in the first period, 1995-2000, J^{k}_{mhcz}. For our cross-country comparison, we compute the SPS distribution within product-mode bins, but across countries ($k = hz$). This choice implies that the share of J imports can vary between countries even though, worldwide, 25 percent of quadruples fall into the first quartile by construction. We define analogous dummies for the later time period, also with respect to the distribution of SPS_{mhcz} in the *first* time period, to capture changes with respect to the initial distribution. The final two columns of Table 2 report the share of imports from each country in each time period accounted for by buyer quadruples for which $J_{mhcz}^{hz} = 1$. While the 25^{th} percentile cutoff used in this procedure is arbitrary, this measure and SPS provide an indication of variation in J importing across source countries. Consistent with the raw SPS_{mhcz} measure, J import value shares increase over time, overall, and most strongly for Brazil, China, and Mexico.

Appendix B.3 presents further breakdowns of how SPS_{mhcz} varies across groups of ten-digit HS codes. We find that J sourcing is most prevalent for transportation equipment, machinery, and plastics and least prevalent for textiles and for leather and wood products.

3.2 SPS_{mhcz} and Procurement Attributes

We now evaluate the link between SPS_{mhcz} and procurement patterns via an $mhcz$-level OLS regression,

$$\ln(\overline{Y}_{mhcz}) = \beta_1 \ln(SPS_{mhcz}) + \beta_2 \ln(QPW_{mhcz}) + \beta_3 beg_{mhcz} + \beta_4 end_{mhcz} + \lambda_{hcz} + \epsilon_{mhcz}. \tag{7}$$

Guided by our theory, the dependent variable, $\overline{Y}_{mhcz}$, represents the key dimensions by which the A and the J systems differ: average quantity per shipment (QPS_{mhcz}), weeks between shipments (WBS_{mhcz}), and unit value (UV_{mhcz}) across all transactions within the $mhcz$ quadruple. In line with holding quantity fixed in Section 2, we condition on buyers' total order "flow" by controlling for the quantity imported by a buyer quadruple over its entire lifetime divided by its overall length in weeks, QPW_{mhcz}.[25] This variable also controls for the possibility that overall order flow could lead to variation in average shipment sizes or unit values for reasons unrelated to the procurement system, such as quantity discounts. We control for quadruples' first and last weeks of trade, beg_{mhcz} and end_{mhcz}, to capture effects of trading in a specific time period—such as a particular stage in the business cycle—and duration effects (Heise, 2024; Monarch and Schmidt-Eisenlohr, 2023).[26] The sample period is 1992 to 2016, and standard errors are two-way clustered at the country and product level.[27]

[25] We normalize the total quantity traded by the number of weeks since it is straightforward to implement in our weekly dataset. An alternative would be to use the annual quantity traded.

[26] beg_{mhcz} and end_{mhcz} are continuous variables indicating the week numbers that the relationship commences and ceases.

[27] As before, we only use quadruples with at least five shipments over the entire sample period. In Appendix D, we show that results are qualitatively identical for a cutoff of 10 shipments. We

Table 3: SPS_{mhcz} and Procurement Attributes

	(1)	(2)	(3)	(4)	(5)	(6)
Dep. var.	$\ln(QPS_{mhcz})$	$\ln(WBS_{mhcz})$	$\ln(UV_{mhcz})$	$\ln(QPS_{mhcz})$	$\ln(WBS_{mhcz})$	$\ln(UV_{mhcz})$
$\ln(SPS_{mhcz})$	0.418***	0.452***	−0.123***			
	0.017	0.017	0.021			
$1\{SPS_{mhcz} = Q2\}$				0.328***	0.350***	−0.117***
				0.014	0.015	0.014
$1\{SPS_{mhcz} = Q3\}$				0.552***	0.591***	−0.179***
				0.024	0.024	0.023
$1\{SPS_{mhcz} = Q4\}$				0.792***	0.856***	−0.226***
				0.034	0.035	0.038
$\ln(QPW_{mhcz})$	0.701***	−0.308***	−0.287***	0.687***	−0.323***	−0.282***
	0.014	0.014	0.020	0.013	0.014	0.019
Observations	2,966,000	2,966,000	2,966,000	2,966,000	2,966,000	2,966,000
Fixed effects	*hcz*	*hcz*	*hcz*	*hcz*	*hcz*	*hcz*
R-squared	0.947	0.674	0.845	0.945	0.661	0.845
Controls	beg, end	beg, end	beg, end	beg, end	beg, end	beg, end

Source: LFTTD and authors' calculations. Table reports the results of regressing noted attributes of importer by product by country by mode of transport ($mhcz$) bins on bins' sellers per shipment (SPS_{mhcz}), sellers per shipment quartile dummies, and total quantity shipped per week (QPW_{mhcz}). (QPS_{mhcz}), (WBS_{mhcz}), and (UV_{mhcz}) are average quantity per shipment, average weeks between shipment, and average unit value. All regressions include product by country by mode of transport (hcz) fixed effects, control for the beginning and end week of the quadruple, and exclude quadruples with less than five shipments. Standard errors, adjusted for clustering by country (c) and product (h) are reported below coefficient estimates. ***, **, and * represent statistical significance at the 1, 5 and 10 percent levels.

The product-country-mode-of-transportation fixed effects (λ_{hcz}) in equation 7 isolate effects attributable specifically to procurement systems by capturing a wide range of other factors that might also affect the outcome variables we examine. Examples of such factors include product-specific shipment and inventory costs, distance, transport times, the reliability of the transport network, and administrative barriers (Alessandria et al., 2025; Hummels and Schaur, 2010; Evans and Harrigan, 2005; Kropf and Sauré, 2014; Hornok and Koren, 2015b). Therefore, with these sets of fixed effects and $mhcz$-level controls, our estimates can determine the empirical relevance of firms' adoption of different procurement systems while accounting for other factors that can influence shipping patterns.

Results for specification (7) are reported in Table 3. In the first three columns, we find that quadruples with higher SPS_{mhcz}, i.e., those that are more A, receive shipments for a given total order flow that are larger, less frequent, and lower in price, consistent with Proposition 2.3.[28] Furthermore, the coefficient estimates for

describe the construction of all variables in detail in Appendix C.

[28]We explore whether the empirical relationship between QPS_{mhcz} and SPS_{mhcz} in column one is driven by a mechanical relationship via the total number of shipments appearing in the denominator of the dependent and independent variables and find evidence that it is not. First, we obtain similar results when we use measures of shipment size that do not depend on the total number of shipments at the $mhcz$ level, including the median shipment size within $mhcz$ quadruples and shipment size at

our quantity control, QPW_{mhcz}, are in line with Proposition 5.1, discussed below, where an increase in the total quantity procured leads to an increase in shipment size and reductions in the number of weeks between shipments and unit value. Coefficient estimates for SPS_{mhcz} indicate that increasing sellers per shipment by one standard deviation from its mean (from 0.33 to 0.58) is associated with a 23 log point rise in quantity per shipment, a 25 log point increase in weeks between shipments, and a 7 log point decline in price.[29]

In the final three columns of Table 3, we consider a related specification that relaxes the restriction of a linear relationship between procurement attributes and sellers per shipment by replacing SPS_{mhcz} with a series of dummy variables indicating the quartile into which buyer quadruples fall. We compute these quartiles separately for each hcz bucket using the entire sample period. The first quartile, $1\{SPS_{mhcz} = Q1\}$, is the left-out category. This specification further justifies the use of SPS_{mhcz} as a metric of J sourcing, as coefficient estimates for SPS_{mhcz} rise or fall monotonically from quartile 1 to quartile 4 in a manner consistent with the quartiles representing increasingly A quadruples.[30]

3.3 SPS_{mhcz} and Other Characteristics

Relationship Length: Buyers under the J system rely on repeat purchases from the same seller, while buyers under the A system choose potentially different lowest-cost suppliers for each transaction. An implication of these choices is that J buyers have longer relationships with their suppliers. We investigate this prediction using the

less aggregated levels (see Appendix D). Furthermore, we note that results for unit values (UV_{mhcz}), relationship length, inventories, etc. are consistent with the model's predictions but not subject to the same potential empirical concern.

[29]Our analysis computes SPS at the level of buyer quadruples ($mhcz$). One concern with this definition might be that buyers obtain shipments across multiple modes of transportation, and therefore procurement systems – and hence SPS – should be better defined at the mhc level. Analogously, SPS could be defined at at an even more aggregated mh level. In Appendix D, we re-run specification (7) where we compute SPS using the ratio of sellers to transactions within buyer-product-country triples (SPS_{mhc}) and buyer-product doubles (SPS_{mh}), and find similar results. We also show that including importer fixed effects in our regressions increases R-Squared values modestly while yielding highly similar coefficient estimates.

[30]In Appendix Section D we show that the relationships displayed above are robust to analyzing procurement patterns separately by mode of transport, i.e., vessel versus air. We also show that the results are similar when we examine procurement patterns within $mxhcz$ buyer-seller relationships, and that procurement patterns for differentiated products based on Rauch (1999) are more J compared to commodities.

Table 4: SPS_{mhcz} and Relationship Length

	(1)	(2)
Dep. var.	$\ln(length_{mhcz})$	$\ln(length_{mhcz})$
$\ln(SPS_{mhcz})$	-0.576^{***}	
	0.015	
$(SPS_{mhcz} = Q2)$		-0.383^{***}
		0.015
$(SPS_{mhcz} = Q3)$		-0.683^{***}
		0.027
$(SPS_{mhcz} = Q4)$		-1.139^{***}
		0.047
$\ln(QPW_{mhcz})$	-0.147^{***}	-0.130^{***}
	0.006	0.005
Observations	$2,966,000$	$2,966,000$
R-squared	0.431	0.413
Fixed effects	hcz	hcz
Controls	beg, end	beg, end

Source: LFTTD and authors' calculations. Table reports results of regressing average buyer-seller quadruple relationship length ($length_{mhcz}$) on quadruples' sellers per shipment (SPS_{mhcz}), sellers per shipment quartile dummies and total quantity shipped per week (QPW_{mhcz}). Regressions include product by country by mode of transport (hcz) fixed effects, control for the beginning and end week of the quadruple, and exclude quadruples with less than 5 shipments. Standard errors, adjusted for clustering by country (c) and product (h) bin are reported below coefficient estimates. ***, **, and * represent statistical significance at the 1, 5 and 10 percent levels.

variable $length_{mhcz}$, which tracks the average length of the mx buyer-seller relationships associated with $mhcz$ buyer quadruples. This variable is constructed in two steps. First, for each $mxhcz$ quintuple, we compute the total number of weeks passed between the first and the last transaction of any product by any mode between the buyer m and seller x, i.e., their total relationship length. Second, for each $mhcz$ buyer quadruple, we take the average of these numbers of weeks across all $mxhcz$ quintuples within the quadruple. This average allows for the possibility that buyers already sourcing one product from a given supplier, or already using a different mode of transportation with that seller, add products over time.

We use the same specification outlined in equation (7) but using $length_{mhcz}$ as the dependent variable. The results, reported in Table 4, show that $mhcz$ buyer quadruples with lower ratios of SPS_{mhcz} tend to have longer relationships.[31] In column (1), we find that a one standard deviation increase of sellers per shipment from its mean is associated with a 31 log point decrease in average relationship length. In column (2), the average relationship length for quadruples in the fourth quartile

[31] Our SPS measure is related to – yet different from – the "relationship stickiness" measure by Martin et al. (2023). While J relationships tend to be longer, and hence more "sticky," importers that transact the same product with many suppliers in long-term relationships would be classified as using the A system in our framework. Our measure assigns the J system to importers that use relatively few suppliers. An advantage of this measure is that it can be used in shorter samples.

Table 5: SPS_m and Firm Characteristics

	(1)	(2)	(3)	(4)
Dep. var.	$\ln(sales_m)$	$\ln(pay_m)$	$\ln(wage_m)$	$(inv/sales)_m$
$\ln(SPS_m)$	-0.291^{***}	-0.350^{***}	-0.056^{***}	0.015^{***}
	0.005	0.006	0.002	0.001
Observations	184,000	184,000	184,000	48,500
R-squared	0.015	0.018	0.003	0.006

Source: LFTTD and authors' calculations. Table reports the results of regressing importer characteristics in the year of the importer's first transaction on sellers per shipment (SPS_{mhcz}) averaged across all quadruples involving the importer. All regressions exclude quadruples with less than five shipments. ($sales_m$), (pay_m), ($wage_m$), and ($(inv/sales)_m$) are total sales, total payroll, average wage (i.e., payroll divided by number of employees), and total inventory at the beginning of the year divided by total sales, respectively. Robust standard errors are reported below coefficient estimates. ***, **, and * represent statistical significance at the 1, 5 and 10 percent levels.

(most A) is about 114 log points lower than that in the first quartile (most J).[32]

Buyer Characteristics: In Appendix B.3, we show that the importer dimension is the most important for explaining variation in SPS_{mhcz} across quadruples. We therefore next investigate how various firm-level attributes are related to import sourcing strategy, measured by SPS_{mhcz}. We aggregate the quadruples across products, countries, and modes to the importer-level and run the importer-level regression

$$\ln(\overline{Y}_m) = \beta_1 \ln(SPS_m) + \epsilon_m., \tag{8}$$

where $\overline{Y}_m$ is one of importer m's total sales, total payroll, average wage, or the firm's inventory-to-sales ratio, and SPS_m is an average of SPS_{mhcz} across all quadruples of the importer. We obtain sales, payroll, and wages at the firm-level from the Longitudinal Business Database (LBD), where the average wage is constructed as the firm's total payroll divided by the number of employees. We obtain beginning-of-year inventories for manufacturing firms from the Annual Survey of Manufactures (ASM) and the Census of Manufactures (CMF). We use for each firm attribute the earliest non-missing observation available for the firm.[33] Table 5 shows the regression results.

We find that firms that on average rely on more A procurement practices tend

[32] In Appendix section D, we show that all our robustness checks also go through for the length variable. We also consider an alternative definition of relationship length where we treat each quintuple as a separate relationship, rather than using the overall importer-supplier pair, and show that our results still hold.

[33] Results are robust to using an average across all active years (see Appendix D).

to be smaller, pay lower wages, and hold higher inventories. An increase in average sellers per shipment by one standard deviation from its mean is associated with a 16 log point decline in sales, 19 log point decline in payroll, and a 3 log point decline in the average wage.[34] A one standard deviation increase in SPS_{mhcz} from its mean raises the inventory-to-sales ratio by 0.8 log points, consistent with A procurement leading to larger inventories.[35]

Consistent with a firm-wide sourcing strategy, we also find that importers' procurement system is correlated across products. Using all importers with at least two products in a given country-mode bin, we randomly draw two of these products for each importer. We then use the J indicator J^{hcz}_{mhcz}, computed using the distribution of SPS_{mhcz} within hcz bins for the entire sample period, and regress $J^{hcz}_{mhcz,1}$ of the first product on $J^{hcz}_{mhcz,2}$ of the second product. We re-run this regression 1000 times, where we re-draw the two products on every run. Our estimated average coefficient on $J^{hcz}_{mhcz,2}$ is 0.234 (bootstrap s.e. = 0.001) with a constant of 0.214 (s.e. = 0.001), indicating that the probability of the second product being J approximately doubles when the first one is.

Finally, we note that buyers may enter into long-term relationships with sellers for multiple reasons, such as inducing sellers to make productivity-enhancing investments.[36] However, our finding of correlations between SPS and a wide range of outcomes – in the manner predicted by the model – is evidence that the choice of procurement system is a relevant feature of US trade flows.

4 PNTR and the Choice of Procurement System

A key insight from the model presented in Section 2 is that trade policy can alter buyers' choice of procurement system by affecting the probability of trade disruptions. In this section, we show that a decrease in the probability of a trade war can induce buyers to shift from A to J procurement using a plausibly exogenous change in US trade policy, the US granting of Permanent Normal Trade Relations (PNTR) to China

[34] As we will show in Section 6 below, these findings are qualitatively consistent with our model, where we find that larger importers are more likely to use the J system.

[35] We observe firms' overall inventories. Our results complement Alessandria et al. (2010), who link firm inventories to shipping frequencies and transaction-level economies of scale. Here, we show that firms' optimal choice of procurement systems is associated with tangible variation in shipping frequencies and inventories.

[36] Though such investments might be expected to result in a positive correlation between unit values and SPS, rather than the negative relationship observed in the data.

in 2001. We assess these shifts across both continuing and new $mxhcz$ quintuples, and in terms of importers' sellers per shipment (SPS).

As described in Pierce and Schott (2016), prior to PNTR, US imports from China were subject to the risk of punitive tariff increases absent annual action from the President and Congress. Pierce and Schott (2016) and Alessandria et al. (2024) document the trade-dampening effects of this uncertainty on US importers prior to PNTR, and Handley and Limão (2017) provide a theoretical basis for these effects that operates via suppressed entry by Chinese exporters. We measure exposure to PNTR via the "NTR Gap" from Pierce and Schott (2016), which measures the amount that tariffs could have increased prior to PNTR and varies by product.[37]

PNTR and continuing mxhcz quintuple attributes: Our first approach to testing whether PNTR influences procurement is to examine its impact on the procurement attributes examined in Section 3: quantity per shipment, weeks between shipments and unit value. These attributes are observed at the buyer-seller $mxhcz$ quintuple level. We therefore analyze procurement attributes among *continuing* quintuples—which trade in both the pre- and the post-PNTR period—in this subsection, and for new quintuples in the next subsection.

Our OLS triple difference-in-differences (DID) identification strategy examines the relationship between PNTR and the procurement attributes for products with higher versus lower NTR gaps (first difference), before versus after the change in policy (second difference), for imports from China versus other source countries (third difference),

$$\begin{aligned} \ln(Y_{mxhczt}) = {} & \beta_1 1\{t = Post\} * 1\{c = China\} * NTR\,Gap_h \\ & + \beta_2 ln(QPW_{mxhczt}) + \beta_3 \chi_{mxhczt} + \lambda_{mxhcz} + \lambda_t + \epsilon_{mxhczt}. \end{aligned} \tag{9}$$

The first difference captures the fact that products with larger NTR gaps experience a greater decline in the relationship termination probability, which is a function of the change in China's NTR status (identical for all products) and the increase in tariff rates that could have occurred before PNTR, which varies by product. The model indicates that the largest shift toward J procurement after PNTR should occur in US imports of high-NTR-gap products from China.

[37] Appendix E provides details. The probability of tariff increases was identical across products. Their potential to break importer-supplier relationships varies across products with the NTR Gap.

Table 6: Baseline Within $mxhcz$ Quintuple PNTR DID Regression

	(1)	(2)	(3)
Dep. var.	$\ln(QPS_{mxhczt})$	$\ln(WBS_{mxhczt})$	$\ln(UV_{mxhczt})$
$Post_t * China_c * NTRGap_h$	-0.197***	-0.168***	0.092***
	0.009	0.009	0.023
$ln(QPW_{mxhczt})$	0.368***	-0.632***	-0.124***
	0.009	0.008	0.013
Observations	439,000	439,000	439,000
R-squared	0.982	0.894	0.985
Fixed effects	$mxhcz, t$	$mxhcz, t$	$mxhcz, t$
Controls	Yes	Yes	Yes

Source: LFTTD and authors' calculations. Table reports the results of regressing noted attribute of US importer by exporter by product by country by mode of transport ($mxhcz$) bins on the difference-in-differences term of interest and quantity shipped per week. Pre-and post periods are 1995 to 2000 and 2002 to 2007. QPS_{mxhczt}, WBS_{mxhczt}, and UV_{mxhczt} are average quantity per shipment, average weeks between shipment, and average unit value (i.e. value divided by quantity) in period t. All regressions include $mxhcz$ and period t fixed effects, control for the beginning and end week of the quintuple as well as all variables needed to identify the DID term of interest. Standard errors, adjusted for clustering by country (c) and product (h), are reported below coefficient estimates. ***, **, and * represent statistical significance at the 1, 5 and 10 percent levels.

The variable Y_{mxhczt} on the left-hand side of specification (9) represents one of the three procurement attributes: quantity per shipment (QPS_{mxhczt}), weeks between shipments (WBS_{mxhczt}), and unit value (UV_{mxhczt}).[38] The first term on the right-hand side is the triple difference-in-differences (DID) term of interest, an interaction of an indicator for the post period, $1\{t = Post\}$, a dummy for imports from China, $1\{c = China\}$, and the $NTR\ Gap_h$. The variable χ_{mxhczt} represents the full set of interactions of those variables required to identify β_1. The remaining terms on the right-hand side control for the average quantity traded per week in each of the two periods (QPW_{mxhczt}) as well as buyer-seller quintuple (λ_{mxhcz}) and period (λ_t) fixed effects. Our two five-year periods (t), 1995 to 2000 and 2002 to 2007, are chosen to straddle the change in policy in 2001 and end before the Great Recession.[39] Standard errors are two-way clustered at the country and product level.

Conducted at the $mxhcz$ level, equation (9) is restricted to continuing buyer-seller relationships via the $mxhcz$ quintuple fixed effect. We restrict the sample to quintuples that transact at least twice both before PNTR and after the policy change so that weeks between shipments (WBS_{mxhczt}) can be computed.

Results, reported in Table 6, indicate that higher exposure to PNTR is associated

[38] Appendix C provides more details on how the variables in this section are constructed.

[39] Appendix F demonstrates that all results are robust to using 2004 to 2009 as post-PNTR period.

with changes in shipping attributes that are consistent with a move toward Japanese-style procurement within existing buyer-seller quintuples. Coefficient estimates in the first two columns show that a one standard deviation increase in the $NTR\ Gap$ (0.23) induces a relative decline in quantity per shipment and weeks between shipments of 4.5 log points and 3.9 log points respectively. Moreover, results in column 3 reveal that a one standard deviation increase in exposure to PNTR is associated with a relative increase in unit value of 2.1 log points. In each case, the findings in Table 6 are consistent with the predictions of Propositions 2.1 and 2.3, indicating a switch from A to J procurement, as opposed to an adjustment within the J system. These results highlight a new dimension of firms' adjustment to PNTR that is not present in existing work, which has focused on investment in new equipment or entry into the export market (Pierce and Schott, 2016; Handley and Limão, 2017), but does not predict changes in firms' procurement patterns.[40]

PNTR and new mxhcz quintuple attributes: We next compare the procurement attributes of *new* buyer-seller $mxhcz$ quintuples formed in the post-PNTR period to relationships that were new in the pre-PNTR period. For both periods, we define new quintuples as those involving buyer-seller mx pairs that had not yet appeared before the beginning of the period, i.e., from 1992 to 1994 for the first period and from 1992 to 2001 for the second period.

As in the previous section, the regression is performed at the $mxhcz$ level and standard errors are two-way clustered at the country and product level. Instead of $mxhcz$ quintuple fixed effects, however, we include separate buyer quadruple ($mhcz$), exporter (x), and period (t) fixed effects, thereby focusing on buyers and sellers that exist in both time periods (with at least one trading partner), but who form new relationships across the time periods.[41]

Results, reported in Table 7, are consistent with relatively greater entry of J relationships after PNTR: buyer-seller quintuples trading goods with greater exposure to the change in policy formed after it was implemented exhibit relatively smaller and

[40] Increases in trade resulting from such investments are captured by the time-varying control for imported quantity, $ln(QPW_{mxhczt})$. Our coefficient estimates are consistent with Proposition 5.1: an increase in the procurement quantity increases the size of shipments, raises shipping frequency, and reduces unit values. Appendix F confirms that our conclusions are qualitatively unchanged when we do not include QPW_{mxhczt} as a covariate. Finally, the effect of PNTR on the three procurement attributes is robust to estimation at the $mhcz$ quadruple level.

[41] As noted in Appendix F, results are robust to including both continuing and new $mxhcz$ buyer-seller quintuples simultaneously in one regression.

Table 7: New $mxhcz$ Quintuple PNTR DID Regression

	(1)	(2)	(3)
Dep. var.	$\ln(QPS_{mxhczt})$	$\ln(WBS_{mxhczt})$	$\ln(UV_{mxhczt})$
$Post_t * China_c * NTRGap_h$	-0.116***	-0.097***	0.090**
	0.023	0.023	0.038
$ln(QPW_{mxhczt})$	0.409***	-0.594***	-0.129***
	0.013	0.012	0.018
Observations	3,184,000	3,184,000	3,184,000
R-squared	0.966	0.842	0.972
Fixed effects	$mhcz, x, t$	$mhcz, x, t$	$mhcz, x, t$
Controls	Yes	Yes	Yes

Source: LFTTD and authors' calculations. Table reports the results of comparing new buyer-seller relationships in the pre-versus post-PNTR period. Pre-and post periods are 1995 to 2000 and 2002 to 2007. New relationships are defined as mx pairs that appear for the first time in each period. (QPS_{mxhczt}), (WBS_{mxhczt}), and (UV_{mxhczt}) are average quantity per shipment, average weeks between shipment, and average unit value (i.e. value divided by quantity) in period t. All regressions include $mhcz$, x and period t fixed effects, control for the beginning and end week of the quintuple as well as all variables needed to identify the DID term of interest. Standard errors, adjusted for clustering by country (c) and product (h), are reported below coefficient estimates. ***, **, and * represent statistical significance at the 1, 5 and 10 percent levels.

more frequent shipments, at relatively higher prices, than quintuples formed before PNTR. Point estimates indicate that a one standard deviation increase in exposure is associated with a 2.7 log point and 2.2 log point decline in shipment size and weeks between shipments, respectively, and a 2.1 log point rise in unit value.

PNTR and Sellers per Shipment (SPS): The previous two exercises demonstrate that higher exposure to PNTR is associated with relatively more J procurement attributes after the policy change. We next focus on the impact of PNTR on buyers' sellers per shipment, the metric for identifying J relationships introduced in Section 3. We consider both the continuous measure SPS_{mhcz} as well as the indicator for whether this ratio falls into the first quartile of the pre-PNTR period distribution within product by country by mode bins, $J^{hcz}_{mhcz} = 1$.

Our triple DID specification is similar to equation (9), but takes place at the buyer $mhcz$ quadruple level,

$$\begin{aligned} ln(Y_{mhczt}) =& \beta_1 1\{t = Post\} * 1\{c = China\} * NTRGap_h + \beta_2 ln(QPW_{mhczt}) + \\ & \beta_3 \chi_{mhczt} + \lambda_{mhcz} + \lambda_t + \epsilon_{mhczt}. \end{aligned} \quad (10)$$

As before, the triple DID term of interest is an interaction of post-period and China-import dummies with the NTR gap, and χ_{mhczt} represents the full set of interactions

Table 8: Within-Importer PNTR Regression, Buyer Characteristics

	(1)	(2)	(3)	(4)
Dep. var.	$\ln(SPS_{mhczt})$	$1\{J^{hcz}_{mhczt} = 1\}$	$\ln(SPS_{hczt})$	J^{hcz}_{hczt}
$Post_t * China_c * NTRGap_h$	-0.006	0.041*	-0.021**	0.034*
	0.031	0.022	0.009	0.019
$ln(QPW_{mhczt})$	-0.171***	0.124***	-0.062***	0.032***
	0.006	0.005	0.002	0.003
Observations	738,000	291,000	368,000	28,500
R-squared	0.772	0.675	0.695	0.547
Fixed effects	$mhcz, t$	$mhcz, t$	hcz, t	hcz, t
Controls	Yes	Yes	Yes	Yes

Source: LFTTD and authors' calculations. First two columns report the results of regressing noted attribute of US importer by product by country by mode of transport ($mhcz$) bins on the difference-in-differences term of interest and quantity shipped per week. Second two columns are analogous but at the hcz level of aggregation. Pre- and post-PNTR periods are 1995 to 2000 and 2002 to 2007. All regressions include $mhcz$ and period t fixed effects, control for the beginning and end week of the quadruple as well as all variables needed to identify the DID term of interest. Columns 2 and 4 exclude quadruples with less than five shipments in both periods. Standard errors, adjusted for clustering by country (c) and product (h), are reported below coefficient estimates. ***, **, and * represent statistical significance at the 1, 5 and 10 percent levels.

of those variables required to identify β_1. The remaining terms on the right-hand side control for the average quantity traded per week in each of the two periods (QPW_{mhczt}) as well as buyer quadruple (λ_{mhcz}) and period (λ_t) fixed effects. Standard errors are two-way clustered at the country and product level. Conducted at the $mhcz$ level, equation (10) is restricted to continuing importers—i.e. those active before and after granting of PNTR—via the $mhcz$ buyer quadruple fixed effect.

While our model requires repeated interactions between buyers and sellers, it does not mandate relationships be long-established. Moreover, existing research finds substantial relative growth in US-importer-Chinese-exporter relationships after PNTR (Pierce and Schott, 2016). As a result, we also estimate equation (10) at the more aggregated hcz level, which broadens the analysis to include entering importers. For this regression, SPS_{hczt} is defined as the average SPS_{mhczt} within $hczt$ cells. The variable J^{hcz}_{hczt} is defined analogously as average J^{hcz}_{mhczt}.

Results in Table 8 indicate that PNTR induced a shift towards more J importing, with this effect driven by the entry of new importers. As shown in the first two columns, we find only a modest relationship between the policy change and SPS_{mhczt}, though continuing buyer quadruples more exposed to the change in policy exhibit relative increases in the probability of being in the first SPS quartile ($J^{hcz}_{mhczt} = 1$)

after PNTR.[42] When we re-estimate equation (10) at the hcz level—which accounts for the role of new importers that enter in the post-PNTR period—we find that higher exposure to PNTR is associated not only with a higher probability of $J^{hcz}_{mhczt} = 1$, but also with a precisely estimated reduction in SPS_{hczt}. The estimates in columns 3 and 4 indicate that a one standard deviation increase in exposure to PNTR is associated with a 0.5 percent relative decline in SPS and a 0.8 percent increase in falling within the first quartile of the SPS distribution.[43]

Tables 6 and 7 provide diverse, shipment-level evidence consistent with firms switching from the A to the J procurement system in response to a reduction in the probability of a trade war. A potential concern is that this evidence may be driven by an alternate mechanism. For example, one may argue that PNTR could lead to quality upgrading by Chinese exporters for reasons unrelated to changes in procurement systems, and that this upgrading may manifest as higher unit-values as well as lower shipment size and frequency if the increase in quality coincides with or causes higher variable shipment costs. We address this concern with the evidence presented in Table 8, which, while somewhat less precise, shows that in response to PNTR, firms use fewer sellers per shipment, a hallmark of J procurement.[44] Thus, even if quality upgrading in response to PNTR occurs, and it contributes to the patterns reported in Tables 6 and 7, the results in Table 8 show that firms indeed adjust their procurement strategies in response to reductions in potential trade disruption. Table 4 provides further evidence that fewer suppliers per shipment are associated with a lower ρ since it demonstrates that relationship length goes up when SPS falls.[45] Consequently, despite the possibility that quality may change in response to PNTR, our broad array of empirical results supports the model's prediction that firms re-optimize their procurement strategies in response to potential trade disruptions.

[42] The observation count is lower with the J^{hcz}_{mhczt} indicator because we require at least five observations in each period to classify a relationship as J .

[43] To analyze the influence of initial buyer experimentation immediately after PNTR, we also consider, in Appendix F, a slightly later — 2004 to 2009 — post-PNTR time period. Coefficient estimates have the same sign, are larger in magnitude, and more precise. This suggests that adjustment to PNTR continued beyond our baseline sample period.

[44] Lower precision is unsurprising. Table 8 must rely on proxy variables, rather than observable contracts, to distinguish procurement systems. The use of such proxy variables can lead to larger standard errors for regression coefficient estimates.

[45] In principle, one could make $\bar{\theta}$ a decreasing function of ρ to capture quality upgrading in our theory. Decreases in ρ could then amplify increases in unit values and shipping frequencies. We do not incorporate this mechanism since we already get these effects holding $\bar{\theta}$ fixed. What matters for our purposes is that changes in ρ induce changes in procurement system.

Note that while a switch from A to J procurement is associated with higher *import* prices, *consumer* prices are determined by overall procurement costs, which also include the inspection cost. Since a lower likelihood of a trade war reduces the overall cost of the J system while leaving the cost of the A system unchanged, trade stability (weakly) reduces consumer prices. We evaluate the effect of trade stability on consumer prices in a quantitative equilibrium model in the following sections.

5 Multi-Country Setup with Endogenous Demand

In this section, we embed the partial equilibrium model introduced in Section 2 within the multi-country, multi-product general equilibrium model of Eaton and Kortum (2002). We use the model to assess the equilibrium effects of an increase in the probability of a trade war between the United States and its trading partners in Section 7. Such analysis is of particular relevance given recent efforts to reverse globalization, such as "Brexit," the 2018-19 US-China tariffs, and the widespread tariffs proposed and implemented in the second Trump administration, which have increased trade policy uncertainty worldwide.

Our main point of departure from Eaton and Kortum (2002) is the introduction of homogeneous *buyer* firms in each country, which purchase manufacturing goods from *sellers* and distribute these goods to consumers. Buyer and seller firms are subject to the procurement problem described in Section 2.

5.1 Environment

Households: Our modeling is standard. There are N countries, indexed by n and i. Each country is populated by L_n consumers who purchase a continuous flow of a manufactured composite good and a homogeneous "outside" good to maximize Cobb-Douglas utility of the form $Q_n^{\alpha} Z_n^{1-\alpha}$, where Q_n is the quantity of a composite manufactured good and Z_n is the quantity of a homogeneous good. The composite good is a CES aggregate of a continuum of differentiated products indexed by $\omega \in [0, 1]$,

$$Q_n = \left(\int_0^1 q_n(\omega)^{(\sigma-1)/\sigma} d\omega \right)^{\sigma/(\sigma-1)}, \tag{11}$$

where $\sigma > 0$ is the elasticity of substitution and $q_n(\omega)$ is quantity. This aggregator implies the standard price index $P_n = \left(\int p_n(\omega)^{1-\sigma} d\omega\right)^{1/(1-\sigma)}$. We assume that each consumer supplies one unit of labor.

Manufacturing sellers: Manufactured good ω can be produced by homogeneous seller firms in country n with the linear production function $q = \frac{\Upsilon}{\theta} l$ introduced in Section 2. Sellers are perfect competitors, taking prices as given. Their productivity $\Upsilon_n(\omega)$ is specific to each origin country-product combination. Sellers in country n incur fixed logistic and transport costs f_n in units of seller country labor for each destination supplied. We assume that a country's firms are owned by their households.

Manufacturing buyers: We add a continuum of homogeneous buyer firms in each country into the standard framework. Buyers purchase manufactured goods from sellers domestically or abroad, and offer them to the households in their country at prices $p_n(\omega)$. Transactions between buyers and sellers take place as described in Section 2: given household demand $q_n(\omega)$, buyers in country n choose the lowest-cost sourcing country i for product ω, the procurement system, and the optimal order size. Buyers using the A system need to use an additional $m_n(\omega)$ labor units to inspect the quality of the good. Buyers choosing the J system pay an incentive premium to ensure quality.[46]

Homogeneous good: The homogeneous good in country n is produced by a representative firm according to $Z_n = a_n L_n^O$, where a_n is productivity and L_n^O is the aggregate labor used in the production of the good. Labor is paid the wage rate w_n. The homogeneous good is directly sold to households and can be costlessly traded across countries. We set its price as the numeraire and normalize it to one. Labor is perfectly mobile between manufacturing and the homogeneous good sector.

5.2 Partial Equilibrium with Endogenous q

In this section, we describe how $q_n(\omega)$ is determined in equilibrium. We assume that the buyer has already chosen the source country and procurement system and discuss how these are chosen in the next section. As we are focusing on a single market in this section, we omit country and product subscripts.

[46] These payments imply that sellers obtain positive profits under the J system. Profits are not competed away since sellers offering a lower price would violate the incentive constraint.

Our first step to determine the equilibrium, Proposition 5.1, establishes that batch size and shipping frequency increase with quantity ordered, q:

Proposition 5.1. *An increase in the procurement target q raises batch sizes x_s^* and the shipping frequency q/x_s^* in both systems, and, as a corollary, lowers unit values in both systems.*

Proof. See Appendix A.6. □

Intuitively, for a given fixed shipping frequency, buyers must increase the batch size x_s in both systems to meet an increase in q. But by the first-order condition (5), buyers trade-off variable procurement costs against fixed per-shipment costs. Therefore, as variable procurement costs increase, buyers respond by spreading the larger quantities over more shipments. As a result, larger quantities lead to both greater shipment sizes, x_s, but also greater order frequencies. Unit values decrease since fixed per-shipment costs are spread over greater per-shipment quantities. Additionally, in the J system, an increase in the shipping frequency implies a lower premium to motivate desired quality, which lowers the unit value further.

The comparative statics with respect to q are supported by the empirical estimates in Sections 3 and 4. As indicated in Tables 3, 6, and 7, we find that shipment size is positively related to the quantity shipped per week (QPW), and that both weeks between shipments and unit values are negatively related to QPW.

We next show that buyers' average cost curves are downward sloping:

Lemma 5.2. *At the optimal order size x_s^*, both procurement systems provide economies of scale, i.e., $\frac{\partial AC(x_s^*,q)}{\partial q} < 0$. Moreover, the second derivative of the average cost with respect to q is positive, $\frac{\partial^2 AC(x_s^*(q),q)}{\partial q^2} > 0$, and the average cost in both systems reaches a positive and finite limit as $q \to \infty$.*

Proof. See Appendix A.7. □

In our model, sellers face the standard constant marginal costs and perfect competition, but the fixed logistic and transport costs generate a natural monopoly for buyers in the downstream market. Downward-sloping average cost curves are a key departure of our model from trade models based on Eaton and Kortum (2002), which generally assume constant marginal cost. We therefore need to choose an appropriate market structure. Our assumption is that buyers compete in a "contestable" market for consumers, a natural extension of Bertrand competition when firms' costs exhibit economies of scale (Baumol et al., 1982; Tirole, 1988). In a contestable market, there exist several homogeneous competitors whose entry is costless. Due to downward-sloping average costs, in equilibrium a single buyer serves the entire consumer market for each product.

Lemma 5.2 indicates that average cost curves are convex, and therefore a demand curve that uniquely intersects the single buyer's optimized average cost curve from above determines a unique, sustainable, and feasible equilibrium in the product market, q^*. The buyer prices and supplies the final consumers along its average cost curve. If the buyer were to price above average costs, entrants would contest the positive profits and take over the market. If the buyer were to price below average costs, she would realize negative profits. Since for any $q < q^*$ consumers are willing to pay prices greater than average costs, potential entry forces an incumbent offering q to lower its prices and to increase quantity to the level q^* where supply equals demand.

Under appropriate assumptions on the demand system, the market equilibrium is a corollary of Lemma 5.2.[47]

Corollary 5.2.1. *If markets are contestable and demand intersects average costs from above at q^* and remains below average costs as $q^* < q \to \infty$, then a single buyer procures the product from the seller and distributes it on the consumer market using the buyer's cost minimizing procurement system at optimal shipping frequencies.*

5.3 General Equilibrium with Endogenous q

We now embed the product market equilibrium into the equilibrium of the overall economy. Equilibrium requires that (i) buyer firms minimize costs such that the contestable market equilibrium is feasible and sustainable in each product-destination country market, (ii) the household maximizes the CES objective, and (iii) the goods and labor markets clear.

Cost minimization: Buyer firms in country n minimize average costs $AC_n(q_n(\omega))$ of

[47] In principle our CES demand system may intersect the downward sloping average cost curve multiple times. For equilibrium to exist in that case, the demand curve must cut the average cost curve from above at the intersection that determines the greatest equilibrium quantity, q^*_{high}. Intuitively, if the demand curve were to cut from below, it would be above the average cost curve for all $q^*_{high} < q \to \infty$, implying that consumers are willing to buy an infinite quantity of the good when the buyer sets price equal to average costs.

purchasing $q_n(\omega)$ by choosing the lowest-cost system and country:

$$AC_n(q_n(\omega))^* = \min\left\{\min\left\{AC_{ni,A}(x^*_{ni,A}(\omega), q_n(\omega)), AC_{ni,J}(x^*_{ni,J}(\omega), q_n(\omega))\right\};\ i = 1, ..., N\right\}, \tag{12}$$

where $AC_{ni,s}(x^*_{ni,s}(\omega), q_n(\omega))$ are average costs of purchasing $q_n(\omega)$ under system s from country i, and $x^*_{ni,s}(\omega)$ is the optimal batch size determined by the first-order condition (5). Since average costs are downward sloping in q and the market is contestable, in equilibrium there is only one buyer firm serving the market in each destination country. The contestable market price is $p_n(\omega) = AC_n(q_n(\omega))^*$.

Utility maximization: Consumption of each manufactured good is chosen to maximize (11) subject to the budget constraint

$$\int_0^1 p_n(\omega)q_n(\omega)\, d\omega \leq \alpha\left(w_n L_n + \sum_i \sum_s \int \pi^s_{in,s}(\omega) I_{in,s}(\omega) d\omega\right). \tag{13}$$

The right-hand side of the equation is the share of country n's total income W_n spent on manufacturing goods. Since labor is perfectly mobile between sectors, the wage rate is pinned down by the productivity of the homogeneous good sector as $w_n = a_n$, as is standard. The second term on the right-hand side, which is new relative to the standard framework, represents the incentive premia collected from shipments to countries i under $s = J$. Here, $\pi^s_{in,s}(\omega)$ is the continuous flow of profits to sellers in country n from sales to country i of product ω under system s, and $I_{in,s}(\omega)$ is an indicator that is equal to one if seller n uses system s to country i. Profits are zero if shipments are under the A system. Consumption of the homogeneous good satisfies $Z_n = (1-\alpha)W_n$.

Market clearing: Equilibrium requires market clearing for each manufactured good ω and for the homogeneous good, and labor market clearing in each country. We provide these market clearing conditions in Appendix G.[48]

[48] In the quantitative simulations, we verify that a positive amount of labor is allocated to both manufacturing and the production of the homogeneous good in each country in equilibrium.

6 Quantitative Analysis

In this section, we estimate a three-country version of the model quantitatively before using it in Section 7 to illustrate the potential effects of changes in trade policy on trade flows and prices.[49] This analysis highlights the impact of firms' choice of procurement system on the trade effects of a higher probability of trade war, as well as the relevance of the model for the current international trading environment. We parameterize the model using a combination of external calibration and within-model moment matching. Due to the non-linearity of the buyer's problem, our model does not admit an analytical solution. We therefore use an iterative algorithm and provide more details on the solution algorithm in Appendix H.

6.1 Parameterization and Calibrated Parameters

We set each time period to one quarter. We set $N = 3$ countries and interpret these countries to be the United States, China, and the Rest of the World (RoW). As in Eaton and Kortum (2002), productivity $\Upsilon_n(\omega)$ is drawn from a Fréchet distribution $F_n(\Upsilon) = e^{-\Lambda_n \Upsilon^{-\zeta}}$, where the country-specific parameter Λ_n scales the mean of the distribution and ζ scales the variation. The productivity draws are independent across products within each country.

We assume inspection costs for domestic procurement to be zero, implying that all domestic sourcing takes place under the A system.[50] For imports, we assume that the distribution of inspection costs is Pareto and given by $G_n(m) = 1 - (\underline{m}/m)^{\gamma_n}$, where $\underline{m}$ is the lower bound of inspection costs, and γ_n is a parameter to be estimated.[51] We set $\underline{m} = 0.001$ as inspection is essentially costless for some goods, e.g., commodities. Heterogeneous inspection costs generate dispersion in the relative costs of A and J procurement, and hence in the system used, across goods coming from the same country. The shape of the inspection cost distribution is directly tied to the price effects of policy: if some products have more extreme inspection costs, then a high

[49] Our model generalizes to more countries, but three are sufficient for our purposes.

[50] This normalization is necessary because we do not have domestic data estimate the share of J and A trade within countries. Equivalently, since domestic inspection costs are zero, we could also refer to "domestic" sourcing as a third type of procurement system that does not face an incentive problem and hence corresponds to the first-best outcome.

[51] We let a given destination country have the same distribution of inspection costs for all origins to reduce the degrees of freedom. Nevertheless, the model fits the data well, as we show below.

probability of trade war that forces firms to use the A system for these products can lead to large increases in overall procurement costs, and therefore, consumer prices.

We calibrate some parameters outside of the model, and summarize their values in Table 9. We provide more information on their calibration in Appendix I, and discuss here only the rate of exogenous relationship break-ups, ρ_{ni}. In the model, this variable reflects any exogenous shock that ends relationships. We assume that this break-up rate is symmetric between country pairs, $\rho_{ni} = \rho_{in}$, and set it for the US by fitting the exponential decay parameter that best matches the empirically observed fraction of plausibly J buyer-seller ($mxhcz$) quintuples that survive for $2, ..., 100$ quarters in the US trade data. Trade wars between the United States and RoW were considered unlikely in our sample period 1992-2016, and we thus interpret the estimated decay parameter for relationships between US and RoW firms, equal to 0.087, as normal churn due to firm exits, product obsolescence, and so on.[52] We therefore set $\rho_{US,RoW} = 0$. For relationships between US and Chinese suppliers, we estimate a decay parameter of 0.114. We interpret this higher likelihood of break-ups as arising due to the additional uncertainty of trading with China, and thus set the relationship break-up rate between the United States and China equal to the difference in the decay parameters, leading to $\rho_{US,CN} = 0.0264$. For trade between China and RoW, we set $\rho_{CN,RoW} = 0$ as well.[53]

6.2 Targeted Moments and Estimation

We estimate the remaining productivity scales T_n, the country-specific fixed costs f_n, and the inspection cost distribution parameters γ_n via simulated method of moments using the LFTTD and aggregate data. The column labeled "Moment in Data" in Table 10 summarizes the values of the targeted moments in the data.

We next describe the empirical moments targeted and the underlying identification assumptions. Appendix I provides more details. We normalize $T_{US} = 1$, and estimate the other two productivity parameters using the share of imports from China and from the rest of the world in US domestic manufacturing sales in 2016 (rows 1 and 2 of

[52] While narrow trade disputes between the United States and RoW—such as safeguards and antidumping duties—occur often, the WTO's formal dispute settlement system was an effective deterrent to full-fledged trade war between the United States and RoW during our sample period.

[53] While trade tensions were also present between RoW and China, a variety of bilateral disagreements between the US and China meant that the risk of RoW-China trade war was substantially lower.

Table 9: Calibrated Parameters

Parameter	Value	Source
Interest rate (r)	0.01	Caliendo et al. (2019)
Elasticity of substitution (σ)	3.85	Antràs et al. (2017)
Cost of low quality ($\underline{\theta}$)	0	Normalization
Cost of high quality ($\overline{\theta}$)	1	Normalization
Consumption share of manufactured goods (α)	0.5	Duarte (2020)
Dispersion of productivities (ζ)	3.6	Eaton and Kortum (2002)
Homogeneous good sector productivity (a_n)		
- US	1	Normalization
- China	0.12	Average wage relative to US
- RoW	0.47	Average wage of top-ten US partners
Labor Force (L_n)		
- US	1	Normalization
- China	5	Labor force relative to US
- RoW	2.5	Labor force of top-ten US partners
Rate of exogenous break-ups, US-China ($\rho_{US,CN}$)	0.0264	Census Bureau (LFTTD)
Rate of exogenous break-ups, US-RoW ($\rho_{US,RoW}$)	0	Assumption

Notes: Table presents the exogenously fixed parameters. Column (1) displays the parameter value, and column (2) shows its source.

Table 10). A lower value of T_n increases country n's productivity, which raises that country's share in US domestic sales.

We estimate the fixed costs f_n and the inspection cost distribution parameters γ_n using the observed shipping patterns in the trade data. A corollary of Proposition 2.2 is that, given a total quantity ordered q, higher fixed costs lead to shipments that are less frequent under both systems. We can therefore estimate the fixed shipment costs f_{CN} and f_{RoW} from the observed shipping frequencies of likely A and J shipments by running a modified classification regression (7) with average weeks between shipments ($\overline{WBS}_{mhcz}$) as dependent variable, separately for China and for the rest of the world,

$$\ln(\overline{WBS}_{mhcz}) = \beta_0 + \beta_1 1\{\overline{WBS}_{mhcz} = Q4\} + \beta_2 \ln(QPW_{mhcz}) + \beta_3 beg_{mhcz} + \beta_4 end_{mhcz} + \lambda_{hcz} + \epsilon_{mhcz}. \tag{14}$$

We control for the total quantity per week, QPW, to be consistent with the theory, and for time variation and fixed effects by product by country by mode to remove potentially confounding variation that is unrelated to fixed costs. To isolate sourcing that is most likely under the A and the J system, our regression sample includes only quadruples that fall into the first or the fourth quartile of the SPS_{mhcz} dis-

Table 10: Estimated Parameters and Targeted Moments

	(1)	(2)	(3)	(4)	(5)
	Parameter	Estimated Value	Moment that Primarily Identifies the Parameter	Moment in Data	Moment in Model
(1)	Productivity China (T_{CN})	15.482	Share of Chinese imports in domestic sales	0.074	0.066
(2)	Productivity RoW (T_{RoW})	2.745	Share of RoW imports in domestic sales	0.270	0.276
(3)	Fixed costs, China (f_{CN})	0.310	$\exp(\hat{\beta}_0 + \hat{\beta}_1 + \hat{\beta}_3\overline{beg} + \hat{\beta}_4\overline{end})$ from (14) for CN	91.00	91.10
(4)	Fixed costs, RoW (f_{RoW})	0.061	$\exp(\hat{\beta}_0 + \hat{\beta}_1 + \hat{\beta}_3\overline{beg} + \hat{\beta}_4\overline{end})$ from (14) for RoW	60.90	62.66
(5)	Dispersion of inspection	0.290	$\hat{\beta}_1$ from (14) for China	0.871	0.814
(6)	costs, China (γ_{CN})		Sd of $\hat{\epsilon}$ from (14) for China	0.227	0.180
(7)	Dispersion of inspection	0.101	$\hat{\beta}_1$ from (14) for RoW	0.822	0.818
(8)	costs, RoW (γ_{RoW})		Sd of $\hat{\epsilon}$ from (14) for RoW	0.219	0.207
(9)	Total objective $T(\cdot)$				0.062

Source: LFTTD and authors' calculations. Column (1) lists the parameters estimated for the model. Column (2) contains the estimated parameter values. Column (3) reports the moment targeted to identify the parameter. Column (4) presents the value of the moment in the data, and Column (5) presents the value of the moment computed in our simulated model. The last row presents the value of the function $T(\cdot)$ from (15).

tribution (hence, are most likely J and A, respectively), and includes a dummy, $1\{\overline{WBS}_{mhcz} = Q4\}$, indicating whether $\overline{WBS}_{mhcz}$ falls into the fourth quartile. We set f_n by targeting the predicted average shipping frequency in the fourth quartile, $\exp(\hat{\beta}_0+\hat{\beta}_1+\hat{\beta}_3\overline{beg}+\hat{\beta}_4\overline{end})$, where $\overline{beg}$ and $\overline{end}$ are the simple averages of beg_{mhcz} and end_{mhcz} in the data (rows 3 and 4).[54] Since we do not have information on the procurement choice of foreign importers sourcing from the US, we assume $f_{US} = f_{RoW}$.

The inspection cost parameters γ_{CN} and γ_{RoW}, which are crucial for the share of J sourcing estimated by the model, are also informed by results of estimating equation (14). Starting from $\gamma_n \to \infty$, at which point all inspection costs are zero and all sourcing is under the A system, lowering γ_n increases the number of high inspection cost draws and therefore raises the share of J sourcing. We target two sets of moments. First, we target the difference in shipping frequencies between the first and the fourth quartile of the WBS_{mhcz} distribution, given by $\hat{\beta}_1$ in specification (14) (rows 5 and 7). A greater dispersion of inspection costs (a smaller γ_n) increases the difference in average shipping times between those quadruples that are more likely A and those that are more likely J. Second, we target the dispersion in shipping times across more A $mhcz$ quadruples. When γ_n is low, the inspection cost draws

[54]Since quantity units are heterogeneous across goods in the data, we target the shipping frequency at $\ln(QPW_{mhcz}) = 0$. We target the average shipping frequency within the fourth quartile, hence likely A procurement, to remove variation in shipping patterns that is due to different mixes of A versus J sourcing.

are more dispersed, leading to a higher variance of the shipping frequencies within the A system. We construct this moment by taking the residuals from (14) for all observations that fall into the fourth quartile of the WBS distribution, and compute the standard deviation of these residuals. Rows 6 and 8 show the estimated moments. Similar to the fixed costs, we assume that $\gamma_{US} = \gamma_{RoW}$.

Our estimation algorithm is standard: we solve for a vector of parameters satisfying

$$\phi^* = \arg\min_{\phi \in \mathbb{F}} \sum_x T(\mathcal{M}_x(\phi), \hat{\mathcal{M}}_x) \tag{15}$$

where $T(\cdot)$ is the percentage difference between the model, $\mathcal{M}_x(\phi)$, and data, $\hat{\mathcal{M}}_x$, moments. Appendix J.1 provides more details on the estimation algorithm and outcomes.

We present the estimated values of the parameters in the column labeled "Estimated Value" in Table 10, and the "Moment in Model" column shows the values of the simulated moments with these parameters. The model provides a good fit along several dimensions. First, the model-generated shares of Chinese and RoW imports in US manufacturing consumption are 6.6% and 27.6%, respectively, compared to 7.4% and 27.0% in the data. Second, the model generates shipping frequencies consistent with the data: the time between shipments is about 91 weeks for China and 63 weeks for the rest of the world, conditional on $\ln(QPW_{mhcz}) = 0$.[55] Finally, the model generates substantial variation in shipping frequencies across goods, similar to the data.

The fixed costs of production in terms of labor are about five times larger for China than for the rest of the world (rows 3 and 4). Since wages in China are four times lower than in RoW, the fixed costs in terms of the numeraire good are only about 20 percent higher. These higher fixed costs are an implication of the lower shipping frequency from China compared to the rest of the world. Since the estimation target includes the intercept β_0, which is estimated using the observed trade flows in our sample period, the higher fixed cost reflects any trade barriers between countries in our sample, such as distance (Hummels and Schaur, 2013).

[55] The empirically observed number of weeks between shipments is much lower since shipping frequency increases with quantity shipped. In the first quartile of the WBS distribution from China the average number of weeks between shipments is 9 weeks, in the fourth quartile it is 39 weeks.

Table 11: Baseline Equilibrium Statistics

(1)	Share of consumption from China (%)	6.6%
(2)	- of which, J	9.5%
(3)	Share of consumption from ROW (%)	27.6%
(4)	- of which, J	52.1%
(5)	Share of consumption from United States (%)	65.8%
(6)	Avg. inspection costs	0.4%
(7)	Avg. fixed costs (imports)	4.5%

Table shows various statistics of the equilibrium under the assumption of a Pareto distribution for inspection costs. Rows 1-5 show the share of US manufacturing sales, $P_{US}Q_{US}$, that is from China, from the rest of the world, and from the US, respectively, and the share of these manufacturing sales that is sourced under the J system. Row 6 presents the average inspection costs as a share of the import value, computed over all imports, including under the J system. Row 7 shows the average fixed costs as a share of the import value.

6.3 Model Results

Table 11 summarizes the estimated equilibrium. The first four rows show the share of manufactured goods consumption that is imported from China and the rest of the world, as well as the share of the imports that are obtained under the J system. Our estimates imply that 10 percent of imports from China are under the J system, while 52 percent of imports from the rest of the world take place under J procurement. The higher share for the rest of the world reflects the higher trade war probability with China, which discourages trade under the J system, as well as the higher fixed costs for China, which makes the frequent shipments under the J system more expensive. The structurally-estimated J shares are somewhat smaller than the empirical estimates we obtained using shipments in the first quartile of the SPS_{mhcz} distribution in Table 2 for China, but they are in the ballpark for the rest of the world.

Rows 6 to 7 of Table 11 show that the average product imported by the United States is subject to an inspection cost of 0.4 percent and a fixed cost of 4.5 percent of the import value, respectively. These figures provide a validity check of the model, since they are in line with estimates by Kropf and Sauré (2014), who estimate that Swiss exporters face total fixed shipment costs of 0.8 percent to 5.4 percent of the value imported. As a further check of the model, Appendix K verifies that larger importers are more likely to use the J system, as found in Table 5 above.[56]

[56]We also considered a Fréchet distribution for inspection costs (see Appendix J.2). Results are broadly similar.

7 Counterfactuals

In this section, we examine the effect of several policy-relevant scenarios through the lens of the estimated model. We begin by considering the impact of a symmetric increase in the probability of a trade war between the US and all of its trading partners, as in the universal tariffs threatened and imposed during the second Trump administration. Then, we evaluate the potential effects of two salient trends and policy actions: the adoption of trade facilitation policies and increased automation.

7.1 Higher Probability of US Trade War with All Countries

We model an increase in the probability of a US trade war with all of its trading partners as a symmetric increase in ρ across countries. Figure 4 traces out the effects on the US share of J imports, the share of imports from China, and the US price level in the manufacturing sector. In each panel, we set the trade war probabilities, ρ, to the value on the x-axis for all trade partners, such that moving from left to right symmetrically increases the trade war probability across countries.[57] The effects of higher ρ can be seen by tracing the path of the baseline (shown in the black lines), moving from left to right on the horizontal axis. The diamonds on the right indicate the effects of a trade war probability of one, i.e. a trade war arrival rate $\rho \to \infty$.

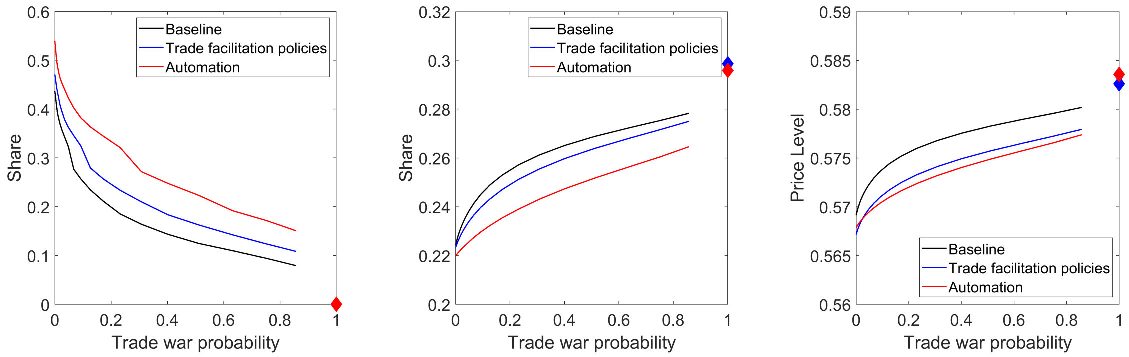
Despite the symmetric nature of the increase in the probability of trade wars, the model indicates important effects on the re-organization of procurement systems, origin of imports, and US prices. As the probability of a trade war with all countries increases, the share of US imports under the J system declines (Panel A), the share of US imports from China increases (Panel B), and consumer prices go up (Panel C). Therefore, this seemingly non-discriminatory trade policy boosts a frequent target of US trade actions, China, and leads to higher prices.[58]

Our model provides the intuition. The increase in ρ raises necessary incentive premia in J procurement with all countries, making that system more costly relative to A. Recalling Table 2 from Section 3.1, compared to other trade partners, US firms importing from China are more likely to use the A system due to China's higher fixed shipment costs and lower productivity, while US firms are more likely to use J for imports from other major trading partners, e.g., Mexico and Japan. Therefore, as

[57] At a trade war arrival rate of zero, US imports from China rise relative to the baseline equilibrium to 7.4% and the J share increases to 15%.

[58] More precisely, imports from China decrease but China's share in total US imports increases.

Figure 4: Counterfactuals



(a) Share of J Imports (b) Share Imports from China (c) Price Level

Figure shows the share of US imports under the J system (panel (a)), the share of US imports from China (panel (b)), and the price level P_n in the manufacturing sector in the United States (panel (c)) as a function of the trade war probability between the United States and its trading partners. The trade war probability is set to the value on the x-axis for US trade with both RoW and China. Black lines present the case in which all other parameters are set to their baseline values. Blue line presents the case in which trade facilitation policies have reduced per-shipment fixed costs by one half. Red line presents the case in which automation has increased $\underline{\theta}$ to 0.8. The diamonds indicate the effects of a trade war probability of one.

the cost of J rises, some firms that had formerly imported via the J system from other countries switch to importing via the A system from China. Although import prices decline when firms switch from J to A due to lower incentive premia, overall sourcing costs must increase if firms were initially optimizing at the lower trade war probability. These higher procurement costs are passed on to consumer prices.

7.2 Trade Facilitation Policies

Trade facilitation policies such as the 2013 WTO Trade Facilitation Agreement reduce administrative barriers to trade and associated fixed per shipment costs (Hornok and Koren, 2015a). The blue lines in Figure 4 illustrate the potential consequences of symmetrically cutting fixed per-shipment costs in our model for all countries by half. Comparing these lines to the base case (black lines), trade facilitation policy favors J procurement (panel a), imports from countries other than China (panel b), and lowers consumer prices (panel c). Again the intuition follows from the model. Lower fixed per-shipment costs reduce the costs of more frequent shipments in the J relative to the A system, leading firms to re-optimize their procurement strategies and passing overall lower cost to consumer prices. Notably, for trade war probabilities greater than 0.3, the blue lines in all panels are steeper than the black lines. Therefore, compared to the base case, trade facilitation policy has the unintended consequence of making procurement strategies, import shares, and prices more sensitive to global trade tensions.

7.3 Automation

Automation can alleviate the quality control problem inherent in buyer-seller relationships by reducing production mistakes that inadvertently lead to low-quality goods, and which buyers may interpret as cheating. We incorporate this possibility in the model via an increase in the "low-quality floor" by raising $\underline{\theta}$ from 0 to 0.8. The red lines in Figure 4 show that automation that raises the quality floor favors the J system (panel a), reduces the share of imports from China (panel b)—given that it is better-suited to A importing—and lowers US prices (panel c). Therefore, technological development such as automation potentially favors countries other than China and reduces US consumer prices.

8 Conclusion

In this paper, we use a combination of theory, transaction-level data, and quantitative methods to examine the importance of firms' procurement systems for the organization of international supply chains, trade flows, and for the transmission of potential trade disruptions to trade patterns and consumer prices. We make several contributions.

First, we provide a theoretical framework in which importers systematically choose between alternative procurement systems. Using a new empirical proxy – sellers per shipment – to distinguish between procurement systems in transaction-level import data, we show that US importers classified as more likely to be using J procurement report more frequent shipments, smaller shipment sizes, and higher import prices than those categorized as using A procurement, consistent with the theory. We provide the first systematic analysis of procurement strategies across industries and products, and show that J trade is more prevalent with Japan than China, and more evident in transportation equipment (e.g. autos) than textiles. Firms using such strategies report longer relationships, pay higher wages, and hold smaller inventories.

Second, we show that firms' use of procurement systems is trade policy relevant. Using a triple difference-in-differences specification, we show that a change in US trade policy that promoted trade stability – the US granting of PNTR to China in 2000 – is associated with a movement toward more J procurement among US importers and Chinese exporters. Quantitative simulations reveal that a symmetric increase in the probability of trade disruptions between the US and its trading partners would *increase* the share of imports from China – even if actual tariffs do not change – as US importers abandon J procurement from countries with which it was *ex ante* favorable and shifted towards A sourcing from China. By making J sourcing more expensive, a less stable trade environment also raises consumer prices. Our findings suggest that how firms structure procurement is an important aspect of international trade, and one that is particularly sensitive to the stability of the trading regime.

Future research may build on our conclusions in several ways. First, more work is needed to analyze how firms' procurement systems affect outcomes such as firms' productivity, and how it relates to product complexity or relationship-specific investments. Second, additional research should further examine the link between policy initiatives such as trade facilitation and firms' choice of procurement system.

References

Ahir, Hites, Nicholas Bloom, and Davide Furceri (2022). "The World Uncertainty Index". Working Paper Series 29763.

Alessandria, George, Joseph P. Kaboski, and Virgiliu Midrigan (2010). "Inventories, Lumpy Trade, and Large Devaluations". *American Economic Review* 100.5, 2304–39.

Alessandria, George, Shafaat Yar Khan, and Armen Khederlarian (2025). "Inventories, Integration, Productivity, and Welfare". *AEA Papers and Proceedings* 115, 611–17.

Alessandria, George A, Shafaat Y Khan, and Armen Khederlarian (2024). "Taking Stock of Trade Policy Uncertainty: Evidence from China's Pre-WTO Accession". *Journal of International Economics*, forthcoming.

Alfaro, Laura, Pol Antràs, Davin Chor, and Paola Conconi (2019). "Internalizing Global Value Chains: A Firm-Level Analysis". *Journal of Political Economy* 127.2, 508–559.

Alfaro, Laura and Davin Chor (2023). *Global Supply Chains: The looming "Great Reallocation"*. Tech. rep. National Bureau of Economic Research.

Amiti, Mary, Mi Dai, Robert C Feenstra, and John Romalis (2020). "How Did China's WTO Entry Affect US Prices?" *Journal of International Economics* 126, 103339.

Amiti, Mary, Stephen J. Redding, and David E. Weinstein (2019). "The Impact of the 2018 Tariffs on Prices and Welfare". *Journal of Economic Perspectives* 33.4, 187–210.

Antoniades, Alexis (2015). "Heterogeneous Firms, Quality, and Trade". *Journal of International Economics* 95.2, 263 –273. ISSN: 0022-1996.

Antràs, Pol (2003). "Firms, Contracts, and Trade Structure". *Quarterly Journal of Economics* 118.4, 1375–1418.

— (2005). "Incomplete Contracts and the Product Cycle". *American Economic Review* 95.4, 1054–1073.

Antràs, Pol and Davin Chor (2018). "On the Measurement of Upstreamness and Downstreamness in Global Value Chains". World Trade Evolution: Growth, Productivity and Employment. Routledge.

Antras, Pol and Davin Chor (2022). "Global Value Chains". *Handbook of International Economics*. Vol. 5, 297–376.

Antràs, Pol, Teresa C. Fort, and Felix Tintelnot (2017). "The Margins of Global Sourcing: Theory and Evidence from US Firms". *American Economic Review* 107.9, 2514–64.

Antràs, Pol and Elhanan Helpman (2008). "Contractual Frictions and Global Sourcing". *The Organization of Firms in a Global Economy*. Ed. by Elhanan Helpman, T. Verdier, and D. Marin. Harvard University Press, 9–54.

Bai, Xiwen, Jesús Fernández-Villaverde, Yiliang Li, and Francesco Zanetti (2024). *The Causal Effects of Global Supply Chain Disruptions on Macroeconomic Outcomes: Evidence and Theory*. Working Paper 32098. National Bureau of Economic Research.

Baumol, W., J. Panzar, and R. Willig (1982). *Contestable Markets and the Theory of Industry Structure*. New York.

Békés, Gábor, Lionel Fontagné, Balázs Muraközy, and Vincent Vicard (2017). "Shipment frequency of exporters and demand uncertainty". *Review of World Economics* 153.4, 1610–2886.

Bernard, Andrew B., J. Bradford Jensen, and Peter K. Schott (2009). "Importers, Exporters and Multinationals: A Portrait of Firms in the U.S. that Trade Goods". *Producer Dynamics: New Evidence from Micro Data*. Ed. by T. Dunne, J. B. Jensen, and M. J. Roberts. Chicago: Chicago University Press.

Blanchard, Emily J, Chad P Bown, and Robert C Johnson (2016). *Global Supply Chains and Trade Policy*. Working Paper 21883. National Bureau of Economic Research.

Boehm, Christoph E., Aaron Flaaen, and Nitya Pandalai-Nayar (2019). "Input Linkages and the Transmission of Shocks: Firm-Level Evidence from the 2011 Tōhoku Earthquake". *The Review of Economics and Statistics* 101.1, 60–75.

— (2020). "Multinationals, Offshoring, and the Decline of U.S. Manufacturing". *Journal of International Economics* 127, 103391.

Bown, Chad, Paola Conconi, Aksel Erbahar, and Lorenzo Trimarchi (2021). "Trade Protection Along Supply Chains". CEPR Discussion Paper No. 15648.

Cajal-Grossi, Julia, Davide Del Prete, and Rocco Macchiavello (2023a). "Supply chain disruptions and sourcing strategies". *International Journal of Industrial Organization* 90. The 49th Annual Conference of the European Association for Research in Industrial Economics, Vienna, 2022, 103004. ISSN: 0167-7187.

Cajal-Grossi, Julia, Rocco Macchiavello, and Guillermo Noguera (2023b). "Buyers' sourcing strategies and suppliers' markups in bangladeshi garments". *The Quarterly Journal of Economics* 138.4, 2391–2450.

Caliendo, Lorenzo, Maximiliano Dvorkin, and Fernando Parro (2019). “Trade and labor market dynamics: General equilibrium analysis of the china trade shock”. *Econometrica* 87.3, 741–835.

Chernozhukov, Victor and Han Hong (2003). “An MCMC Approach to Classical Estimation”. *Journal of Econometrics* 115.2, 293–346.

Defever, Fabrice, Christian Fischer, and Jens Suedekum (2016). “Relational Contracts and Supplier Turnover in the Global Economy”. *Journal of International Economies* 103, 147–165.

Demir, Banu, Ana Cecília Fieler, Daniel Yi Xu, and Kelly Kaili Yang (2024). “O-Ring Production Networks”. *Journal of Political Economy* 132.1, 200–247.

Duarte, Margarida (2020). “Manufacturing consumption, relative prices, and productivity”. *Journal of Macroeconomics* 65, 103232.

Eaton, Jonathan and Samuel Kortum (2002). “Technology, Geography, and Trade”. *Econometrica* 70.5, 1741–1779.

Engbom, Niklas and Christian Moser (2022). “Earnings inequality and the minimum wage: Evidence from Brazil”. *American Economic Review* 112.12, 3803–3847.

Evans, Carolyn L. and James Harrigan (2005). “Distance, Time, and Specialization: Lean Retailing in General Equilibrium”. *American Economic Review* 95.1, 292–313.

Fajgelbaum, Pablo D, Pinelopi K Goldberg, Patrick J Kennedy, and Amit K Khandelwal (Nov. 2019). “The Return to Protectionism*”. *The Quarterly Journal of Economics* 135.1, 1–55.

Feenstra, Robert C. and Gordon H. Hanson (2005). “Ownership and Control in Outsourcing to China: Estimating the Property-Rights Theory of the Firm”. *Quarterly Journal of Economics* 120.2, 729–761.

Feenstra, Robert C., John Romalis, and Peter K. Schott (2002). “U.S. Imports, Exports, and Tariff Data, 1989-2001”. NBER Working Paper No. 9387.

Flaaen, Aaron, Ali Hortaçsu, and Felix Tintelnot (2020). “The Production Relocation and Price Effects of US Trade Policy: The Case of Washing Machines”. *American Economic Review* 110.7, 2103–27.

Flaaen, Aaron and Justin Pierce (2019). “Disentangling the Effects of the 2018-2019 Tariffs on a Globally Connected U.S. Manufacturing Sector”. *Federal Reserve Finance and Economics Discussion Paper* 2019-086.

Gelman, Andrew, John B Carlin, Hal S Stern, and Donald B Rubin (2013). *Bayesian Data Analysis.* Chapman and Hall/CRC.

Grossman, Gene M. and Elhanan Helpman (2004). “Managerial Incentives and International Organization of Production”. *Journal of International Economics* 63.2, 237–262.

Grossman, Gene M., Elhanan Helpman, and Stephen J. Redding (2024). “When Tariffs Disrupt Global Supply Chains”. *American Economic Review* 114.4, 988–1029.

Hallak, Juan Carlos and Peter K. Schott (2011). “Estimating Cross-Country Differences in Product Quality”. *Quarterly Journal of Economics* 126.1, 417–474.

Handley, Kyle (2014). “Exporting under Trade Policy Uncertainty: Theory and Evidence”. *Journal of International Economics* 94.1, 50–66.

Handley, Kyle and Nuno Limão (2017). “Policy Uncertainty, Trade, and Welfare: Theory and Evidence for China and the United States”. *American Economic Review* 107.9, 2731–83.

— (2022). “Trade Policy Uncertainty”. *Annual Review of Economics* 14.1, null.

Heise, Sebastian (2024). “Firm-to-firm relationships and the Pass-Through of Shocks: Theory and Evidence”. *Review of Economics and Statistics*, 1–45.

Helper, Susan R. and Mari Sako (1995). “Supplier Relations in Japan and in the United States: Are They Converging?” *Sloan Management Review* 36.3, 77–84.

Hornok, Cecília and Miklós Koren (2015a). “Administrative Barriers to Trade”. *Journal of International Economics* 96, S110–S122.

— (2015b). “Per-Shipment Costs and the Lumpiness of International Trade”. *Review of Economics and Statistics* 97.2, 525–530.

Hummels, David and Alexandre Skiba (2004). “Shipping the Good Apples Out? An Empirical Confirmation of the Alchian-Allen Conjecture”. *Journal of Political Economy* 112.6, 1384–1402.

Hummels, David L. and Georg Schaur (2010). “Hedging price volatility using fast transport”. *Journal of International Economics* 82.1, 15–25. ISSN: 0022-1996.

Hummels, David L and Georg Schaur (2013). “Time as a Trade Barrier”. *American Economic Review* 103.7, 2935–59.

Johnson, Robert C. (2018). “Measuring Global Value Chains”. *Annual Review of Economics* 10.1, 207–236.

Kamal, Fariha and Ryan Monarch (2018). "Identifying Foreign Suppliers in US Import Data". *Review of International Economics* 26.1, 117–139.

Kamal, Fariha and Heiwai Tang (2015). "Relational Trade: Evidence from the United States". mimeograph.

Kandori, Michihiro (2002). "Introduction to Repeated Games with Private Monitoring". *Journal of Economic Theory* 102.1, 1–15.

Khandelwal, Amit (2010). "The Long and Short (of) Quality Ladders". *Review of Economic Studies* 77.4, 1450–1476.

Khandelwal, Amit, Peter Schott, and Shang-Jin Wei (2013). "Trade Liberalization and Embedded Institutional Reform: Evidence from Chinese Exporter". *American Economic Review* 103.6, 2169–95.

Kropf, Andreas and Philip Sauré (2014). "Fixed Costs Per Shipment". *Journal of International Economics* 92.1, 166–184.

Kugler, Maurice and Eric Verhoogen (2012). "Prices, Plant Size, and Product Quality". *Review of Economic Studies* 79.1, 307–339.

Kukharskyy, Bohdan (2016). "Relational contracts and global sourcing". *Journal of International Economics* 101.C, 123–147.

Kukharskyy, Bohdan and Michael Pflüger (2010). "Relational Contracts and the Economic Well-Being of Nations". IZA Discussion Paper No. 5394.

Lise, Jeremy, Costas Meghir, and Jean-Marc Robin (2016). "Matching, sorting and wages". *Review of Economic Dynamics* 19, 63–87.

Manova, Kalina and Zhihong Yu (2017). "Multi-product firms and product quality". *Journal of International Economics* 109, 116 –137. ISSN: 0022-1996.

Martin, Julian (2012). "Markups, Quality, and Transport Costs". *European Economic Review* 56.4, 777–791.

Martin, Julien, Isabelle Mejean, and Mathieu Parenti (2023). "Relationship stickiness, international trade, and economic uncertainty". *Review of Economics and Statistics*, forthcoming.

Matsui, Yoshiki (2007). "An empirical analysis of just-in-time production in Japanese manufacturing companies". *International Journal of Production Economics* 108.1. Principles and practices of managing inventories, 153–164. ISSN: 0925-5273.

Monarch, Ryan and Tim Schmidt-Eisenlohr (2023). "Longevity and the value of trade relationships". *Journal of International Economics* 145, 103842. ISSN: 0022-1996.

Nunn, Nathan (2007). "Relationship-Specificity, Incomplete Contracts, and the Pattern of Trade". *Quarterly Journal of Economics* 122.2, 569–600.

Ossa, Ralph (2014). "Trade Wars and Trade Talks with Data". *American Economic Review* 104.12, 4104–4146.

Pierce, Justin and Peter K. Schott (2016). "The Surprisingly Swift Decline of U.S. Manufacturing Employment". *American Economic Review* 106.7, 1632–1662.

Pierce, Justin R. and Peter K. Schott (2012). "Concording U.S. Harmonized System Categories Over Time". *Journal of Official Statistics* 28.1, 53–68.

Rauch, James E. (1999). "Networks versus Markets in International Trade". *Journal of Int. Econ.* 48.1, 7–35.

Schott, Peter K. (2004). "Across-Product versus Within-Product Specialization in International Trade". *Quarterly Journal of Economics* 119.2, 647–678.

Spencer, Barbara J. (2005). "International Outsourcing and Incomplete Contracts". *Canadian Journal of Economics* 38.4, 1107–1135.

Taylor, Curtis R. and Steven N. Wiggins (1997). "Competition or Compensation: Supplier Incentives under the American and Japanese Subcontracting Systems". *American Economic Review* 87.4, 598–618.

Tirole, Jean (1988). *The Theory of Industrial Organization*. Cambridge, MA: MIT Press.

Verhoogen, Eric A. (2008). "Trade, Quality Upgrading, and Wage Inequality in the Mexican Manufacturing Sector". *The Quarterly Journal of Economics* 123.2, 489–530.

World Bank (2020). "Trading for Development in the Age of Global Value Chains". *World Development Report*.

Online Appendix

A Analytical Results

A.1 Second Order Conditions Hold

American System The second derivative of the average cost yields

$$AC_A''(x,q) = \frac{r}{q}\frac{\left(\frac{r}{q}\right) e^{-rx/q}\frac{\bar{\theta}}{\Upsilon}\left[-2\left(1-e^{-rx/q}\right)+\left(\frac{r}{q}\right)\left[1+e^{-rx/q}\right]\left[x+\frac{f+m}{\bar{\theta}/\Upsilon}\right]\right]}{\left[1-e^{-rx/q}\right]^3}.$$

Thus the first-order condition is strictly upward sloping, $AC_A''(x,q) > 0$, if and only if

$$\left[1+e^{-rx/q}\right]\left[r\frac{x}{q}+\left(\frac{r}{q}\right)\left(\frac{f+m}{\bar{\theta}/\Upsilon}\right)\right]-2\left[1-e^{-rx/q}\right] > 0. \tag{A.1}$$

Consider the case when $f+m=0$. If the condition holds for this case, it must also hold for $f+m>0$, because (A.1) is increasing in $f+m$. Define $y \equiv rx/q$. Note that for $y=0$ and $f+m=0$ the left-hand side of equation (A.1) is equal to zero. Taking the derivative of the left-hand side of equation (A.1) with respect to y we obtain $1-e^{-y}(1-y)>0$. Thus, the left-hand side of (A.1) is strictly increasing in y for $0<y<1$. Therefore, if $0<y<1$, then $AC_A''(x,q)>0$.

Japanese System

$$\begin{aligned} AC_J''(x) = \Bigg[& \frac{\left(\frac{r}{q}\right)^2 e^{-rx/q}\left[f+\underline{\theta}\frac{1}{\Upsilon}x+e^{(r+\rho)x/q}(\bar{\theta}-\underline{\theta})\frac{1}{\Upsilon}x\right]\left[1+e^{-rx/q}\right]}{\left[1-e^{-rx/q}\right]^3} \\ & -\frac{2\left(\frac{r}{q}\right)e^{-rx/q}\left[\underline{\theta}\frac{1}{\Upsilon}+e^{(r+\rho)x/q}(\bar{\theta}-\underline{\theta})\frac{1}{\Upsilon}\left(1+\left(\frac{r+\rho}{q}\right)x\right)\right]\left[1-e^{-rx/q}\right]}{\left[1-e^{-rx/q}\right]^3} \\ & +\frac{\left(\frac{r+\rho}{q}\right)e^{(r+\rho)x/q}(\bar{\theta}-\underline{\theta})\frac{1}{\Upsilon}\left[2+\left(\frac{r+\rho}{q}\right)x\right]\left[1-e^{-rx/q}\right]^2}{\left[1-e^{-rx/q}\right]^3}\Bigg]\frac{r}{q}. \end{aligned}$$

Then $AC_J''(x)>0$ if and only if the numerator is greater than zero. Note that the numerator increases in f. Therefore, if the numerator is positive for $f=0$, it is positive for $f > 0$. Assume $f = 0$, and factor the numerator of $AC_J''(x)$ to obtain

$$\left(\frac{r}{q}\right) e^{-rx/q} \left[\underline{\theta}\tfrac{1}{\Upsilon} + e^{(r+\rho)x/q}(\bar{\theta} - \underline{\theta})\tfrac{1}{\Upsilon}\right] \left[\left(\frac{r}{q}\right) x \left(1 + e^{-rx/q}\right) - 2\left(1 - e^{-rx/q}\right)\right]$$
$$+ \left(\frac{r+\rho}{q}\right) e^{(r+\rho)x/q}(\bar{\theta} - \underline{\theta})\tfrac{1}{\Upsilon}\left[1 - e^{-rx/q}\right] \left\{\left[1 - e^{-rx/q}\right]\left[2 + \left(\tfrac{r+\rho}{q}\right)x\right] - 2\left(\frac{r}{q}\right) x e^{-rx/q}\right\}$$

Define $y \equiv rx/q$. For the first term note that $\left(1 + e^{-y}\right) y - 2\left(1 - e^{-y}\right) > 0$ for $0 < y < 1$. For the second term to be positive, we require that $\left([1 - e^{-y}]\left[2 + y + \left(\frac{\rho}{q}\right)x\right] - 2ye^{-y}\right) > 0$. If $\rho = 0$, then $(\cdot) > 0$ for $0 < y < 1$. Because $(\cdot)$increases in ρ, it must be true that $(\cdot) > 0$ for $\rho > 0$ and $0 < y < 1$. Therefore, if $\rho > 0$ and $0 < y < 1$, then $AC_J''(x) > 0$.

A.2 Effect of Quality and Trade Wars on Average Costs

$$\left.\frac{\partial p_J}{\partial \underline{\theta}}\right|_{\underline{\theta}<\bar{\theta}} = \left[\left(e^{(r+\rho)x_J/q} - 1\right) x_J r\right] \Big/ \left[\Upsilon(e^{-rx/q} - 1)q\right] < 0$$

$$\left.\frac{\partial p_J}{\partial \bar{\theta}}\right|_{\underline{\theta}<\bar{\theta}} = x_J r e^{(r+\rho)x_J/q} \Big/ \left[\Upsilon(1 - e^{-rx_J/q})q\right] > 0$$

$$\frac{\partial p_J}{\partial \rho} = \left(e^{(r+\rho)x_J/q} x_J^2(\bar{\theta} - \underline{\theta})r\right)\Big/ q^2\Upsilon\left(1 - e^{-\frac{rx}{q}}\right) > 0$$

Finally, comparing procurement costs in both systems note that:

$$\frac{r}{q}\frac{f + \bar{\theta}\frac{1}{\Upsilon}x_J^* + (\bar{\theta} - \underline{\theta})\frac{1}{\Upsilon}x_J^*\left[e^{rx_J^*/q} - 1\right]}{1 - e^{-rx_J^*/q}} > \frac{r}{q}\frac{f + \bar{\theta}\frac{1}{\Upsilon}x_J^*}{1 - e^{-rx_J^*/q}} > \frac{r}{q}\frac{f + \bar{\theta}\frac{1}{\Upsilon}x_A^*}{1 - e^{-rx_A^*/q}}$$

The first inequality holds since $e^{rx_J^*/q} > 1$, and the second inequality holds because the batch size that minimizes average costs in the J system is strictly less than the batch size that minimizes average costs in the A system when $m = 0$, i.e., $x_J^* < x_A^*(m = 0)$. Hence, the average procurement cost under the J system is strictly greater than under the A system for any $\rho \geq 0$ when $m = 0$.

A.3 Proof of Proposition 2.1

For $\bar{\theta} - \underline{\theta} > 0$ and $\rho > 0$, when $m_A = 0$ average costs under the J system must be higher than under the A system by the discussion above Proposition 2.1 and in Appendix A.2. Since average costs under the A system grow without bound as $m_A \to \infty$, there must be an m^* such that average costs under the systems are equalized.

A.4 Proof of Proposition 2.2

Japanese System: We apply the implicit function theorem to the FOC (5):

$$\frac{\partial FOC_J}{\partial \rho} = \frac{2xe^{\frac{x\rho}{q}}\left(\bar{\theta} - \underline{\theta}\right)}{q^2 \Upsilon (e^{-\frac{rx}{q}} - 1)} \left[\frac{x\rho}{2}\left(e^{\frac{rx}{q}} - 1\right) + q\left(\left(\frac{rx}{2q} + 1\right) e^{\frac{rx}{q}} - \frac{rx}{q} - 1\right)\right]$$

Define $y = rx/q$. Note that $\lim_{y \downarrow 0} \left(\frac{y}{2} + 1\right) e^y - y - 1 = 0$ and $\frac{d}{dy}\left(\frac{y}{2} + 1\right) e^y - y - 1 = -1 + \frac{1}{2}(y+3)e^y > 0$. Therefore $\frac{\partial FOC_J}{\partial \rho} > 0$. Then by the implicit function theorem

$$\frac{\partial x}{\partial \rho} = -\frac{\frac{\partial FOC_J}{\partial \rho}}{SOC_J} < 0,$$

where we denote by SOC_J the second-order condition, which is greater than zero as shown in Supplemental Appendix A.1.

Remember that $v_J(x_J, \rho) = f + \bar{\theta}\frac{1}{\Upsilon}x^*_J + (\bar{\theta} - \underline{\theta})\frac{1}{\Upsilon}x^*_J\left[e^{rx^*_J/q} - 1\right]$. Average costs in the "Japanese" system are then $\frac{r}{q}\frac{v_J(x_J,\rho)}{1-exp(-\frac{rx_J}{q})}$. Taking the first-order condition of these average costs and setting zero we can write.

$$\frac{\partial v(x_J, \rho)}{\partial x_J} = \frac{r}{q}\frac{v(x_J, \rho)exp(-\frac{rx_J}{q})}{1 - exp(-\frac{rx_J}{q})}$$

Now take the derivative of the unit value, $\frac{v_J(x_J,\rho)}{x_J}$,with respect to ρ to obtain

$$\left(\frac{\partial v(x_J, \rho)}{\partial x_J}\frac{\partial x_J}{\partial \rho}x + \frac{\partial v(x_J, \rho)}{\rho}x_J - v(x_J, \rho)\frac{\partial x_J}{\partial \rho}\right)\frac{1}{x_J^2}$$

Substituting for $\frac{\partial}{\partial x}v(x_J, \rho)$ from the equilibrium condition (22) into (23) we can rewrite (23) to obtain

$$\left[\left(\frac{rx_J}{q}\frac{exp(-\frac{rx_J}{q})}{1 - exp(-\frac{rx_J}{q})} - 1\right)\frac{\partial x_J}{\partial \rho}v(x_J, \rho) + \frac{\partial v(x_J, \rho)}{\rho}x_J\right]\frac{1}{x_J^2}$$

Note that $\frac{\partial v(x_J,\rho)}{\rho}x_J = \frac{x_J^3(\bar{\theta}-\underline{\theta})}{exp(-\frac{(r+\rho)x_J}{q})q\Upsilon} > 0$. Also note that $\frac{rx_J}{q}\frac{exp(-\frac{rx_J}{q})}{1-exp(-\frac{rx_J}{q})} - 1 < 0$ for $0 < \frac{rx}{q} < 1$. Then because $\frac{\partial x_J}{\partial \rho} < 0$ we have shown that $\frac{\partial}{\partial \rho}\frac{v_J(x_J,\rho)}{x_J} > 0$

American System: We apply the implicit function theorem to show:

$$\frac{\partial x_A^*}{\partial m} = -\frac{\frac{\partial FOC_A}{\partial m}}{SOC_A} = \frac{r^2 e^{-\frac{rx_A}{q}}}{q^2\left(1-e^{-\frac{rx_A}{q}}\right)^2} > 0$$

Note that unit values in the "American" system are simply $\frac{v_A(x_A)}{x_A} = \frac{f}{x_A} + \frac{\bar{\theta}}{\Upsilon}$.Therefore, $\frac{\partial x_A^*}{\partial m} > 0 \Rightarrow \frac{\partial \frac{v_A(x_A)}{x_A}}{\partial m} < 0$.

A.5 Proof of Proposition 2.3

Part 1: Comparing shipping sizes: $x_J^* < x_A^*$ First note that if $m = 0$ and $\bar{\theta} - \underline{\theta} = 0$, then average costs in the two procurement systems are identical. If $\frac{\partial x_A^*}{\partial m} > 0$ and $\frac{\partial x_J^*}{\partial \underline{\theta}} > 0$, then $x_J^* < x_A^*$all else equal. We apply the implicit function theorem. Let $FOC_A$and FOC_J denote the first-order conditions to minimize average procurement costs, and, let $SOC_A > 0$ and $SOC_J > 0$ be the associated second-order conditions that are greater than zero as shown in Supplemental Appendix A.1.

American System

$$\frac{\partial x_A^*}{\partial m} = -\frac{\frac{\partial FOC_A}{\partial m}}{SOC_A} = \frac{r^2 e^{-\frac{rx_A}{q}}}{q^2\left(1-e^{-\frac{rx_A}{q}}\right)^2} > 0$$

Japanese System

$$\begin{aligned}\frac{\partial x_J^*}{\partial \underline{\theta}} = -\frac{\frac{\partial FOC_J}{\partial \underline{\theta}}}{SOC_J} \quad &= \quad \left(\frac{r}{q}\right)\frac{1}{\Upsilon}\frac{\left[1-e^{(r+\rho)x_J^*/q}\left[1+\left(\frac{r+\rho}{q}\right)x_J^*\right]\right]\left[1-e^{-rx_J^*/q}\right]}{\left(1-e^{-rx_J^*/q}\right)^2} \\ &- \quad \left(\frac{r}{q}\right)^2\frac{1}{\Upsilon}\frac{x_J^* e^{-rx_J^*/q}\left[1-e^{(r+\rho)x_J^*/q}\right]}{\left(1-e^{-rx_J^*/q}\right)^2}.\end{aligned}$$

For $(r+\rho)x_J^*/q > 0$, this expression is negative if and only if

$$\frac{\left[1-e^{(r+\rho)x_J^*/q}\left[1+\left(\frac{r+\rho}{q}\right)x_J^*\right]\right]}{\left[1-e^{(r+\rho)x_J^*/q}\right]} > \frac{\left(\frac{r}{q}\right)x_J^* e^{-rx_J^*/q}}{\left[1-e^{-rx_J^*/q}\right]}. \tag{A.2}$$

Note that the left-hand side is greater than 1. Hence, we need to show that the right-hand side is less than 1. Define $y \equiv rx_J^*/q$, where $0 < y < 1$. We find for the right-hand side $\lim_{y\to 0} \frac{ye^{-y}}{1-e^{-y}} = \lim_{y\to 0} 1 - y = 1$. Next, note that $\frac{d}{dy}\frac{ye^{-y}}{1-e^{-y}} = \frac{e^{-y}\left[(1-y)-e^{-y}\right]}{\left[1-e^{-y}\right]^2} < 0$. It follows that the right-hand side of (A.2) is never greater than 1. Therefore, $\partial FOC/\partial\underline{\theta} < 0$ and$\partial x_J^*/\partial\underline{\theta} > 0$.

Part 2: Comparing unit values: $v_A(x_A)/x_A < v_J(x_J)/x_J$

$$v_s(x_s)/x_s = \begin{cases} \frac{f}{x_A^*} + \frac{\bar{\theta}}{\Upsilon} & \text{if } s = A \\ \frac{f}{x_J^*} + \frac{\bar{\theta}}{\Upsilon} + \left(e^{\frac{(r+\rho)x}{q}} - 1\right)(\bar{\theta} - \underline{\theta})\frac{1}{\Upsilon} & \text{if } s = J \end{cases}$$

Comparing the expressions, $x_A^* > x_J^*$(see Part 1) and $\left(e^{\frac{(r+\rho)x}{q}} - 1\right)(\bar{\theta} - \underline{\theta})\frac{1}{\Upsilon} \Rightarrow v_A(x_A)/x_A < v_J(x_J)/x_J$.

A.6 Proof of Proposition 5.1

Part 1: Order size and shipping frequency increase in q.

American System We apply the implicit function theorem to the first-order condition in the "American" system. From the first-order condition and setting to zero we obtain $v'(x) = \frac{r(v(x)+m)e^{-rx/q}}{q\left(1-e^{-rx/q}\right)}$. Substituting this optimality condition into $\frac{\partial FOC_A}{\partial q}$ we obtain

$$\frac{\partial x_A}{\partial q} = -\frac{\frac{\partial FOC_A}{q}}{SOC_A} = \frac{\left[1 - \frac{\frac{rx}{q}\mathrm{e}^{-\frac{rx}{q}}}{1-\mathrm{e}^{-\frac{rx}{q}}} - \frac{rx}{q}\right]}{SOC_A}\frac{r^2\left(v\left(x\right)+m\right)\mathrm{e}^{-\frac{rx}{q}}}{q^3\left(1-\mathrm{e}^{-\frac{rx}{q}}\right)^2}$$

Then, $0 < \frac{rx}{q} < 1 \Rightarrow [\cdot] < 0 \Rightarrow \frac{\partial x_A}{\partial q} > 0$ over the relevant parameter range where costs are positive.

For the shipment frequency, $d(x_A^*/q)/dq < 0$, define $\psi_A = x_A^*/q$. Then, simplifying the first-order condition under the "American" system we have

$$FOC(\psi_A) = \bar{\theta}\frac{1}{\Upsilon}\left[1-e^{-r\psi_A}\right] - \left(\frac{r}{q}\right)e^{-r\psi_A}\left[f + m + \bar{\theta}\frac{1}{\Upsilon}q\psi_A\right] = 0.$$

Applying the implicit function theorem to this expression yields

$$\frac{\partial \psi_A}{\partial q} = -\frac{\frac{\partial FOC(\psi_A)}{\partial q}}{\frac{\partial FOC(\psi_A)}{\partial \psi_J}} = -\frac{[f+m]}{rq\left[f+m+\bar{\theta}\frac{1}{\Upsilon}q\psi_A\right]} < 0,$$

and hence the time between shipments decreases, i.e., shipping frequency increases.

Japanese System We follow the same strategy as in the proof for the American system. From the first-order condition, FOC_J, we obtain $\frac{\partial v_J(x_J,q)}{\partial x_J} = \frac{rv_J(x_J,q)e^{-\frac{rx}{q}}}{q\left(1-e^{-\frac{rx}{q}}\right)}$ which we substitute into $\frac{\partial FOC_J}{\partial q}$ to obtain:

$$\begin{aligned}\frac{\partial FOC_J}{q} &= \left[1 - \frac{rxe^{-\frac{rx}{q}}}{q\left(1-e^{-\frac{rx}{q}}\right)} - \frac{rx}{q}\right]\left(\frac{r^2 v(x,q)e^{-\frac{rx}{q}}}{q^3\left(1-e^{-\frac{rx}{q}}\right)^2}\right) \\ &- \frac{2(r+\rho)(\bar{\theta}-\underline{\theta})xre^{\frac{x\rho}{q}}}{q^4\Upsilon(e^{-\frac{rx}{q}}-1)^2}\left(\frac{x\rho}{2}\left(e^{\frac{rx}{q}}-1\right)+\left[\left(\frac{rx}{2q}+1\right)e^{\frac{rx}{q}}-\frac{rx}{q}-1\right]q\right)\end{aligned}$$

Note that $0 < \frac{rx}{q} < 1 \Rightarrow \left[1 - \frac{rxe^{-\frac{rx}{q}}}{q\left(1-e^{-\frac{rx}{q}}\right)} - \frac{rx}{q}\right] < 0$ & $\left[\left(\frac{rx}{2q}+1\right)e^{\frac{rx}{q}} - \frac{rx}{q} - 1\right] > 0 \Rightarrow -\frac{\frac{\partial FOC_J}{q}}{SOC_J} > 0 \Rightarrow \frac{\partial x_J^*}{\partial q} > 0$, because all other terms are positive by inspection.

To see that $d(x_J^*/q)/dq < 0$, define $\psi_J = x_J^*/q$. The first-order condition under the "Japanese" system can then be simplified to

$$\begin{aligned}FOC(\psi_J) = &\left[\underline{\theta}\tfrac{1}{\Upsilon} + \left(\bar{\theta}-\underline{\theta}\right)\tfrac{1}{\Upsilon}e^{(r+\rho)\psi_J}\left[1+(r+\rho)\psi_J\right]\right]\left(1-e^{-r\psi_J}\right) \\ &- \left(\frac{r}{q}\right)e^{-r\psi_J}\left[f+\underline{\theta}\tfrac{1}{\Upsilon}\psi_J q + (\bar{\theta}-\underline{\theta})\tfrac{1}{\Upsilon}e^{(r+\rho)\psi_J}\psi_J q\right] = 0.\end{aligned} \tag{A.3}$$

Applying the implicit function theorem to this expression yields

$$\frac{\partial \psi_J}{\partial q} = -\frac{\frac{\partial FOC(\psi_J)}{\partial q}}{\frac{\partial FOC(\psi_J)}{\partial \psi_J}}.$$

For the numerator, we have

$$\frac{\partial FOC(\psi_J)}{\partial q} = \frac{r}{q^2}e^{-r\psi_J}f > 0.$$

For the denominator we find

$$\frac{\partial FOC(\psi_J)}{\partial \psi_J} = (r+\rho)(\bar{\theta}-\underline{\theta})\tfrac{1}{\Upsilon}e^{(r+\rho)\psi_J}\left[2+(r+\rho)\psi_J\right]\left[1-e^{-r\psi_J}\right]$$
$$+\frac{r^2}{q}e^{-r\psi_J}\left[f+\underline{\theta}\tfrac{1}{\Upsilon}\psi_J+(\bar{\theta}-\underline{\theta})\tfrac{1}{\Upsilon}e^{(r+\rho)\psi_J}\psi_J\right]>0.$$

Therefore, $\partial FOC(\psi_J)/\partial q > 0$, and thus $d(x_J^*/q)/dq < 0$.

A.7 Proof of Lemma 5.2: Average cost curves are downward sloping, convex, and reach a limit

Part 1: Average cost curves are downward sloping

American System The average cost function under the "American" system is

$$AC(q) = \frac{\theta\frac{x}{q}+\frac{f}{q}+\frac{m}{q}}{1-exp(-\frac{rx}{q})}.$$

Taking the first derivative of the expression with respect to q, and fully writing out also the terms that involve x, we get

$$AC'(q) = \frac{-\frac{f+m}{q^2}+\theta\frac{x'(q)}{q}-\theta\frac{x}{q^2}}{1-exp(-\frac{rx}{q})} - \frac{\frac{r}{q}exp(-\frac{rx}{q})\left[\theta\frac{x}{q}+\frac{f}{q}+\frac{m}{q}\right]x'(q)}{\left[1-exp(-\frac{rx}{q})\right]^2} + \frac{\left(\frac{rx}{q^2}\right)exp(-\frac{rx}{q})\left[\theta\frac{x}{q}+\frac{f}{q}+\frac{m}{q}\right]}{\left[1-exp(-\frac{rx}{q})\right]^2}.$$

Re-arranging this expression, we obtain

$$AC'(q) = \frac{-\frac{f+m}{q^2}}{1-exp(-\frac{rx}{q})}+\frac{1}{q}x'(q)\left\{\frac{\theta}{1-exp(-\frac{rx}{q})}-\frac{\frac{r}{q}exp(-\frac{rx}{q})\left[\theta x+f+m\right]}{\left[1-exp(-\frac{rx}{q})\right]^2}\right\}$$
$$-\frac{x}{q^2}\left\{\frac{\theta}{1-exp(-\frac{rx}{q})}-\frac{\frac{r}{q}exp(-\frac{rx}{q})\left[\theta x+f+m\right]}{\left[1-exp(-\frac{rx}{q})\right]^2}\right\}.$$

Note that the two terms in brackets are the first-order condition of the cost function with respect to x, which is equal to zero (this is the "Envelope condition")! This is key: because in the average cost function x and q almost always appear as x/q, we can re-arrange terms to not only cancel the expression containing $x'(q)$, but also the term involving x/q^2. Thus, we get

$$AC'(q) = \frac{-\frac{f+m}{q^2}}{1 - exp(-\frac{rx}{q})}. \tag{A.4}$$

This clearly shows that average cost curves are decreasing.

Japanese System The proof proceeds in the same way as before. Average costs under the "Japanese" system are

$$AC(q) = \frac{\theta \frac{x}{q} exp(\frac{(r+\rho)x}{q}) + \frac{f}{q}}{1 - exp(-\frac{rx}{q})}.$$

The first derivative with respect to q is (ignoring the derivative with respect to x here, which we know must be zero)

$$AC'(q) = \frac{-\frac{f}{q^2} - \theta \frac{x}{q^2} exp(\frac{(r+\rho)x}{q}) - \theta(r+\rho)\frac{x^2}{q^3} exp(\frac{(r+\rho)x}{q})}{1 - exp(-\frac{rx}{q})} + \frac{\left(\frac{rx}{q^2}\right) exp(-\frac{rx}{q}) \left[\theta \frac{x}{q} exp(\frac{(r+\rho)x}{q}) + \frac{f}{q}\right]}{\left[1 - exp(-\frac{rx}{q})\right]^2}.$$

Re-arranging yields

$$AC'(q) = \frac{-\frac{f}{q^2}}{1 - exp(-\frac{rx}{q})} - \frac{x}{q^2} \left\{ \frac{\theta exp(\frac{(r+\rho)x}{q}) \left[1 + (r+\rho)\frac{x}{q}\right]}{1 - exp(-\frac{rx}{q})} - \frac{\frac{r}{q} exp(-\frac{rx}{q}) \left[\theta x exp(\frac{(r+\rho)x}{q}) + f\right]}{\left[1 - exp(-\frac{rx}{q})\right]^2} \right\}.$$

Similar to before, the term in curly brackets is the first-order condition with respect to x and is equal to zero. Therefore, we have

$$AC'(q) = \frac{-\frac{f}{q^2}}{1 - exp(-\frac{rx}{q})}. \tag{A.5}$$

This function must be convex because the function under the American system was convex for all m, and thus also for $m = 0$.

Part 2: Average cost curves are convex and converge to a finite limit.

American System Using (A.4) in Appendix A, the second derivative of average costs is

$$AC''(q) = \frac{2\frac{f+m}{q^3}}{1-exp(-\frac{rx}{q})} - \frac{\left(\frac{rx}{q^2}\right) exp(-\frac{rx}{q}) \left(\frac{f+m}{q^2}\right)}{\left[1-exp(-\frac{rx}{q})\right]^2} + \frac{\left(\frac{rx'(q)}{q}\right) exp(-\frac{rx}{q}) \left(\frac{f+m}{q^2}\right)}{\left[1-exp(-\frac{rx}{q})\right]^2}.$$

The last term is positive since $x'(q) > 0$. Therefore, to prove that the average cost function is convex, we only need to show that the first two terms together are positive. These terms can be re-written as

$$\frac{2\left[1-exp(-\frac{rx}{q})\right]\left(\frac{f+m}{q^3}\right) - \left(\frac{rx}{q}\right) exp(-\frac{rx}{q}) \left(\frac{f+m}{q^3}\right)}{\left[1-exp(-\frac{rx}{q})\right]^2},$$

which is positive if

$$2\left[1-exp(-\frac{rx}{q})\right] > \left(\frac{rx}{q}\right) exp(-\frac{rx}{q}).$$

This expression holds if

$$2\left[exp(\frac{rx}{q})-1\right] > \left(\frac{rx}{q}\right),$$

which is true. Therefore, average costs are convex, for any m and f.

Japanese System Equation (A.5) in Appendix A gives the slope of the average cost curve in the "Japanese" system. By the same arguments as in the "American" system $AC''(q) > 0$.

Part 2: Average cost curves reach a limit

Asymptote for both systems We first show $(x(q)/q) \to 0$ as $q \to \infty$.

From the Monotone Convergence Theorem, since $(x(q)/q)$ is strictly decreasing and bounded from below by zero, it must converge to a limit. Call this limit $\psi^* \geq 0$. To show that $\psi^* = 0$, assume for contradiction that $\psi^* = K > 0$. Then, it must be the case that there exists no combination of $\psi = x(q)/q < K$ and q that solves the first-order condition of the cost minimization problem. Thus, if we can find a q solving the first-order condition for a $\psi < K$, then K cannot have been the limit since ψ is strictly decreasing.

For the "American" system, pick any $0 \leq \psi_A < K$. The first-order condition of the cost minimization problem under the American system is

$$\bar{\theta}\frac{w_z}{\Upsilon}\left[1 - e^{-r\psi_A}\right] = \left(\frac{r}{q}\right) e^{-r\psi_A}\left[f + mw_b + \bar{\theta}\frac{w_z}{\Upsilon}q\psi_A\right].$$

Re-arranging this expression, we can solve for q as a function of ψ_A and find that

$$q = \frac{[f + mw_b]\, re^{-r\psi_A}}{\bar{\theta}\frac{w_z}{\Upsilon}\left[1 - e^{-r\psi_A}\left[1 + r\psi_A\right]\right]}. \tag{A.6}$$

This expression gives the q that solves the first-order condition for a given pick of $\psi_A = x_A/q$. If we can show that for any pick $\psi_A \geq 0$ there exists a $q \geq 0$ solving the equation, then it cannot be the case that $K > 0$ is the limit. For this result to hold, we need to show that the denominator is non-negative. To see that it is non-negative, note that

$$\begin{aligned} 1 - e^{-r\psi_A}\left[1 + r\psi_A\right] &\geq 0 \\ \Leftrightarrow \quad e^{r\psi_A} &\geq 1 + r\psi_A, \end{aligned}$$

which holds. Thus, for any $\psi_A \geq 0$ there exists a $q \geq 0$ solving the equation. In particular, such a q exists for any $\psi_A < K$. Therefore, $(x(q)/q)$ must converge to zero. Indeed, from the equation we can see that for $\psi_A = 0$, q must be infinite.

We can construct a similar proof for the "Japanese" system. The first-order condition under the "Japanese" system is

$$\frac{e^{(r+\rho)\psi_J}\bar{\theta}\frac{w}{\Upsilon}\left[1 + (r+\rho)\psi_J\right]}{1 - e^{-r\psi_J}} = \frac{\left(\frac{r}{q}\right)e^{-r\psi_J}\left[f + e^{(r+\rho)\psi_J}\bar{\theta}\frac{w}{\Upsilon}q\psi_J\right]}{\left[1 - e^{-r\psi_J}\right]^2}.$$

We can re-arrange this expression to solve for q and find that

$$q = \frac{fre^{-r\psi_J}}{\bar{\theta}\frac{w_z}{\Upsilon}e^{(r+\rho)\psi_J}\left[(r+\rho)\psi_J\left[1 - e^{-r\psi_J}\right] + 1 - e^{-r\psi_J}\left[1 + r\psi_J\right]\right]}. \tag{A.7}$$

By the same argument as before, the term in the denominator is non-negative and therefore for any $\psi_J \geq 0$ there exists a $q \geq 0$ solving the equation. Therefore, $(x(q)/q)$ must converge to zero. Indeed, from the equation we can see that for $\psi_J = 0$, q must be infinite.

Convergence in the "American" System Consider average costs $C(x,q)/q$. Under the "American" system, we have that

$$\frac{C(x,q)}{q} = \frac{\theta\frac{x}{q}}{1-exp(-\frac{rx}{q})} + \frac{\frac{f}{q}+\frac{m}{q}}{1-exp(-\frac{rx}{q})}.$$

We want to show the limit of this expression goes to a positive number as $q \to \infty$. For the second term we have that

$$\lim_{q\to\infty}\frac{(f+m)\frac{x^*(q)}{q}\frac{1}{x^*(q)}}{1-exp(-r\frac{x^*(q)}{q})} = \lim_{q\to\infty}\frac{(f+m)\frac{x^*(q)}{q}}{1-exp(-r\frac{x^*(q)}{q})}\cdot\lim_{q\to\infty}\frac{1}{x^*(q)} = \lim_{\psi_A\to 0}\frac{(f+m)\psi_A}{1-exp(-r\psi_A)}\cdot 0 = \frac{f+m}{r}\cdot 0,$$

by the multiplication rule of limits, where the first term converges to $(f+m)/r$ by L'Hopital's rule since $\psi_A \to 0$ as $q \to \infty$, and the second term converges to zero because $x^*(q) \to \infty$ as $q \to \infty$. Therefore, the overall term converges to 0.

For the first term we have that

$$\lim_{q\to\infty}\frac{\theta\frac{x}{q}}{1-exp(-\frac{rx}{q})} = \lim_{\psi_A\to 0}\frac{\theta\psi_A}{1-exp(-r\psi_A)} = \frac{\theta}{r},$$

where we again applied L'Hopital's rule. Therefore, overall, the average cost function under the "American" system converges to (θ/r), which is positive.

Convergence in the "Japanese" System Next consider the "Japanese" system. We have that average costs are

$$\frac{C(x,q)}{q} = \frac{\theta e^{(r+\rho)(x/q)}\frac{x}{q}}{1-exp(-\frac{rx}{q})} + \frac{\frac{f}{q}}{1-exp(-\frac{rx}{q})}.$$

The second term converges to zero by the same argument as before. For the first term we find

$$\lim_{\psi_J\to 0}\frac{\theta e^{(r+\rho)\psi_J}\psi_J}{1-exp(-r\psi_J)} = \lim_{\psi_J\to 0} e^{(r+\rho)\psi_J}\cdot\lim_{\psi_J\to 0}\frac{\theta\psi_J}{1-exp(-r\psi_J)} = 1\cdot\frac{\theta}{r},$$

and hence average costs under the "Japanese" system asymptote to exactly the same positive limit as under the "American" system.

B Data Refinement and Summary Statistics

B.1 Data Refinement

We use version c201601 of the LFTTD data, which we refine as follows. First, we drop all transactions that are warehouse entries. Second, we remove all transactions that do not include a valid importer identifier, an HS code, a value, a quantity, or a valid transaction date. We also drop observations with invalid exporter identifiers, e.g., those that do not begin with a letter (identifiers should start with the country ISO code). Third, we exclude from our analysis all related-party transactions.[59] We choose a conservative approach and exclude all relationships in which the two parties ever report being related, as well as all observations for which the related-party identifier is missing. Fourth, we use the concordance developed by Pierce and Schott (2012) to create time-consistent HS10 codes so that purchases of goods can be tracked over time. Fifth, we deflate transaction values using the quarterly GDP deflator of the Bureau of Economic Analysis, so that all values are in 2009 real dollars.[60] Sixth, since shipments of the same product between the same buyer and seller spread over multiple containers are recorded as separate transactions, we aggregate the dataset to the weekly level. We perform this aggregation to ensure that each observation in our data reflects a genuinely new transaction rather than being part of a larger shipment. Finally, to remove unit value outliers, we follow Hallak and Schott (2011) in dropping observations where the unit value is below the 1st or above the 99th percentile within HS10 by country by mode of transportation by quarter cells.

B.2 Baseline Sample

Our baseline sample restricts our cleaned data to importer (m) by HS10 product (h) by country (c) by mode of transportation (z) $mhcz$ quadruples with at least five transactions. Table A.1 provides some details for our sample period 1992-2016. The importers in our sample purchased 5.68 trillion dollars worth of goods at arm's length, the majority of which arrived by water (vessel). These imports span 360 thousand unique US importers and just over 5 million unique foreign exporters. The penultimate row shows that our sample contains almost 3 million $mhcz$ quadruples. The final

[59] The Census Bureau defines parties as related if either party owns, controls or holds voting power equivalent to 6 percent of the outstanding voting stock or shares of the other organization.

[60] https://fred.stlouisfed.org/series/GDPDEF

row of the table reports the number of "buyer-seller relationships" associated with these bins, i.e., the number of $mxhcz$ quintuples, where x denotes the exporter. There are nearly 22 million of these relationships within the 3 million buyer quadruples, or an average of about 7 sellers per $mhcz$ cell.

We compare our baseline sample to an alternative arm's-length sample that does not restrict to buyer quadruples with at least five transactions. Since we cannot compute some variables such as weeks between shipments (WBS_{mhcz}) for quadruples that trade only a single time, we focus for consistency on the arm's-length sample consisting of quadruples with two or more transactions. Table A.2 compares the two samples. The first row shows that the baseline sample accounts for slightly more than 80 percent of the broader sample of arm's-length trade by quadruples with at least two transactions. The next row shows that the broader sample contains almost twice as many importers, suggesting that most of the additional importers in the broader sample do not have substantial imports. The third row presents the number of unique exporters and the fourth row shows the number of unique importer (m) by HS10 product (h) by country (c) by mode of transportation (z) $mhcz$ quadruples. The latter rises more than twofold in the broader sample. The last row presents the number of unique quintuples. These do not increase nearly as much in percentage terms as the number of quadruples, as most of the quadruples unique to the broader sample have only few suppliers.

Table A.3 compares the $mhcz$ quadruples in the two samples. The first row shows that the average value traded by a quadruple in the broader sample is only about half of the trade value in the baseline sample. Rows two to four show that quadruples in the broader sample are shorter-lived, contain fewer shipments, and source from fewer suppliers on average. However, the average value per shipment is relatively similar to the baseline sample (row 5). Shipments in the broader sample are significantly more spaced out over time (row 6). The last two rows show that the average importer-exporter relationship length associated with a quadruple in the broader sample is shorter than in the baseline sample and that quadruples in the broader sample have a higher ratio of suppliers to shipments. The latter fact suggests that many of the additional quadruples not in the baseline sample conduct their few transactions with different suppliers.

Table A.1: US Import Transaction Summary Statistics

Total Imports ($\$Bill$)	5,680
Vessel Imports ($\$Bill$)	4,030
Air Imports ($\$Bill$)	988
Unique Importers (m)	360,000
Unique Exporters (x)	5,037,000
Unique Importer-Product-Country-Mode Quadruples ($mhcz$)	2,966,000
Unique Exporter-Importer-Product-Country-Mode Relationship Quintuples ($mxchz$)	21,700,000

Source: LFTTD and authors' calculations. Table summarizes US arm's-length imports from 1992 to 2016. Observations are restricted to quadruples with at least five transactions. Import values are in billions of real 2009 dollars. Vessel imports refer to imports arriving over water. The final four rows of the table provide counts of unique importers, exporters, buyer quadruples, i.e., US importer by HS product by origin country by mode of transport cells, and buyer-seller relationships, i.e., US importer by foreign exporter by HS product by origin country by mode of transport cells. Observation counts are rounded to the nearest thousand per US Census Bureau disclosure guidelines.

Table A.2: US Import Transaction Summary Statistics

	Baseline $t \geq 5$	Sample $t \geq 2$
Total Imports ($\$Bill$)	5,680	6,990
Unique Importers (m)	360,000	637,000
Unique Exporters (x)	5,037,000	6,531,000
Unique Importer-Product-Country-Mode Quadruples ($mhcz$)	2,966,000	7,615,000
Unigue Exporter-Importer-Product-Country-Mode Quintuples ($mxchz$)	21,700,000	30,600,000

Source: LFTTD and authors' calculations. Table summarizes US arm's-length imports from 1992 to 2016. Observations are based on the cleaned data described in Appendix B. The first column restricts to our baseline sample of quadruples with at least five transactions ($t \geq 5$), analogous to Table A.1. The final column restricts to the broader sample of quadruples with two or more transactions ($t \geq 2$). Import values are in billions of real 2009 dollars. The final four rows of the table provide counts of unique importers, exporters, buyer quadruples, i.e., US importer by HS product by origin country by mode of transport cells, and buyer-seller relationships, i.e., US importer by foreign exporter by HS product by origin country by mode of transport cells. Observation counts are rounded to the nearest thousand per US Census Bureau disclosure guidelines.

Table A.3: Attributes of $mhcz$ Quadruples

	Baseline Sample $t \geq 5$		Broader Sample $t \geq 2$	
	Mean	*Standard Deviation*	*Mean*	*Standard Deviation*
Total Value Traded ($)	1,914,000	36,300,000	918,400	24,100,000
Length Between Buyer's First and Last Shipment (Weeks)	304.3	266	187.9	229.8
Total Shipments	38.6	157.9	17.8	100.4
Number of Sellers (x)	7.3	25.5	4.0	16.2
Value per Shipment (VPS), ($)	35,910	386,100	38,090	470,500
Weeks Between Shipments (WBS)	23.5	28.5	44.5	79.8
Average Relationship Length in Weeks ($length$)	180.8	154.7	147.2	156.7
Ratio of Sellers to Shipments (SPS)	0.334	0.241	0.512	0.306

Source: LFTTD and authors' calculations. Table reports the mean and standard deviation across importer (m) by country (c) by ten-digit Harmonized System category (h) by mode of transport (z) quadruples during our 1992 to 2016 sample period. Observations are based on the cleaned data described in Appendix B. Import values are in real 2009 dollars. The first two columns restrict to our baseline sample of quadruples with at least five transactions, analogous to Table 1. The final two columns restrict to the broader sample of quadruples with two or more transactions. Observation counts are rounded to the nearest thousand per US Census Bureau disclosure guidelines.

B.3 Additional Statistics on Sellers per Shipment

Table A.4 provides information on the average number of sellers per shipment (SPS_{mhcz}) by ten-digit HS code, analogous to Table 2 in the main text. For columns (3) and (4), we define J dummies J^k_{mhcz} that take a value of one if SPS_{mhcz} falls in the first quartile of its distribution within country-mode bins in the first time period ($k = cz$) to retain variation across products. We find that J sourcing is most prevalent for transportation equipment, machinery, plastics, and optical products.

Table A.4: "Japanese" Relationships by HS Category

	Mean SPS		$J^{cz}_{mhcz} = 1$ Share of Import Value	
	(1)	(2)	(3)	(4)
Product code (HS chapter)	1995-2000	2002-2007	1995-2000	2002-2007
Transportation (86-89)	0.107	0.081	0.783	0.880
Machinery (84-85)	0.130	0.133	0.754	0.763
Plastics (39-40)	0.130	0.096	0.727	0.820
Optical products (90-92)	0.137	0.127	0.726	0.768
Footwear (64-67)	0.142	0.117	0.750	0.827
Other products (93-99)	*0.151*	*0.124*	*0.697*	*0.808*
Metals (72-83)	0.154	0.128	0.600	0.737
Food (16-24)	0.155	0.120	0.601	0.747
Chemicals (28-38)	0.156	0.121	0.600	0.736
Stones & Jewelry (68-71)	0.159	0.141	0.658	0.674
Animal products & vegetables (01-15)	0.166	0.132	0.511	0.608
Minerals (25-27)	0.182	0.203	0.570	0.500
Leather and wood products (41-49)	0.188	0.153	0.556	0.688
Textiles (50-63)	0.224	0.177	0.463	0.604

Source: LFTTD and authors' calculations. The first two columns report the weighted average sellers per shipment (SPS_{mhcz}) across buyer quadruples with at least five transactions by HS category and period, where import values are used as weights. Numbers in parentheses refer to the Harmonized System chapter of the product. The second two columns report the share of the value of US imports accounted for by quadruples with SPS_{mhcz} in the first quartile of the distribution of SPS_{mhcz} within country-mode in the first period. Rows of the table are sorted by column (1).

Most of the variation in SPS_{mhcz} is driven by importers. We run a series of regressions of SPS_{mhcz} separately on importer, product, country, importer industry, and mode of transportation fixed effects, and examine the R-squared from these regressions to study how much of the variation is explained.[61] We find that importer, product, industry, country, and mode fixed effects individually explain 35%, 12%, 10%, 8%, and 7% of the variation in SPS_{mhcz}, respectively. The large heterogeneity in SPS_{mhcz} across importers is consistent with different firms choosing different

[61]For industry, we use 6-digit NAICS fixed effects. We define the importer's main industry in each year as the one with the largest share of employment, and then take the modal main industry across the years in which the quadruple is active.

procurement strategies.

C Construction of the Variables

As discussed in the main text, we collapse all transactions of the same importer (m) - product (h) - country (c) - mode of transportation (z) quadruple in the same week into one. Therefore, a "transaction" (i) refers to a week in which the quadruple imports. Table A.5 provides a summary of how we construct the variables in Section 3. Table A.6 describes the variables used in Section 4.

Table A.5: Classification Regressions

	Formula	Description
Quantity per Shipment (QPS_{mhcz})	$\frac{\sum_i Quantity_{mhczi}}{Ntrans_{mhcz}}$	$Quantity_{mhczi}$ is the quantity imported by quadruple $mhcz$ at transaction i and $Ntrans_{mhcz}$ is the total number of transactions by the quadruple in 1992-2016.
Value per Shipment (VPS_{mhcz})	$\frac{\sum_i Value_{mhczi}}{Ntrans_{mhcz}}$	$Value_{mhczi}$ is the value imported by quadruple $mhcz$ at transaction i and $Ntrans_{mhcz}$ is the total number of transactions by the quadruple in 1992-2016.
Weeks between Shipments (WBS_{mhcz})	$\frac{end_{mhcz}-beg_{mhcz}}{Ntrans_{mhcz}-1}$	end_{mhcz} is the number of the week of the last transaction of the quadruple and beg_{mhcz} is the number of the week of the first transaction of the quadruple (see definition below). The denominator represents the number of time periods between subsequent transactions of the quadruple, which is one less than the number of transactions. Since we require at least five transactions in our baseline, the expression is finite.
Unit Value (UV_{mhcz})	$\frac{1}{Ntrans_{mhcz}} \sum_i \frac{Value_{mhczi}}{Quantity_{mhczi}}$	$Value_{mhczi}$ is the value imported by quadruple $mhcz$ at transaction i, $Quantity_{mhczi}$ is the corresponding quantity.
Quantity per Week (QPW_{mhcz})	$\frac{\sum_i Quantity_{mhczi}}{end_{mhcz}-beg_{mhcz}}$	In contrast to QPS_{mhcz}, this variable does not divide by the number of transactions but by the "flow" of imports in an average week. We note that since we require at least five transactions in our baseline, the beginning and end week are never the same and therefore the expression is finite.
First week (beg_{mhcz}) Last week (end_{mhcz})	$min\{Week_{mhczi}\}$ $max\{Week_{mhczi}\}$	$Week_{mhczi}$ is the week number of the transaction, relative to the first week of 1960. Thus, for example the first week of 2016 has week number 2912.
Avg. relationship length ($length_{mhcz}$)	$\frac{\sum_x length_{mx}}{Sellers_{mhcz}}$	$length_{mx} = max\{Week_{mxi}\} - min\{Week_{mxi}\}$. $Week_{mxi}$ is the week number of a transaction i of the buyer-seller pair mx in any good or mode of transportation, relative to the first week of 1960. $Sellers_{mhcz}$ is the number of exporters (x) with which the quadruple ($mhcz$) has an $mxhcz$ quintuple relationship.

Table A.6: PNTR Regressions

	Formula	Description
Quantity per Shipment (QPS_{mxhczt})	$\frac{\sum_i Quantity_{mxhczti}}{Ntrans_{mxhczt}}$	$Quantity_{mxhczti}$ is the quantity imported by quintuple $mxhcz$ in period t (either 1995-2000 or 2002-2007) at transaction i and $Ntrans_{mxhczt}$ is the total number of transactions by the quintuple in period t.
Weeks between Shipments (WBS_{mxhczt})	$\frac{end_{mxhczt} - beg_{mxhczt}}{Ntrans_{mxhczt} - 1}$	end_{mxhczt} is the number of the week of the last transaction of the quintuple in period t (either 1995-2000 or 2002-2007) and beg_{mxhczt} is the number of the week of the first transaction of the quintuple. The week number is relative to the first week of 1960. Thus, for example the first week of 2016 has week number 2912. The denominator represents the number of time periods between subsequent transactions of the quintuple, which is one less than the number of transactions. If $Ntrans_{mxhczt} = 1$, the average time gap cannot be computed. The PNTR regressions therefore require for each quintuple at least two transactions in each period t.
Unit Value (UV_{mxhczt})	$\frac{1}{Ntrans_{mxhczt}} \sum_i \frac{Value_{mxhczti}}{Quantity_{mxhczti}}$	$Value_{mxhczti}$ is the value imported by quintuple $mxhczt$ at transaction i in period t, and $Quantity_{mxhczti}$ is the corresponding quantity.
Quantity per Week (QPW_{mxhczt})	$\frac{\sum_i Quantity_{mxhczti}}{end_{mxhczt} - beg_{mxhczt}}$	In contrast to QPS_{mxhczt}, this variable does not divide by the number of transactions but by the “flow” of imports in an average week. As described above for WBS_{mxhczt}, we require for each quintuple at least two transactions in each period t so that this variable can be computed.

D Additional A vs J Classification Regressions

Thicker Relationships: Our baseline regressions in Section 3.2 are restricted to $mhcz$ quadruples with at least five transactions over our sample period. One concern might be that for quadruples that trade only relatively few times, our variable suppliers per shipment (SPS_{mhcz}) is mismeasured because we did not observe a sufficient number of transactions. In Table A.7, we show that our results are robust to restricting the regression to quadruples with at least 10 transactions.

More Aggregated Suppliers per Shipment: Another concern with our measure of SPS might be that buyers obtain shipments across multiple modes of transportation, and therefore procurement systems – and hence SPS – should be better defined at the mhc or even mh level. In Tables A.8 and A.9 we show that our results are robust to defining SPS at these higher levels of aggregation (i.e., SPS_{mhc} or SPS_{mh}), where we keep all other variables at the $mhcz$ level of the baseline.

Median of Dependent Variables: The baseline regressions in Section 3.2 contain the total number of shipments both in the denominator of the dependent variables QPS_{mhcz} and WBS_{mhcz} and in the denominator of the right-hand side variable SPS_{mhcz}, raising concerns about a mechanical correlation between these terms. We therefore re-run specification (7) using the median quantity shipped, $MedQPS_{mhcz}$ and the median weeks between shipments $MedWBS_{mhcz}$ as right-hand side variables. We also run a regression using the median unit value, $MedUV_{mhcz}$ as right-hand side variable. Results in Table A.10 are very similar to the baseline.

Importer Fixed Effects: We explore to what extent our findings are driven by variation across importers by adding importer fixed effects to specification (7). Results in Table A.11 show that R-squared increases modestly while the estimated coefficients are very similar to before.

Different Modes of Transportation: We next investigate whether the results hold separately for vessel vs. air shipments. Results in Table A.12 indicate similar results for both forms of transport.

Differentiated Products Versus Commodities: We examine whether buyers are more likely to use J procurement for differentiated goods. If differentiated products have higher inspection costs, then by Proposition 2.1 buyers are more likely to use J procurement for them, which implies smaller shipment size, greater frequency, and higher unit import values than products sourced under the A system (Proposition 2.3). Moreover, as discussed in Section 3.3, this J sourcing of differentiated products should be associated with fewer suppliers and longer relationships. We examine these features of the model using the commonly cited measure of product-differentiation from Rauch (1999) in the following $mhcz$-level OLS specification,

$$\overline{Y}_{mhcz} = \beta_0 + \beta_1 Diff_h + \beta_2 \ln(VPW_{mhcz}) + \beta_3 beg_{mhcz} + \beta_4 end_{mhcz} + \lambda_{cz} + \epsilon_{mhcz}. \tag{A.8}$$

We consider four dependent variables. The first is the average number of weeks between shipments WBS_{mhcz} as in the main text. We do not consider quantity per shipment or unit value here since the regression compares shipping systems across products, which are recorded in different units.[62] Instead, we use as our second dependent variable the average transaction value per shipment, VPS_{mhcz}, as a measure of average transaction size. Third, we consider the average relationship length ($length_{mhcz}$) as in Section 3.3. Finally, the fourth variable is a measure of the buyer's procurement type, sellers per shipment (SPS_{mhcz}) introduced in the main text. On the right-hand side, $Diff_h$ is a dummy variable indicating that product h is either differentiated or has a reference price, as opposed to being a commodity, according to the product categorization scheme proposed by Rauch (1999).[63] Because the right-hand-side variable of interest varies only at the product level, we are unable to include product fixed effects, so comparisons are made within country-mode bins by including fixed effects at that level (λ_{cz}). Since we cannot standardize quantities to be consistent across products, we control for potential scale effects using value per week (VPW_{mhcz}), rather than quantity per week, which was used in the main text. The sample period is 1992 to 2016, we include only buyer quadruples with at least five transactions, and standard errors are clustered at the country-product level.

Results, reported in Table A.13, are consistent with the model's predictions regarding inspection costs, while providing further support for the use of sellers per shipment to identify buyer types. As indicated in the first three columns of the table, we find that differentiated products are more J: they are shipped with fewer weeks between shipments, the average transaction size is smaller, and the average relationship length is longer. Results in the final column provide further support for

[62]For example, we cannot really compare the price of one barrel of oil to the price of one shoe.

[63]Rauch (1999) provides both a liberal and a conservative definition of differentiated goods. We use the liberal definition for the results reported in the main text, but note that these results are similar when we use the conservative definition.

this view, as buyer quadruples encompassing differentiated goods tend to have lower sellers per shipment.

A vs J Within Sellers: We next examine whether *mhcz* buyer quadruples' sellers per shipment, SPS_{mhcz}, predicts theory-consistent procurement patterns *within* each of their exporter relationships. In principle, a buyer quadruple could appear J in aggregate even if it were not with respect to each of its sellers. For example, a buyer quadruple might obtain frequent shipments from a few sellers, thus appearing to be J , but shipments within each seller might be dispersed if the buyer alternates among them. We use the following *mxhcz*-level OLS regression,

$$\begin{aligned} Y_{mxhcz} = \beta_0 + \beta_1 SPS_{mhcz} + \beta_2 \ln(QPW_{mxhcz}) + \beta_3 beg_{mxhcz} + \beta_4 end_{mxhcz} \\ + \lambda_{xhcz} + \epsilon_{mxhcz}. \end{aligned} \tag{A.9}$$

In this specification, Y_{mxhcz} represents procurement attributes at the buyer-seller relationship quintuple (*mxhcz*) level, and the right-hand-side variables are defined at this level as well, with the exception of SPS_{mhcz} which continues to be at the *mhcz* level.[64] We also include exporter by product by country by mode fixed effects (λ_{xhcz}) to compare buyer procurement patterns within sellers who may be heterogeneous in a number of attributes, including production costs. Standard errors are two-way clustered at the country (c) and product (h) level.

Results, reported in Table A.14, are similar to those in Section 3.2, providing further support for Proposition 2.3, as well as the use of SPS_{mhcz}. Across US buyer quadruples within foreign exporters, we find that increasing sellers per shipment by one standard deviation from its mean (from 0.33 to 0.58) is associated with a 5 log point rise in quantity per shipment, a 38 log point increase in weeks between shipments, a 3 log point decline in price, and a 16 log point drop in average relationship length.

Alternative Definition of Relationship Length: We next analyze the robustness of our measure of relationship length. If firms treat relationships with the same supplier across different products or modes of transportation as different relationships, then relationship length should not be defined using the time passed since the first ever

[64] Thus, a different number of shipments is used in the denominator of the dependent variable QPS_{mxhcz} and the independent variable SPS_{mhcz}, alleviating concerns about a mechanical correlation between the two in this regression.

transaction with the supplier overall but instead using the duration of the quintuple. We therefore construct an alternative relationship duration variable. First, for each $mxhcz$ quintuple, we compute the total number of weeks passed between the first and the last transaction. Second, for each $mhcz$ buyer quadruple, we take the average over the length of the $mxhcz$ quintuples within it. We refer to this variable as $Qlength_{mhcz}$ to indicate that it is based on the duration of the quintuple, rather than the overall length of the relationship between the importer and the exporter.

We run the same specification outlined in equation (7) using $Qlength_{mhcz}$ as the dependent variable. The results, reported in Table A.15, are similar to those in Table 4 in the main text, with coefficients that are about twice as large. The first column of the table shows that increasing sellers per shipment by one standard deviation from its mean is associated with a 61 log point decline in average relationship length. The second column shows that the average relationship length for quadruples in the fourth quartile is about 235 log points lower than the average relationship length for quadruples in the first quartile.

Average Firm Attributes: In regression (8), we use the firm-level attribute in the year of the firm's first import transaction. In Table A.16 we instead compute for each buyer quadruple an average of the firm attribute across all years in which the quadruple is active, and then average across quadruples. The two specifications could generate different results if the firm's attributes change significantly over time. The results are similar to the baseline.

Table A.7: A vs J Classification Regression With At Least 10 Transactions

	(1)	(2)	(3)	(4)
Dep. var.	$\log(QPS_{mhcz})$	$\log(WBS_{mhcz})$	$\log(UV_{mhcz})$	$\log(length_{mhcz})$
$\log(SPS_{mhcz})$	0.359***	0.370***	−0.064***	−0.504***
	0.015	0.016	0.020	0.013
$\log(QPW_{mhcz})$	0.700***	−0.306***	−0.273***	−0.134***
	0.014	0.014	0.019	0.005
Observations	1,645,000	1,645,000	1,645,000	1,645,000
R-squared	0.950	0.659	0.855	0.488
Fixed effects	hcz	hcz	hcz	hcz
Controls	beg, end	beg, end	beg, end	beg, end

Source: LFTTD and authors' calculations. Table reports the results of regressing noted attribute of importer by product by country by mode of transport ($mhcz$) bins on sellers per shipment (SPS_{mhcz}) and total quantity shipped per week (QPW_{mhcz}). QPS_{mhcz}, WBS_{mhcz}, UV_{mhcz}, and $length_{mhcz}$ are average quantity per shipment, average weeks between shipment, average unit value, and average relationship length. All regressions include product by country by mode of transport (hcz) fixed effects, control for the beginning and end week of the quadruple, and exclude quadruples with less than 10 shipments. Standard errors, adjusted for clustering by country (c) and product (h) are reported below coefficient estimates. ***, **, and * represent statistical significance at the 1, 5 and 10 percent levels.

Table A.8: A vs J Classification Regression With SPS at mhc Level

	(1)	(2)	(3)	(4)
Dep. var.	$\log(QPS_{mhcz})$	$\log(WBS_{mhcz})$	$\log(UV_{mhcz})$	$\log(length_{mhcz})$
$\log(SPS_{mhc})$	0.346^{***}	0.376^{***}	-0.083^{***}	-0.578^{***}
	0.014	0.015	0.018	0.013
$\log(QPW_{mhcz})$	0.687^{***}	-0.322^{***}	-0.279^{***}	-0.147^{***}
	0.015	0.015	0.020	0.005
Observations	$2,966,000$	$2,966,000$	$2,966,000$	$2,966,000$
R-squared	0.944	0.654	0.844	0.442
Fixed effects	hcz	hcz	hcz	hcz
Controls	beg, end	beg, end	beg, end	beg, end

Source: LFTTD and authors' calculations. Table reports the results of regressing noted attribute of importer by product by country by mode of transport ($mhcz$) bins on sellers per shipment defined for broader mhc bins (SPS_{mhc}) and total quantity shipped per week (QPW_{mhcz}). QPS_{mhcz}, WBS_{mhcz}, UV_{mhcz}, and $length_{mhcz}$ are average quantity per shipment, average weeks between shipment, average unit value, and average relationship length. All regressions include product by country by mode of transport (hcz) fixed effects, control for the beginning and end week of the quadruple, and exclude quadruples with less than five shipments. Standard errors, adjusted for clustering by country (c) and product (h) are reported below coefficient estimates. ***, **, and * represent statistical significance at the 1, 5 and 10 percent levels.

Table A.9: A vs J Classification Regression With SPS at mh Level

	(1)	(2)	(3)	(4)
Dep. var.	$\log(QPS_{mhcz})$	$\log(WBS_{mhcz})$	$\log(UV_{mhcz})$	$\log(Length_{mhcz})$
$\log(SPS_{mh})$	0.285^{***}	0.311^{***}	-0.063^{***}	-0.483^{***}
	0.019	0.020	0.021	0.009
$\log(QPW_{mhcz})$	0.668^{***}	-0.343^{***}	-0.274^{***}	-0.115^{***}
	0.014	0.014	0.020	0.006
Observations	$2,966,000$	$2,966,000$	$2,966,000$	$2,966,000$
R-squared	0.940	0.631	0.844	0.379
Fixed effects	hcz	hcz	hcz	hcz
Controls	beg, end	beg, end	beg, end	beg, end

Source: LFTTD and authors' calculations. Table reports the results of regressing noted attribute of importer by product by country by mode of transport ($mhcz$) bins on sellers per shipment defined for broader mh bins (SPS_{mh}) and total quantity shipped per week (QPW_{mhcz}). QPS_{mhcz}, WBS_{mhcz}, UV_{mhcz}, and $length_{mhcz}$ are average quantity per shipment, average weeks between shipment, average unit value, and average relationship length. All regressions include product by country by mode of transport (hcz) fixed effects, control for the beginning and end week of the quadruple, and exclude quadruples with less than five shipments. Standard errors, adjusted for clustering by country (c) and product (h) are reported below coefficient estimates. ***, **, and * represent statistical significance at the 1, 5 and 10 percent levels.

Table A.10: A vs J Classification Regression With Median Variables

	(1)	(2)	(3)
Dep. var.	$\log(MedQPS_{mhcz})$	$\log(MedWBS_{mhcz})$	$\log(MedUV_{mhcz})$
$\log(SPS_{mh})$	0.317^{***}	0.384^{***}	-0.229^{***}
	0.028	0.017	0.023
$\log(QPW_{mhcz})$	0.656^{***}	-0.301^{***}	-0.358^{***}
	0.012	0.014	0.029
Observations	$2,926,000$	$2,926,000$	$2,926,000$
R-squared	0.913	0.540	0.857
Fixed effects	hcz	hcz	hcz
Controls	beg, end	beg, end	beg, end

Source: LFTTD and authors' calculations. Table reports the results of regressing noted median attribute of importer by product by country by mode of transport ($mhcz$) bins on sellers per shipment defined for $mhcz$ bins (SPS_{mhcz}) and total quantity shipped per week (QPW_{mhcz}). $MedQPS_{mhcz}$, $MedWBS_{mhcz}$, and $MedUV_{mhcz}$ are median quantity per shipment, median weeks between shipment, and median unit value. All regressions include product by country by mode of transport (hcz) fixed effects, control for the beginning and end week of the quadruple, and exclude quadruples with less than five shipments. Standard errors, adjusted for clustering by country (c) and product (h) are reported below coefficient estimates. ***, **, and * represent statistical significance at the 1, 5 and 10 percent levels.

Table A.11: A vs J Classification Regression With Importer Fixed Effects

	(1)	(2)	(3)	(4)
Dep. var.	$\log(QPS_{mhcz})$	$\log(WBS_{mhcz})$	$\log(UV_{mhcz})$	$\log(Length_{mhcz})$
$\log(SPS_{mh})$	0.466^{***}	0.502^{***}	-0.167^{***}	-0.498^{***}
	0.015	0.015	0.014	0.017
$\log(QPW_{mhcz})$	0.681^{***}	-0.327^{***}	-0.265^{***}	-0.124^{***}
	0.019	0.019	0.018	0.006
Observations	$2,825,000$	$2,825,000$	$2,825,000$	$2,825,000$
R-squared	0.961	0.769	0.892	0.599
Fixed effects	hcz, m	hcz, m	hcz, m	hcz, m
Controls	beg, end	beg, end	beg, end	beg, end

Source: LFTTD and authors' calculations. Table reports the results of regressing noted attribute of importer by product by country by mode of transport ($mhcz$) bins on sellers per shipment defined for $mhcz$ bins (SPS_{mh}) and total quantity shipped per week (QPW_{mhcz}). QPS_{mhcz}, WBS_{mhcz}, UV_{mhcz}, and $length_{mhcz}$ are average quantity per shipment, average weeks between shipment, average unit value, and average relationship length. All regressions include product by country by mode of transport (hcz) and importer (m) fixed effects, control for the beginning and end week of the quadruple, and exclude quadruples with less than five shipments. Standard errors, adjusted for clustering by country (c) and product (h) are reported below coefficient estimates. ***, **, and * represent statistical significance at the 1, 5 and 10 percent levels.

Table A.12: A vs J Classification Regression Across Mode of Transport

	(1)	(2)	(3)	(4)
Dep. var.	$\log(QPS_{mhcz})$	$\log(WBS_{mhcz})$	$\log(UV_{mhcz})$	$\log(length_{mhcz})$
		Vessel		
$\log(SPS_{mhcz})$	0.419***	0.451***	-0.172***	-0.570***
	0.015	0.015	0.013	0.018
$\log(QPW_{mhcz})$	0.661***	-0.347***	-0.263***	-0.177***
	0.011	0.011	0.018	0.008
Observations	1,506,000	1,506,000	1,506,000	1,506,000
R-squared	0.924	0.686	0.829	0.434
		Air		
$\log(SPS_{mhcz})$	0.410***	0.443***	-0.058**	-0.609***
	0.022	0.022	0.025	0.018
$\log(QPW_{mhcz})$	0.737***	-0.272***	-0.300***	-0.106***
	0.015	0.015	0.023	0.005
Observations	1,029,000	1,029,000	1,029,000	1,029,000
R-squared	0.933	0.635	0.764	0.416

Source: LFTTD and authors' calculations. Table reports the results of regressing noted attribute of importer by product by country by mode of transport ($mhcz$) bins on bins' sellers per shipment (SPS_{mhcz}) and total quantity shipped per week (QPW_{mhcz}). QPS_{mhcz}, WBS_{mhcz}, P_{mhcz}, and $length_{mhcz}$ are average quantity per shipment, average weeks between shipment, average unit value (i.e. value divided by quantity), and average relationship length. All regressions include product by country by mode of transport (hcz) fixed effects, control for the beginning and end week of the quadruple, and exclude quadruples with less than five shipments. Standard errors, adjusted for clustering by country (c) and product (h), are reported below coefficient estimates. ***, **, and * represent statistical significance at the 1, 5 and 10 percent levels.

Table A.13: A vs J Classification Regression for Differentiated Goods

	(1)	(2)	(3)	(4)
Dep. var.	$\log(WBS_{mhcz})$	$\log(VPS_{mhcz})$	$\log(length_{mhcz})$	$\log(SPS_{mhcz})$
$Diff_h$	-0.234***	-0.225***	0.073**	-0.082***
	0.026	0.025	0.028	0.025
$\log(VPW_{mhcz})$	-0.464***	0.557***	-0.045***	-0.203***
	0.002	0.002	0.001	0.001
Observations	$2,589,000$	$2,589,000$	$2,589,000$	$2,589,000$
R-squared	0.611	0.730	0.193	0.278
Fixed effects	cz	cz	cz	cz
Controls	beg, end	beg, end	beg, end	beg, end

Source: LFTTD and authors' calculations. Table reports the results of regressing noted attribute of US importer by product by country by mode of transport ($mhcz$) bins on a dummy for whether the bin's product code is differentiated or reference priced according to the liberal classification by Rauch, 1999 and on value shipped per week (VPW_{mhcz}). WBS_{mhcz}, VPS_{mhcz}, $length_{mhcz}$, and SPS_{mhcz} are average weeks between shipment, average value per shipment, average relationship length, and sellers per shipment. All regressions include country by mode of transport (cz) fixed effects, control for the beginning and end week of the quadruple, and exclude quadruples with less than five shipments. Standard errors, adjusted for clustering by country and product, are reported below coefficient estimates. ***, **, and * represent statistical significance at the 1, 5 and 10 percent levels.

Table A.14: A vs J Classification Regression Across $mxhcz$ Quintuples

	(1)	(2)	(3)	(4)
Dep. var.	$\log(QPS_{mxhcz})$	$\ln(WBS_{mxhcz})$	$\ln(UV_{mxhcz})$	$\ln(length_{mxhcz})$
$\ln(SPS_{mhcz})$	0.100***	0.696***	−0.062***	−0.302***
	0.015	0.041	0.006	0.011
$\ln(QPW_{mxhcz})$	0.511***	−0.171***	−0.130***	−0.241***
	0.010	0.009	0.011	0.008
Observations	4,783,000	4,783,000	4,783,000	4,783,000
R-squared	0.966	0.621	0.953	0.786
Fixed effects	*xhcz*	*xhcz*	*xhcz*	*xhcz*
Controls	beg, end	beg, end	beg, end	beg, end

Source: LFTTD and authors' calculations. Table reports the results of regressing noted attribute of US importer by foreign exporter by product by country by mode of transport (*mxhcz*) bins on bins' sellers per shipment (SPS_{mhcz}) and total quantity shipped per week (QPW_{mxhcz}). QPS_{mxhcz}, WBS_{mxhcz}, P_{mxhcz}, and $length_{mxhcz}$ are average quantity per shipment, average weeks between shipment, average unit value (i.e. value divided by quantity), and average relationship length. All regressions include exporter by product by country by mode of transport (*xhcz*) fixed effects, control for the beginning and end week of the quintuple, and exclude buyer quadruples with less than five shipments. Standard errors, adjusted for clustering by country (c) and product (h) bins are reported below coefficient estimates. ***, **, and * represent statistical significance at the 1, 5 and 10 percent levels.

Table A.15: SPS_{mhcz} and Alternative Relationship Length

	(1)	(2)
Dep. var.	$\log(Qlength_{mhcz})$	$\log(Qlength_{mhcz})$
$\log(SPS_{mhcz})$	−1.126***	
	0.039	
$(SPS_{mhcz} = Q2)$		−0.653***
		0.013
$(SPS_{mhcz} = Q3)$		−1.230***
		0.024
$(SPS_{mhcz} = Q4)$		−2.348***
		0.046
$\log(QPW_{mhcz})$	−0.164***	−0.137***
	0.008	0.006
Observations	2,966,000	2,966,000
R-squared	0.619	0.613
Fixed effects	*hcz*	*hcz*
Controls	beg, end	beg, end

Source: LFTTD and authors' calculations. Table reports the results of regressing the average quintuple relationship length within each quadruple ($Qlength_{mhcz}$) quadruples' sellers per shipment (SPS_{mhcz}), sellers per shipment quartile dummies and total quantity shipped per week (QPW_{mhcz}). The regressions include product by country by mode of transport (*hcz*) fixed effects. All regressions control for the beginning and end week of the quadruple, and exclude quadruples with less than five shipments. Standard errors, adjusted for clustering by country (c) and product (h) bins are reported below coefficient estimates. ***, **, and * represent statistical significance at the 1, 5 and 10 percent levels.

Table A.16: SPS_m and Firm Characteristics

	(1)	(2)	(3)	(4)
Dep. var.	$\log(sales_m)$	$\log(pay_m)$	$\log(wage_m)$	$(inv/sales)_m$
$\log(SPS_m)$	-0.255^{***}	-0.313^{***}	-0.066^{***}	0.016^{***}
	0.005	0.006	0.002	0.001
Observations	$184,000$	$184,000$	$184,000$	$48,500$
R-squared	0.012	0.014	0.004	0.007

Source: LFTTD and authors' calculations. Table reports the results of regressing importer characteristics averaged across all years in which the importer is active on sellers per shipment (SPS_{mhcz}) averaged across all quadruples involving the importer. All regressions exclude quadruples with less than five shipments. ($sales_m$), (pay_m), ($wage_m$), and ($(inv/sales)_m$) are total sales, total payroll, average wage (i.e., payroll divided by number of employees), and total inventory at the beginning of the year divided by total sales, respectively. Robust standard errors are reported below coefficient estimates. ***, **, and * represent statistical significance at the 1, 5 and 10 percent levels.

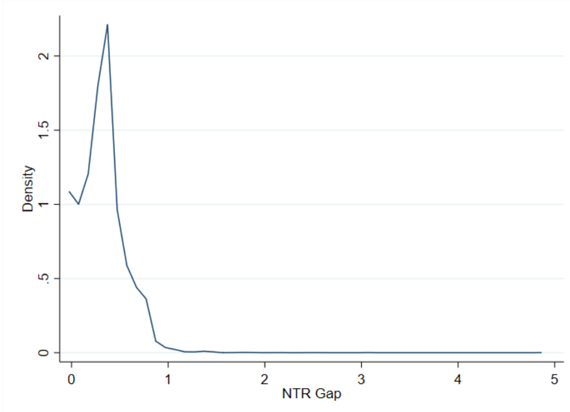
E Description of PNTR

This section provides more detail on the US granting permanent normal trade relations (PNTR) to China. US imports from non-market economies such as China are generally subject to relatively high "column two" tariff rates originally set under the Smoot-Hawley Tariff Act of 1930, as opposed to the generally low Normal Trade Relations (NTR) tariff rates the United States offers to trading partners that are members of the World Trade Organization (WTO). A provision of US trade law, however, allows imports from non-market economies to enter the United States under NTR tariffs subject to *annual* approval by both the President and Congress. Chinese imports first began entering the United States under this provision in 1980 after the warming of bilateral relations. Annual approval became controversial and less certain after the Tiananmen Square incident in 1989, and this uncertainty continued throughout the 1990s. During this time, firms engaged in or considering US-China trade faced the possibility, each year, of substantial tariff increases if China's NTR status was not re-approved. The magnitude of these potential tariff increases—32 percentage points for the average product—make clear that some buyer-seller relationships that were profitable under NTR tariff rates would not be profitable under a shift to "column two" tariffs. Indeed, Pierce and Schott (2016) document extensive discussion by US firms of the trade-dampening effects of this uncertainty in the 1990s, and Handley and Limão (2017) provide a theoretical basis for these effects that operates via suppressed entry by Chinese exporters.[65] Alessandria et al. (2024) show that uncertainty regarding the annual renewal of China's NTR status each summer reduced US imports from China, while also driving intra-year seasonal patterns in imports. When the United States granted PNTR to China in 2001, it locked in NTR rates, eliminating the need for annual renewals and the potential for relationship-severing tariff increases. This plausibly exogenous policy change provides a useful opportunity for testing Proposition 2.1, i.e., whether a decrease in the probability of a trade war leads to the adoption of more "Japanese" sourcing.[66] Our strategy follows Pierce and Schott (2016) in defining a product's exposure to PNTR as the difference

[65] Handley and Limão (2017) also estimate that the reduction in uncertainty associated with PNTR's ultimate approval was equivalent to a 13 percentage point permanent reduction in tariff rates.

[66] See also Blanchard et al. (2016), who examine how the presence of global value chains can affect the longer-term endogenous determination of tariff rates as part of multilateral trade negotiations.

Figure A.1: Distribution of the *NTR Gap*



Source: Feenstra et al., 2002 and authors' calculations. Figure displays the distribution of the $NTR\,Gap_h$, the difference between the relatively low NTR tariff rate that was locked in by PNTR and the higher rate to which US tariffs on Chinese goods might have risen absent the change in policy.

between the non-NTR rate to which its tariff could have risen before PNTR and the lower NTR rate that was locked in by the policy change,

$$NTR\,Gap_h = Non\;NTR\,Rate_h - NTR\,Rate_h. \tag{A.10}$$

We compute these gaps as of 1999, the year before the change in policy, using *ad valorem* equivalent tariff rates provided by Feenstra et al. (2002). As indicated in Figure A.1, these gaps vary widely across products, and have a mean and standard deviation of 0.32 and 0.23, respectively.

F Additional DID Regressions

Alternate Time Periods: We show that our baseline DID results also hold if we use a different post-PNTR period from 2004 to 2009. Table A.17 presents the results from the continuing relationship PNTR regression (9), and Table A.18 shows the results for the regression with only new relationships. All results retain their expected sign and remain significant. Table A.19 presents the results from the within-importer regression, equation (10), both at the $mhcz$ level and at the hcz level. On average, we find that the results from the main text become stronger for this later post-period, possibly because the shift of systems takes time.

No Quantity Control: One concern with our analysis could be that by conditioning on quantity we do not take into account that PNTR also affects the quantity traded, which could in turn affect the procurement system. We therefore run the baseline PNTR regression (9) without quantity control, QPW_{mxhczt}. Results in Table A.20 show that we still find a decline in the quantity per shipment and an increase in the unit value. The effect on weeks between shipments is qualitatively consistent with the theory, though not significant at conventional levels.

mhcz Quadruple Level: In the main text we show that PNTR changed the shipping patterns (quantity per shipment, weeks between shipments, and unit value) at the $mxhcz$ level. We next examine whether the shift from A to J procurement in response to PNTR also altered the shipping patterns at the $mhcz$ quadruple level. Compared to the regressions of continuing relationships at the $mxhcz$ level, this regression aggregates across the supplier dimension, and computes shipping attributes of the quadruple using transactions with all suppliers. It also allows for an additional margin of extensive margin adjustment, namely the formation of relationships with new suppliers that did not sell to the United States prior to PNTR. We use the following $mhczt$-level DID regression,

$$\begin{aligned}\ln(Y_{mhczt}) =& \beta_1 1\{t = Post\} * 1\{c = China\} * NTRGap_h + \beta_2 ln(QPW)_{mhczt} + \\ & \beta_3 \chi_{mhczt} + \lambda_{mhcz} + \lambda_t + \epsilon_{mhczt}. \end{aligned} \tag{A.11}$$

As before, Y_{mhczt} represents one of the three procurement attributes: average quantity per shipment (QPS_{mhczt}), average weeks between shipments (WBS_{mhczt}), and average unit value (i.e. value divided by quantity) (UV_{mhczt}).

Results, displayed in Table A.21, show a significant decline in the average shipping size and weeks between shipments, consistent with a shift towards J procurement. The increase in unit values, while positive, is statistically insignificant at conventional levels. One potential explanation for this outcome is the entry of new Chinese exporters during this period (Pierce and Schott, 2016; Amiti et al., 2020), including privately owned firms that tend to have lower prices than state-owned incumbents (Khandelwal et al., 2013). New suppliers might also charge low, introductory prices to gain market share, further dampening unit values.

All Relationships: We re-run our relationship-level PNTR regression (9) using both continuing and new relationships simultaneously for all buyer quadruples and sellers that appear in both. Specifically, we run a modified version of the regression,

$$\begin{aligned}\ln(Y_{mxhczt}) =&\beta_1 1\{t = Post\} * 1\{c = China\} * NTR\,Gap_h + \beta_2 ln(QPW_{mxhczt})+\\ &\beta_3 \chi_{mxhczt} + \lambda_{mhcz} + \lambda_x + \lambda_t + \epsilon_{mxhczt},\end{aligned} \tag{A.12}$$

where we use importer-product-country-mode of transportation ($mhcz$) fixed effects, exporter (x) fixed effects, and period (t) fixed effects. Our results in Table A.22 indicate that PNTR leads to a decline in the quantity per shipment and the number of weeks between shipments, and an increase in the unit value for this set of relationships, consistent with a shift to J procurement.

Table A.17: Within $mxhcz$ Quintuple PNTR DID Regression: 2004-2009 vs 1995-2000

	(1)	(2)	(3)
Dep. var.	$\ln(QPS_{mxhczt})$	$\ln(WBS_{mxhczt})$	$\ln(UV_{mxhczt})$
$Post_t * China_c * NTRGap_h$	-0.199***	-0.163***	0.149***
	0.017	0.021	0.031
$ln(QPW_{mxhczt})$	0.403***	-0.606***	-0.133***
	0.009	0.008	0.014
Observations	221,000	221,000	221,000
R-squared	0.980	0.883	0.982
Fixed effects	$mxhcz, t$	$mxhcz, t$	$mxhcz, t$
Controls	Yes	Yes	Yes

Source: LFTTD and authors' calculations. Table reports the results of regressing noted attribute of US importer by exporter by product by country by mode of transport ($mxhcz$) bins on the difference-in-differences term of interest and quantity shipped per week. Pre-and post periods are 1995 to 2000 and 2004 to 2009. (QPS_{mxhczt}), (WBS_{mxhczt}), and (UV_{mxhczt}) are average quantity per shipment, average weeks between shipments, and average unit value (i.e. value divided by quantity) in period t. All regressions include $mxhcz$ and period t fixed effects, control for the beginning and end week of the quintuple as well as all variables needed to identify the DID term of interest. Standard errors, adjusted for clustering by country (c) and product (h), are reported below coefficient estimates. ***, **, and * represent statistical significance at the 1, 5 and 10 percent levels.

Table A.18: New $mxhcz$ Quintuple PNTR DID Regression: 2004-2009 vs 1995-2000

	(1)	(2)	(3)
Dep. var.	$\ln(QPS_{mxhczt})$	$\ln(WBS_{mxhczt})$	$\ln(UV_{mxhczt})$
$Post_t * China_c * NTRGap_h$	-0.087**	-0.067*	0.075*
	0.036	0.035	0.045
$\ln(QPW_{mxhczt})$	0.414***	-0.590***	-0.127***
	0.012	0.011	0.017
Observations	3,158,000	3,158,000	3,158,000
R-squared	0.968	0.845	0.973
Fixed effects	$mhcz, x, t$	$mhcz, x, t$	$mhcz, x, t$
Controls	Yes	Yes	Yes

Source: LFTTD and authors' calculations. Table reports the results of regressing noted attribute of US importer by exporter by product by country by mode of transport ($mxhcz$) bins on the difference-in-differences term of interest and quantity shipped per week. Pre-and post periods are 1995 to 2000 and 2004 to 2009. (QPS_{mxhczt}), (WBS_{mxhczt}), and (UV_{mxhczt}) are average quantity per shipment, average weeks between shipments, and average unit value (i.e. value divided by quantity) in period t. All regressions include $mxhcz$ and period t fixed effects, control for the beginning and end week of the quintuple as well as all variables needed to identify the DID term of interest. Standard errors, adjusted for clustering by country (c) and product (h), are reported below coefficient estimates. ***, **, and * represent statistical significance at the 1, 5 and 10 percent levels.

Table A.19: Within-Importer PNTR Regression: 2004-2009 vs 1995-2000

	(1)	(2)	(3)	(4)
Dep. var.	$\ln(SPS_{mhczt})$	$1\{J^{hcz}_{mhczt} = 1\}$	$\ln(SPS_{hczt})$	J^{hcz}_{hczt}
$Post_t * China_c * NTRGap_h$	-0.076**	0.076**	-0.027**	0.042
	0.037	0.029	0.011	0.027
$ln(QPW_{mhczt})$	-0.186***	0.125***	-0.059***	0.031***
	0.005	0.005	0.002	0.004
Observations	556,000	225,000	355,000	28,000
R-squared	0.757	0.660	0.687	0.550
Fixed effects	$mhcz, t$	$mhcz, t$	hcz, t	hcz, t
Controls	Yes	Yes	Yes	Yes

Source: LFTTD and authors' calculations. First two columns report the results of regressing noted attribute of US importer by product by country by mode of transport ($mhcz$) bins on the difference-in-differences term of interest and quantity shipped per week. Second two columns are analogous but at the hcz level of aggregation. Pre- and post-PNTR periods are 1995 to 2000 and 2004 to 2009. All regressions include period t fixed effects, and control for the beginning and end week of the quadruple as well as all variables needed to identify the DID term of interest. Regressions in columns two and four are restricted to quadruples with at least five transactions in both periods. Standard errors, adjusted for clustering by country (c) and product (h), are reported below coefficient estimates. ***, **, and * represent statistical significance at the 1, 5 and 10 percent levels.

Table A.20: Baseline Within $mxhcz$ Quintuple PNTR DID Regression Without Quantity: 2002-2007 vs 1995-2000

	(1)	(2)	(3)
Dep. var.	$\ln(QPS_{mxhczt})$	$\ln(WBS_{mxhczt})$	$\ln(UV_{mxhczt})$
$Post_t * China_c * NTRGap_h$	-0.2753***	-0.0339	0.1186***
	0.0076	0.0318	0.0191
Observations	439,000	439,000	439,000
R-squared	0.97	0.69	0.98
Fixed effects	$mxhcz, t$	$mxhcz, t$	$mxhcz, t$
Controls	Yes	Yes	Yes

Source: LFTTD and authors' calculations. Table reports the results of regressing noted attribute of US importer by exporter by product by country by mode of transport ($mxhcz$) bins on the difference-in-differences term of interest and quantity shipped per week. Pre-and post periods are 1995 to 2000 and 2002 to 2007. (QPS_{mxhczt}), (WBS_{mxhczt}), and (UV_{mxhczt}) are average quantity per shipment, average weeks between shipment, and average unit value (i.e. value divided by quantity) in period t. All regressions include $mxhcz$ and period t fixed effects, control for the beginning and end week of the quadruple as well as all variables needed to identify the DID term of interest. Standard errors, adjusted for clustering by country (c) and product (h), are reported below coefficient estimates. ***, **, and * represent statistical significance at the 1, 5 and 10 percent levels.

Table A.21: Within $mhcz$ Quadruple PNTR DID Regression

	(1)	(2)	(3)
Dep. var.	$\ln(QPS_{mhczt})$	$\ln(WBS_{mhczt})$	$\ln(UV_{mhczt})$
$Post_t * China_c * NTRGap_h$	-0.043***	-0.058***	0.018
	0.014	0.013	0.024
$ln(QPW_{mhczt})$	0.436***	-0.584***	-0.207***
	0.018	0.018	0.026
Observations	738,000	738,000	738,000
R-squared	0.978	0.887	0.974
Fixed effects	$mhcz, t$	$mhcz, t$	$mhcz, t$
Controls	Yes	Yes	Yes

Source: LFTTD and authors' calculations. Table reports the results of regressing noted attribute of US importer by product by country by mode of transport ($mhcz$) bins on the difference-in-differences term of interest and quantity shipped per week. Pre-and post periods are 1995 to 2000 and 2002 to 2007. (QPS_{mhczt}), (WBS_{mhczt}), and (UV_{mhczt}) are average quantity per shipment, average weeks between shipments, and average unit value (i.e. value divided by quantity) in period t. All regressions include $mhcz$ and period t fixed effects, control for the beginning and end week of the quadruple as well as all variables needed to identify the DID term of interest. Standard errors, adjusted for clustering by country (c) and product (h), are reported below coefficient estimates. ***, **, and * represent statistical significance at the 1, 5 and 10 percent levels.

Table A.22: Within $mxhcz$ Quintuple PNTR DID Regression Using All Relationships: 2002-2007 vs 1995-2000

	(1)	(2)	(3)
Dep. var.	$\ln(QPS_{mxhczt})$	$\ln(WBS_{mxhczt})$	$\ln(UV_{mxhczt})$
$Post_t * China_c * NTRGap_h$	-0.131***	-0.115**	0.078***
	0.012	0.012	0.027
$ln(QPW_{mxhczt})$	0.407***	-0.597***	-0.130***
	0.013	0.012	0.018
Observations	4,023,000	4,023,000	4,023,000
R-squared	0.966	0.838	0.971
Fixed effects	$mhcz, x, t$	$mhcz, x, t$	$mhcz, x, t$
Controls	Yes	Yes	Yes

Source: LFTTD and authors' calculations. Table reports the results of regressing noted attribute of US importer by exporter by product by country by mode of transport ($mxhcz$) bins on the difference-in-differences term of interest and quantity shipped per week. Pre-and post periods are 1995 to 2000 and 2002 to 2007. (QPS_{mxhczt}), (WBS_{mxhczt}), and (UV_{mxhczt}) are average quantity per shipment, average weeks between shipment, and average unit value (i.e. value divided by quantity) in period t. All regressions include $mhcz$, exporter x, and period t fixed effects, and control for the beginning and end week of the quadruple as well as all variables needed to identify the DID term of interest. Standard errors, adjusted for clustering by country (c) and product (h), are reported below coefficient estimates. ***, **, and * represent statistical significance at the 1, 5 and 10 percent levels.

G Market Clearing Conditions

Goods market clearing implies that production equals consumption for each ω:

$$\sum_n \sum_i \sum_s I_{ni,s}(\omega) x^*_{ni,s}(\omega) = \sum_n \sum_i \sum_s I_{ni,s}(\omega) \int_0^{x^*_{ni,s}(\omega)/q_n(\omega)} q_n(\omega) dt \quad \forall \omega, \quad \text{(A.13)}$$

where $I_{ni,s}(\omega)$ is an indicator function that is equal to one if the buyer in country n procures product ω from country i under system s, and zero otherwise.

The market for the homogeneous good clears as well,

$$\sum_n Z_n = \sum_n a_n L^O_n. \quad \text{(A.14)}$$

Finally, labor market clearing in each country requires that

$$L_n = \sum_i \sum_s \int_0^1 I_{in,s}(\omega) \frac{\bar{\theta}}{\Upsilon_n(\omega)} q_i(\omega) d\omega + f_n \sum_i \sum_s \int_0^1 I_{in,s}(\omega) \frac{q_i(\omega)}{x^*_{in,s}(\omega)} d\omega$$
$$+ \sum_i \int_0^1 I_{ni,A}(\omega) m(\omega) \frac{q_n(\omega)}{x^*_{ni,s}(\omega)} d\omega + L^O_n \quad \forall n \in N, \quad \text{(A.15)}$$

where the left-hand side is total labor supply in country n, and on the right-hand side we have labor used in manufacturing production, labor used for fixed costs, labor used for inspections, and the homogeneous "outside" good labor, respectively. Since the fixed costs and the inspection costs are paid for each shipment, we scale these costs by the number of shipments per period.

H Equilibrium Solution Algorithm

We discretize the product space to $\Omega = 5,000$ products, and follow the steps in Table A.23. Our algorithm first computes the average cost curves and shipment sizes on a grid of inspection costs, productivities, trade war arrival rates, and quantities. We then guess a price index and total income for each country, trace out the demand curves, find the intersection of supply and demand, and iterate to convergence. We compute the average cost curves outside of the iteration algorithm since the numerical solution of the buyer's problem is quite time consuming. While in principle it would be possible to solve the buyer's problem within each iteration for each $ni\omega$ tuple, using linear interpolation on a grid during the iteration process is much faster.

Table A.23: Equilibrium Solution Algorithm

Step	Description
1	Initiate the model by drawing an inspection cost $m(\omega)$ for each product ω and country n from $G_n(m)$ and by drawing a productivity $\Upsilon_n(\omega)$ from $F_n(\Upsilon)$. Also set the trade war arrival rates ρ_{ni} for each country pair.
2	Define a four-dimensional grid with $(K_1 \times K_2 \times K_3 \times Q)$ grid points, where $K_1 = 70$, $K_2 = 60$, $K_3 = 60$, and $Q = 70$. Let $\mathbf{k} \equiv (k_1, k_2, k_3, q_k)$ denote a given grid point. Solve numerically for the average costs $AC(\mathbf{k})$ at each grid point under each system, using equation (4), i.e. $AC_A(\mathbf{k}) = \min_x \left(\frac{r}{q_k}\right) \frac{k_1 + k_2 x}{\left[1 - e^{-rx/q_k}\right]}$ and $AC_J(\mathbf{k}) = \min_x \left(\frac{r}{q_k}\right) \frac{k_1 + e^{(r+k_3)x/q_k} k_2 x}{\left[1 - e^{-rx/q_k}\right]}$. We denote by $x_A(\mathbf{k})$ and $x_J(\mathbf{k})$ the cost-minimizing shipment sizes under each system at grid point $\mathbf{k}$.
3	Map the draw $(m(\omega), \Upsilon_i(\omega), \rho_{ni})$ of each origin country (i)-destination country (n)-product (ω) triplet to an estimated average cost for each q_k using linear interpolation on the grid of average costs computed in Step 2, where under the A system we use $k_1 = f_i w_i + m(\omega) w_n$, $k_2 = \frac{\bar{\theta}}{\Upsilon_i(\omega)} w_i$ and under the J system we use $k_1 = f_i w_i$, $k_2 = \frac{\bar{\theta}}{\Upsilon_i(\omega)} w_i$, and $k_3 = \rho_{ni}$. Similarly, obtain the shipment sizes, $x^*_{ni,s}$, from linear interpolation on the grid of shipment sizes computed in Step 2.
4	Determine the cost minimizing system and origin country at each quantity q_k for each destination-product market $n\omega$, using equation (12). This traces out the average cost curve $AC_{n\omega}(q_k)$ of each market.
5	Begin iteration $t = 0$. Guess an initial manufacturing price index in each destination country, $P_n(t)$, and an initial total income, $W_n(t)$.
5.a	Compute each destination-product market $n\omega$'s demand curve, using utility maximization, by computing for each q_k the price $p_n(\omega; q_k, t) = \left(\frac{\alpha W_n(t)}{q_k}\right)^{\frac{1}{\sigma}} P_n(t)^{\frac{\sigma-1}{\sigma}}$.
5.b	Find the intersection between supply and demand curve in each market, using linear interpolation between grid points, to obtain the equilibrium $(p^*_n(\omega), q^*_n(\omega))$. If there are several intersections, find the last intersection at which the demand curve intersects the supply curve from above. Using the equilibrium prices in each market, compute a new price index, $P_n(t+1)$.
5.c	Determine the labor used for production, fixed costs, and inspection costs. Use the labor market clearing condition (A.15) to determine labor used for the homogeneous good sector L^O_n. Verify that this labor is non-negative.
5.d	Compute the total income in each country, $W_n(t+1)$, which is equal to labor income $w_n L_n$ plus profits under the "Japanese" system, see equation (13). Return to Step 5.a with $\{P_n(t+1), W_n(t+1)\}$ and iterate to convergence.

I Parameters and Empirical Moments

Table A.24 provides more detail on how we set the calibrated parameters in Table 9. Table A.25 contains more detail on how we construct the moments for the estimation.

Table A.24: Calibrated Parameters

Parameter	Description
Interest rate (r)	As in Caliendo et al. (2019)
Elasticity of substitution (σ)	We follow Antràs et al. (2017). They find a median markup of 35 percent across establishments. This estimate implies an elasticity of substitution of $\sigma = 3.85$.
Consumption share of manufactured goods (α)	We construct this parameter based on estimates by Duarte (2020), who uses detailed data on household consumption expenditure from the International Comparisons Programs (ICP) to compute consumption expenditures and relative prices of manufactured goods and services in many countries. She computes a real share of manufactured goods consumption in all consumption expenditures of $45\% - 50\%$ for high-income countries such as the United States (Table 4).
Dispersion of productivities (ζ)	We set this parameter based on Eaton and Kortum (2002), who estimate it from a gravity equation that relates bilateral trade flows to the characteristics of the trading partners and the distance between them.
Productivity (a_n)	We exploit that $a_n = w_n$ and set productivity based on average wages. We estimate wages as two thirds times GDP divided by the size of the labor force (i.e., GDP per worker) from the World Bank World Development Indicators (WDI) in 2016. For each country we obtain GDP in current USD (series NY.GDP.MKTP.CD) and the total size of the labor force (series SL.TLF.TOTL.IN). For RoW, we take an average across the US' top-ten trading partners (listed in Table 2) using US imports from each country in 2016 as weight. US is normalized to 1.
Labor force (L_n)	We obtain the size of the labor force from the World Development Indicators (WDI) in 2016 (series SL.TLF.TOTL.IN). For RoW, we sum the labor force of the top ten US trading partners in the period 1992-2016. The United States is normalized to 1.
Rate of trade wars US -China ($\rho_{US,CN}$)	We take all J buyer-seller ($mxhcz$) quintuples in our data, identified as those where the associated $mhcz$ quadruple is in the first quartile of the within-country-product-mode (hcz) SPS distribution in the entire dataset. We compute for these the probability that a relationship separates after τ quarters, separately for China and RoW $$S_{c\tau} = \frac{\sum_{mxhzt} \mathbb{I}^T(\tau_{mxhczt} = \tau)}{\sum_{mxhzt} \mathbb{I}(\tau_{mxhczt} = \tau)}$$ where $\mathbb{I}(\tau_{mxhczt} = \tau)$ is equal to one if quintuple $mxhcz$ is at age $\tau_{mxhczt} = \tau$ quarters in quarter t, and $\mathbb{I}^T(\tau_{mxhczt} = \tau)$ is equal to one for all such quintuples that additionally trade for the last time in quarter t. We then fit the exponential decay function $e^{-\psi_{US,i}t}$ to the estimated separation probabilities to minimize the squared deviation for $i =$China and $i =$RoW. Since many quintuples trade only once, we fit this function from quarter two onwards, $\tau = 2, ..., 100$. We obtain $\psi_{US,RoW} = 0.0873$ and $\psi_{US,CN} = 0.1137$ yielding a difference of $\rho_{US,CN} = 0.0264$.

Table A.25: Construction of Empirical Moments

Moment	Description
Share of Chinese imports in domestic manufacturing sales	We target the US import penetration from China in 2016, computed as $IP_{CN} = \frac{\text{Imports}_{CN}}{\text{Domestic output} + \text{Total imports} - \text{Total exports}}$, where Imports_{CN} are US imports from China from https://www.census.gov/foreign-trade/balance/c5700.html, Domestic output denotes gross output in the manufacturing sector from https://www.bea.gov/itable/gdp-by-industry, and Total imports and Total exports are US imports and exports of goods from https://www.census.gov/foreign-trade/balance/country.xlsx
Share of rest of world imports in domestic manufacturing sales	We target the US import penetration from the rest of the world in 2016, computed as: $IP_{RoW} = \frac{\text{Imports}_{RoW}}{\text{Domestic output} + \text{Total imports} - \text{Total exports}}$ where Imports_{RoW} are US imports from all countries except China from https://www.census.gov/foreign-trade/balance/country.xlsx.
Standard deviation of $\hat{\epsilon}$	We take the residuals from (14) and retain only those that have $\overline{WBS}_{mhcz}$ in the fourth quartile of the WBS distribution, i.e., those most likely associated with A sourcing, separately for imports from China and from the rest of the world. We collapse the residuals to the HS10 level to remove variation in shipping frequency within the same product that is unrelated to inspection costs and then take the standard deviation of the resulting product-level average residuals.

J Additional Estimation Details and Robustness

J.1 Baseline Estimation

The objective is to find a parameter vector ϕ^* that solves

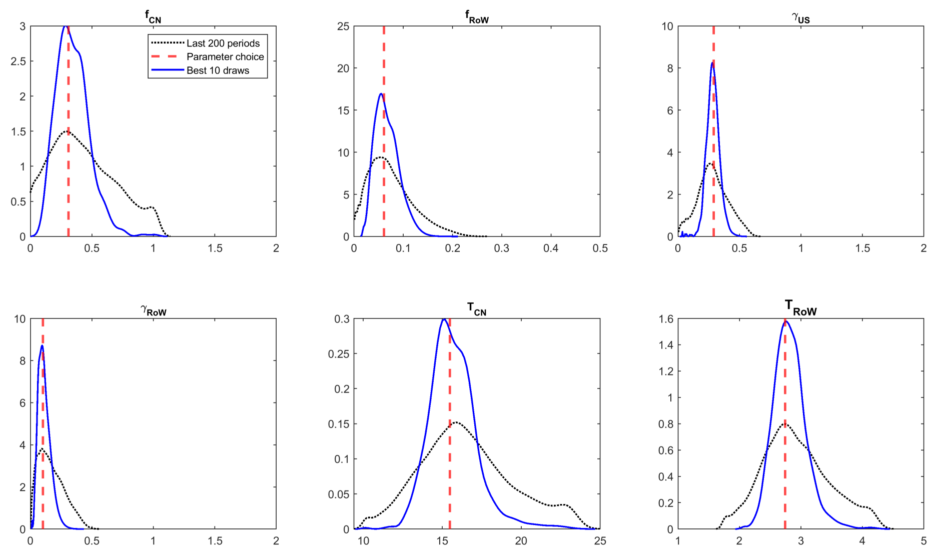
$$\arg\min_{\phi \in \mathbb{F}} \sum_x T(\mathcal{M}_x(\phi), \hat{\mathcal{M}}_x) \tag{A.16}$$

where $T(\cdot)$ is the percentage difference between the model, $(\mathcal{M}_x(\phi))$, and data, $(\hat{\mathcal{M}}_x)$, moments, and $\mathbb{F}$ is the set of admissible parameter vectors, which is bounded to be strictly positive and finite. In the choice of the function $T((\mathcal{M}_x(\phi), (\hat{\mathcal{M}}_x))$ we follow Lise et al. (2016) and minimize the sum of the percentage deviations between model-generated and empirical moments.

The minimization algorithm that we use to solve the problem combines the approaches of Lise et al. (2016) and Engbom and Moser (2022), adapted to our needs. We simulate, using Markov Chain Monte Carlo for classical estimators as introduced in Chernozhukov and Hong (2003), 100 strings of length 1,000 (+ 200 initial scratch periods used only to calculate posterior variances) starting from 100 different guesses for the vector of parameters ϕ_0. In the first run, we choose the initial guesses to span a large space of possible parameter vectors. In updating the parameter vector along the MCMC simulation, we pick the variance of the shocks to target an average rejection rate of 0.7, as suggested by Gelman et al. (2013). The average parameter values across the 20 strings with the lowest values of the objective function provide a first estimate of the vector of parameters. We then repeat the same MCMC procedure, but we start each of our 100 strings from these parameter estimates.

Figure A.2 illustrates our approach. The black dotted line shows the density function of the parameter values associated with the last 200 iterations of our 100 strings. We pick the optimal parameters (red dashed lines) following Engbom and Moser (2022) as the average across the 100 best outcomes across all the draws. These correspond to the estimates reported in Table 10. For comparison, the blue density function shows the density of the 10 best outcomes of each string, computed across all strings. This density provides an alternative way to select the best parameter values. All the densities are single-peaked, which suggests that the model is, at least locally, identified. Moreover, our chosen parameter values are generally very close to the peak of the densities.

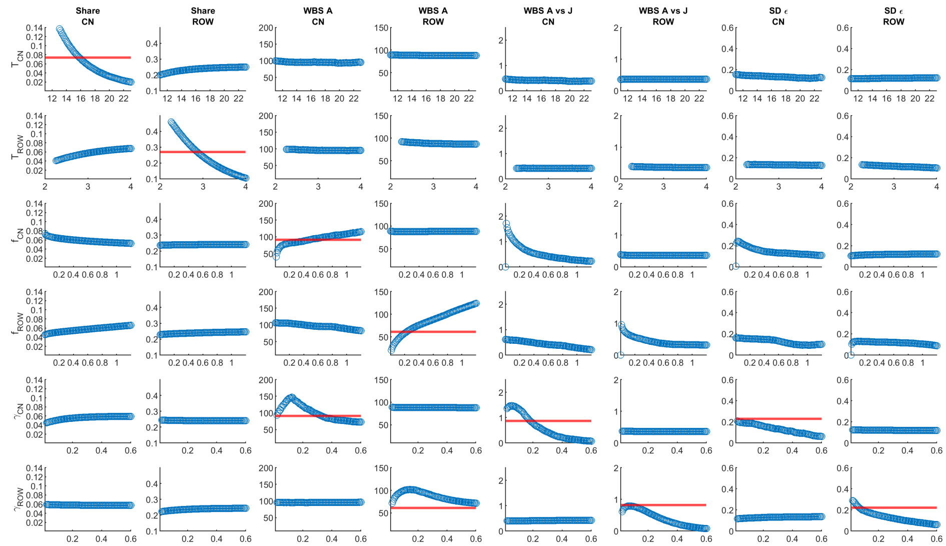
Figure A.2: Estimation Outcomes



Source: Author's calculations, based on the estimation procedure described. Each panel shows the estimated parameter values for the parameter indicated in the title, under the assumption of a Pareto distribution for inspection costs. The black dotted line shows the density function of the parameter values associated with the last 200 iterations of our 100 strings. The red dashed line shows the average parameter values across the 100 best outcomes from all the draws. The blue density functions shows the density of the 10 best outcomes of each string, computed across all strings.

Figure A.3 provides more detail on how each parameter is identified. We start from the optimal parameter values (red dashed lines in the previous figure) and vary each of the six parameters one-by-one on a grid of 100 values. For each parameter combination we solve the model 100 times, re-drawing the random productivity and inspection costs, and compute the average value of each moment. The panels in Figure A.3 plot the different values of each parameter (rows) against the values of the eight moments (columns). The main moments identifying the parameters are along the diagonal. The red horizontal line represents the value of the moment in the data, and hence identifies the parameter value that would lead the model to perfectly match this moment. While the relationships between the first four parameters and their main identifying moments are monotonic, for the last two parameters (the dispersion of inspection costs, γ_n) the relationships with some of the targeted moments are hump-shaped. Thus, there could be multiple values for each of these parameters that match a given moment equally well. We therefore target two sets of moments for these parameters (in the last four columns). This strategy yields a unique value for these parameters that minimizes the objective function.

Figure A.3: Identification of Parameters

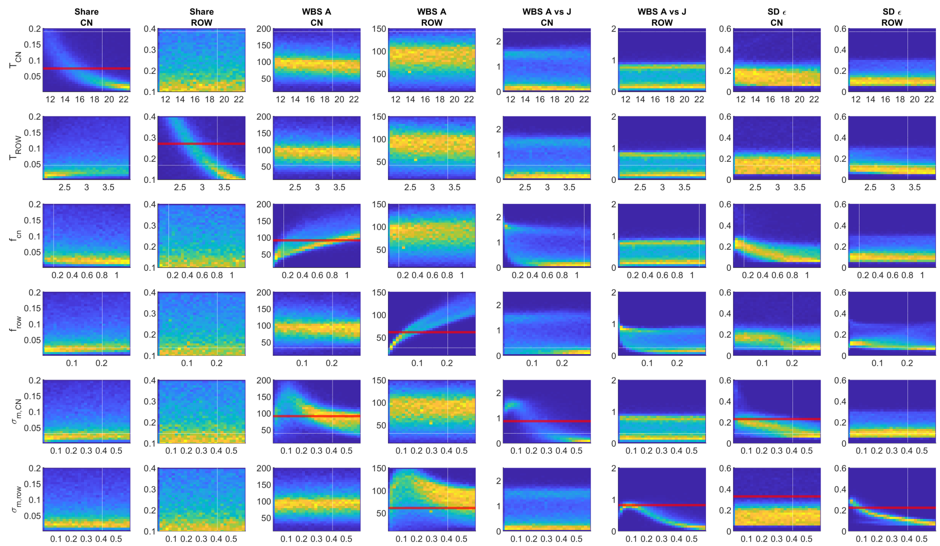


Source: Author's calculations, based on the estimation procedure described. Each panel plots different values of the parameter indicated on the row against the moment indicated on the column, keeping all other parameters fixed at their optimal value. The blue dots show the averaged moment value across 100 runs with the given parameter choice, where the averaging is needed since the inspection cost and productivity draws differ across runs. The red horizontal lines represent the value of the moment in the data. We add these only for the main panels used to identify a given parameter in the data.

We perform an additional identification exercise. We vary all six parameters from the estimation jointly by drawing 100,000 different combinations of parameter values. We then simulate the model for each combination, obtain the simulated moments, and plot the resulting relationships between parameters and moments as a binscatter in Figure A.4. This exercise differs from Figure A.3, where we only varied one parameter at a time. The values of the six parameters are obtained as quasi random numbers drawn from a Sobol sequence. The figure shows similar relationships as Figure A.3, although the associations are noisier since all parameters vary jointly. In particular, there are strong and monotone relationships between the first four parameters and their targeted moments, and more hump-shaped relationships for the final two parameters.

Overall, these exercises highlight that our parameters of interest are well-identified from the moments we target.

Figure A.4: Joint Identification of Parameters



Source: Authors' calculations, based on the estimation procedure described. Each panel plots different values of the parameter indicated on the row against the moment indicated on the column, where all parameters vary jointly based on 100,000 random parameter draws from a Sobol sequence. Lighter colors indicate more frequently observed combinations of parameter values and moment values. The red horizontal lines represent the value of the moment in the data. We add these only for the main panels used to identify a given parameter in the data.

J.2 Fréchet Distribution of Inspection Costs

We re-estimate the model using a Fréchet distribution instead of a Pareto distribution for the inspection costs:

$$G_n(m) = e^{-m^{-\gamma_n}}, \tag{A.17}$$

where γ_n is to be estimated. The other model parameters are set as before.

Figure A.5 presents our estimated parameter values analogously to Figure A.2. We find that all the densities are less tightly estimated than in the Pareto case. Our chosen parameter values are close to the peak of the densities.

Table A.26 presents the estimated parameter values and the values of the targeted moments in the simulations and in the data. The moments are reasonably well-matched, though less well than with the Pareto distribution. The model generates shares of Chinese and RoW imports in US manufacturing consumption that are close to the data, and generates shipping frequencies somewhat in line with their empirical analogues. The model does not match well the difference in shipping frequencies between the first and the fourth quartile for shipments from China in row (5). In the data, the difference in shipping times between the first and the fourth quartile of the WBS_{mhcz} distribution is relatively small, while the dispersion of shipping times within the first quartile is relatively large. To match the latter the model estimates a high volatility of inspection costs (low γ_{CN}), which causes the model to overshoot the former moment for China. For the rest of the world, the two moments are relatively well matched. Due to this deviation from the targeted moments, we prefer the Pareto distribution as our baseline, which matches all moments better due to its different shape.

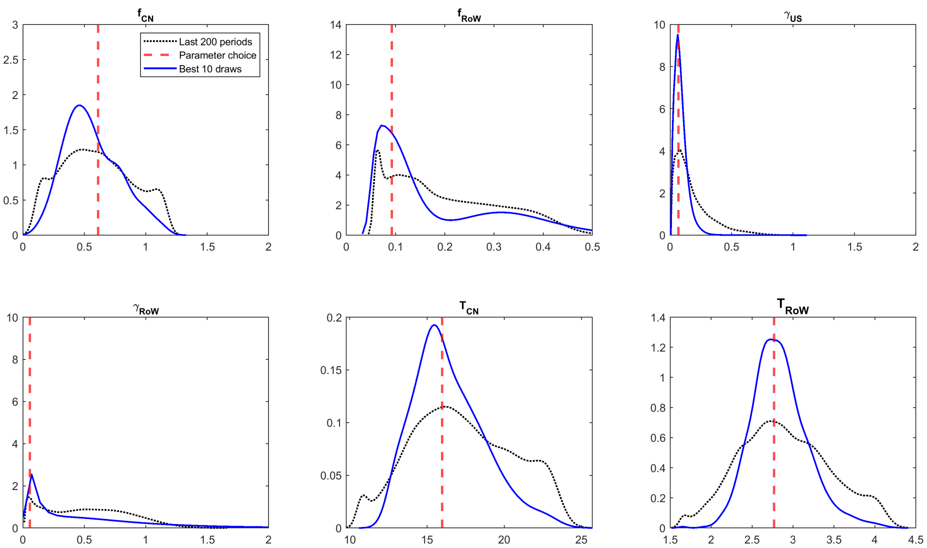
Table A.27 shows selected moments from our equilibrium. Compared to the equilibrium with a Pareto distribution, the estimated share of J relationships is significantly higher for both China and for the rest of the world, with more than half of imports estimated to be under the J system. This higher share of J relationships results from the higher dispersion of inspection costs in this estimation, which generates more high inspection cost draws, leading J sourcing to be cheaper than A sourcing for more products. The structurally estimated J shares are in the ballpark of the empirical estimates we obtained using shipments in the first quartile of the SPS_{mhcz} distribution in Table 2.

Table A.26: Estimated Parameters and Targeted Moments

	(1)	(2)	(3)	(4)	(5)
	Parameter	Estimated Value	Moment that Primarily Identifies the Parameter	Moment in Data	Moment in Model
(1)	Productivity China (T_{CN})	15.973	Share of Chinese imports in domestic sales	0.074	0.049
(2)	Productivity RoW (T_{RoW})	2.769	Share of RoW imports in domestic sales	0.270	0.273
(3)	Fixed costs, China (f_{CN})	0.613	$\exp(\hat{\beta}_0 + \hat{\beta}_1 + \hat{\beta}_3\overline{beg} + \hat{\beta}_4\overline{end})$ from (14) for CN	91.00	105.49
(4)	Fixed costs, RoW (f_{RoW})	0.092	$\exp(\hat{\beta}_0 + \hat{\beta}_1 + \hat{\beta}_3\overline{beg} + \hat{\beta}_4\overline{end})$ from (14) for RoW	60.90	66.35
(5)	Dispersion of inspection	0.068	$\hat{\beta}_1$ from (14) for China	0.871	1.411
(6)	costs, China (γ_{CN})		Sd of $\hat{\epsilon}$ from (14) for China	0.227	0.187
(7)	Dispersion of inspection	0.056	$\hat{\beta}_1$ from (14) for RoW	0.822	0.726
(8)	costs, RoW (γ_{RoW})		Sd of $\hat{\epsilon}$ from (14) for RoW	0.219	0.238
(9)	Total objective $T(\cdot)$				0.580

Source: LFTTD and authors' calculations. Column (1) lists the parameters estimated for the model. Column (2) contains the estimated parameter values. Column (3) reports the moment targeted to identify the parameter. Column (4) presents the value of the moment in the data, and Column (5) presents the value of the moment computed in our simulated model.

Figure A.5: Estimation Outcomes with Fréchet Distribution



Source: Authors' calculations, based on the estimation procedure described, using a Fréchet distribution for inspection costs. Each panel shows the estimated parameter values for the parameter indicated in the title. The black dotted line shows the density function of the parameter values associated with the last 200 iterations of our 100 strings. The red dashed line shows the average parameter values across the 100 best outcomes from all the draws. The blue density functions shows the density of the 10 best outcomes of each string, computed across all strings.

Table A.27: Equilibrium Statistics with Fréchet Distribution

(1)	Share of consumption from China (%)	4.9%
(2)	- of which, J	56.7%
(3)	Share of consumption from ROW (%)	27.3%
(4)	- of which, J	67.6%
(5)	Share of consumption from United States (%)	67.8%
(6)	Avg. inspection costs	0.2%
(7)	Avg. fixed costs (imports)	6.8%

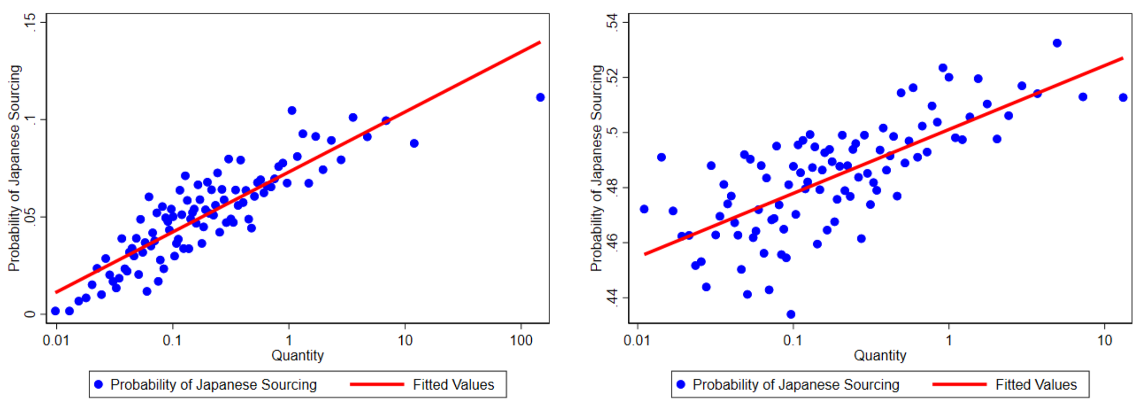
Table shows various statistics of the equilibrium under the assumption of a Fréchet distribution for inspection costs. Rows 1-5 show the share of US manufacturing sales, $P_{US}Q_{US}$, that is from China, from the rest of the world, and from the US, respectively, and the share of these manufacturing sales that is sourced under the J system. Row 6 presents the average inspection costs as a share of the import value, computed over all imports, including under the J system. Row 7 shows the average fixed costs as a share of the import value.

K Additional Quantitative Results

We plot in Figure A.6 the average share of J importers against the average quantity imported for each percentile of the quantity distribution of imports, for China and RoW.[67] The figure shows that larger importers are more likely to use the J system, as in the data. Intuitively, a higher seller productivity raises imports under both systems by reducing variable costs. Under the J system, a higher seller productivity additionally lowers the incentive premium, which makes J sourcing relatively more attractive for high-productivity imports.

Figure A.6: Quantity Imported vs Share of J Importers

(a) China (b) Rest of the World



Notes: The figure shows for each percentile of the distribution of US imports the average quantity imported against the average share of importers using the J system. The left panel presents the results for imports from China, the right panel is for imports from the rest of the world.

[67] We drop outliers below the 1st and above the 99th percentile of the distribution.