

Two-Sided Market Power in Firm-to-Firm Trade*

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Abstract

We provide a framework for analyzing buyer-supplier bargaining over the price of an intermediate input in firm-to-firm trade with two-sided market power. Our main theoretical result is a formula for the bilateral price that tractably nests a wide range of configurations of market power among firms. We demonstrate that a shock to the exporter's costs can have a very different pass-through on import prices depending on the allocation of bargaining power and bilateral market shares. To estimate the model, we build a novel dataset merging transaction-level international trade data for the U.S. with balance sheet information on both the U.S. importers and foreign exporters. Our results shed light on two open questions on firms' participation in global value chains: the relationship between import and export concentration and markups; the role of firms in determining the tariff pass-through on import prices.

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1 Introduction

The recent surge in protectionist trade policies has spurred new interest in the tariff pass-through literature. Studies of the 2018 U.S.-China trade war show robust evidence of a near-complete pass-through of U.S. tariffs into import prices, translating into substantial welfare losses for U.S. consumers.¹ Not only do these findings challenge a conventional terms-of-trade argument for non-zero tariffs (Bagwell and Staiger, 1999), but they are also hard to explain within workhorse models in the international literature, predicting an incomplete pass-through of shocks at most time horizons (Burstein and Gopinath, 2014). As the uncertainty surrounding trade remains high, understanding the determinants of movements in import prices becomes essential in optimizing trade policies.

About 80% of international trade involves global value chains (GVCs) (UNCTAD, 2013). The prevalence of global production networks suggests that theories of international prices need to be built around features of trade in differentiated intermediate inputs. Prominent among those is that intermediate inputs procurement involves significant lock-in effects, resulting in importers and exporters *negotiating* the terms of trade (Antras, 2015). What's more, both importers and exporters in GVCs are *granular* (Gaubert and Itskhoki, 2020) and exert market power over prices (Kikkawa et al., 2019; Morlacco, 2019). However, unlike what the data suggest, existing pricing frameworks in trade often neglect both the bargaining nature of price setting and the two-sided market power of firms.

This paper contributes to bridging the gap between the theoretical and empirical trade literature by investigating the determinants of import prices and pass-through elasticities in firm-to-firm trade with two-sided market power. We make several related contributions. First, we build a new model of price bargaining with two-sided market power, consistent with salient features of GVCs. The model's tractability allows us to decompose and interpret comparative statics on both markups and pass-through elasticities. We then build a novel two-sided trade dataset merging international trade data with two-sided balance sheet information to bring the model to the data. We propose an identification and estimation strategy for the key model's parameters that leverages the full dimensionality of the dataset. Theoretically and empirically, we argue that our framework performs better than traditional models in the literature in reconciling a more comprehensive range of pass-through estimates into bilateral import prices. Thus, our framework is valuable for the optimal design of trade policies, helping policy-makers predict the behavior of international prices more accurately.

¹See, e.g., Fajgelbaum et al. (2020); Flaaen et al. (2020); Amiti et al. (2019, 2020); Cavallo et al. (2020)

Our pricing framework is a partial equilibrium model of international trade where both exporters and importers are granular and exercise bargaining power over the input price. During negotiations, the agents' outside options are assumed to be the profits when the match is terminated, conditional on the pre-existing network, which we take as given. To tractably and feasibly analyze the division of surplus within a relationship, we leverage the Nash-in-Nash solution concept (Horn and Wolinsky, 1988): the negotiated price is the Nash bargaining solution for that pair, given that all other pairs are in equilibrium. The effective bargaining power of each contracting party depends on the party's bargaining weight and market share, which are both match-specific in our model.

Our main theoretical result is a formula for the bilateral markup that tractably nests a wide range of configurations of bargaining power among firms. We show that depending on how the bargaining weight is distributed among buyers and suppliers, the negotiated markup can range from a pure oligopoly markup over marginal cost down to a pure oligopsony markdown below marginal cost. When the bargaining weight is concentrated on suppliers, the markup is above one and increases in the supplier's market share, as in standard oligopolistic competition models (Atkeson and Burstein, 2008; Kikkawa et al., 2019). When the bargaining weight is concentrated on buyers, the negotiated markup (markdown) is below one and decreases with the buyer's bilateral market share (Morlacco, 2019).² In the general case where both firms enjoy bargaining power, the markup will depend both on the relative bargaining weight and the two bilateral market shares in intuitive ways.

We use our framework to analytically characterize the determinants of pass-through elasticities on import prices. On the one hand, our model captures strategic complementarities in pricing among foreign exporters, whereby markups are adjusted downwards following a cost shock. This is the standard source of incomplete pass-through in traditional models (Burstein and Gopinath, 2014; Amiti et al., 2014, 2018). On the other hand, we uncover a novel source of more-than-complete pass-through: when the import price increases following a cost shock, the buyer's market share decreases and so does its effective bargaining power, leading the supplier to charge a higher markup. We show that compared to traditional models with one-sided heterogeneity and market power, our framework can reconcile a much richer range of pass-through elasticities. Notably, it can reconcile higher-than-expected pass-through elasticities onto import prices in the context of the 2018 U.S.-China trade war (Flaen et al., 2020).

²Notably, a necessary condition for markups to be below one is that the supplier's marginal cost curve is increasing in quantity. If the supplier's marginal costs are constant, the negotiated markup is always equal to one regardless of the buyer's market share. See Section 2 for more details.

One of the challenges of studying two-sided market power is that detailed information on outcomes of bilateral transactions between importers and exporters (e.g., prices and quantities) and on characteristics of contracting parties (e.g., size and market shares) are usually hard to obtain. We confront this challenge by constructing a novel dataset containing bilateral price and quantity at the match-level and buyers' and suppliers' characteristics. Trade data come from the Longitudinal Firm Trade Transactions Database (LFTTD) of the U.S. Census Bureau, which comprises the universe of U.S. import transactions during the period 1992-2016. Balance-sheet information on U.S. importers is retrieved from the Longitudinal Business Database (LBD); information on foreign exporters come from the ORBIS database. We integrate the firm-level data with information on tariff changes at the country-product level over the same period. This matched dataset allows us to identify firms' characteristics on both sides of the cross-border trade transaction (Alvarez et al., 2019).

Using our novel dataset, we establish several facts about price dispersion in U.S. firm-to-firm trade. First, we show that firm-to-firm trade largely consists of connected bipartite sets, namely of multiple foreign exporters selling to multiple foreign importers. This means that there is substantial heterogeneity in firm-to-firm trade, which we capture in our pricing framework by letting buyers and suppliers have match-specific market shares. Second, as expected with firm-to-firm trade data, the match-specific residual accounts for a substantial variation in prices (Fontaine et al., 2020). Third, the match-specific residual in price dispersion is significantly correlated with (i) the supplier's share within a buyer's inputs, and (ii) the buyer's share within a supplier's output. As expected from the theory, we find that bilateral prices increase with the supplier's market share and decrease with the buyer's market share. The coefficients are both statistically and economically significant. Fourth, the magnitudes of the price pass-through of cost shocks are correlated with the two bilateral shares in ways that are consistent with the model. Overall, these facts are consistent with concentration among firms and two-sided market power playing an important role in determining variation in prices and their pass-through.

We then move to estimate the main parameters affecting bilateral markups and prices. We provide an identification strategy for the model's main elasticities that leverages the full dimensionality of our dataset. To estimate the bilateral bargaining weight at the match-level, we posit that they can be written as a non-parametric function of a vector of observables, including the relationship's tenure, the firms' age, and their number of employees. Leveraging our model's structure and instrumental variables, we recover the critical elasticities governing this function by matching the observed price differences across buyers

within supplier-product-year combinations with the differences in prices implied by the model.

The estimated parameters are consistent with two-sided market power playing an essential role for bilateral prices. We find that estimates of the bilateral bargaining weights are consistently inside the range where both firms have some price-setting ability. Moreover, the returns to scale parameter in the supplier's production is below one, a necessary condition for the buyer's share to play a meaningful role in equilibrium.

We evaluate the model's performance by assessing its ability to predict changes in bilateral prices during episodes of well-identified import tariff changes. Our model provides a formula for the expected price change as a function of observable buyer and supplier's shares and parameters, making this exercise not only feasible but also easily replicable. We construct the predicted price changes both under our baseline model's assumptions and under more traditional assumptions on price-setting behavior in international trade, tractably nested in our framework. We then run a horse race between all these models to validate our model's performance. We show that our pricing framework performs better than traditional models in predicting price changes. We conclude that our framework is valuable for the optimal design of trade policies, helping policy-makers accurately predict the behavior of international prices.

Related Literature Our paper contributes to several related literatures. First and foremost, we contribute to an extensive literature studying the firm-level determinants of pass-through heterogeneity. [Atkeson and Burstein \(2008\)](#) relate the pass-through elasticity to the supplier's market share; [Amiti et al. \(2014\)](#) show that the exchange-rate pass-through decreases in the supplier's shares and imported share of inputs, while [Berman et al. \(2012\)](#) show that the pass-through is decreasing in the exporter's size. Our pricing framework tractably nests these models, while considering two-sided determinants of pass-through heterogeneity. Similar to our model, [Gopinath and Itskhoki \(2010\)](#) and [Goldberg and Tille \(2013\)](#) discuss the pass-through implications of two-sided bargaining. However, neither of these papers discuss the role of concentration among buyers for bilateral prices and pass-through. We contribute to this set of papers by theoretically and empirically characterizing the role of two-sided granularity for international prices.

Our paper also relates to studies in the trade literature focusing on the role of two-sided heterogeneity for firm-level outcomes. Studies in this literature have tried to explain heterogeneity in firm size ([Bernard et al., 2018a, 2019](#)) and the intensive and extensive margin of trade ([Bernard et al., 2018b; Carballo et al., 2018; Monarch, 2020](#)). Similar to our paper,

some studies focus on price setting in buyer-supplier relationships and generate predictions on markup (Cajal-Grossi et al., 2019; Kikkawa et al., 2019; Fontaine et al., 2020) and pass-through heterogeneity (Heise, 2019). However, none of these papers investigates the joint role of two-sided market power and firm granularity.

Our paper belongs to the literature on buyer-supplier production networks studying input-output networks' role in propagating and amplifying shocks (see Bernard and Moxnes, 2018; Carvalho and Tahbaz-Salehi, 2019 for surveys). In particular, we most closely relate to the growing branch of this literature studying the role of firm-level interactions for shock transmission (Taschereau-Dumouchel, 2018; Tintelnot et al., 2019; Kikkawa et al., 2019; Acemoglu and Tahbaz-Salehi, 2020). Our main contribution to this literature is to characterize analytically the role of two-sided market power and firm granularity for the intensive-margin pass-through elasticity of a supplier's cost shock to the negotiated price. A closely related paper is Grossman and Helpman (2020), who develop a bargaining framework of firm-to-firm trade to study the effect of tariff shocks on the organization of supply chains. We see our work as complementary to theirs: while abstracting from the extensive margin channel, our model captures rich(er) pricing and pass-through patterns by allowing for both two-sided market power and granularity. Therefore, our model is useful to characterize the intensive margin price elasticities in all those settings where the trade network can be "held fixed". Our pass-through application shows one such exercise. Finally, our paper relates to burgeoning literature in industrial organization studying the relationship between market concentration and prices in bilateral bargaining settings (Draganska et al., 2010; Crawford and Yurukoglu, 2012; Grennan, 2013; Lee and Fong, 2013). In particular, we build on a recent set of papers using structural models with Nash-in-Nash bargaining protocols to estimate the impact of changes in market structure on negotiated prices (Gowrisankaran et al., 2015; Ho and Lee, 2017). We are among the first to apply similar techniques to the context of firm-to-firm international trade. To accommodate firm-level data, we rely on a structural framework and functional form assumptions both on the demand and supply sides while allowing for unobserved heterogeneity in estimation.

Structure of the Paper This paper is structured as follows. Section 2 sets up the model and characterizes the properties of import prices. Section 3 analyzes the determinants of tariff pass-through elasticities. Section 4 introduces the data and the main covariates, and outlines the main stylized facts. Identification of the main model's parameters and elasticities are discussed in Section 5. Section 6 presents our estimation results and a

discussion of how our model and estimates can be used in predicting patterns of pass-through across firms and industries. Section 7 concludes.

2 Theory

This section sets out a theory of prices in firm-to-firm trade with two-sided market power. The industry consists of multiple foreign exporters (indexed by i) and multiple U.S. importers (indexed by j) of intermediate inputs. We consider a partial equilibrium environment by focusing on the price-setting problem of an importer-exporter pair. To ease exposition, we assume single-product exporters, such that i denotes both the exporter and the traded variety. We will relax this assumption when we take the model to the data.

2.1 Setup

We let \mathcal{Z}_j denote the set of foreign varieties sourced by buyer j , or the buyer's *sourcing strategy*. Buyer j imperfectly substitutes across foreign input varieties. The foreign intermediate input's quantity and price are defined as:

$$q_j^f = \left(\sum_{k \in \mathcal{Z}_j} \zeta_{kj} (q_{kj})^{\frac{\rho-1}{\rho}} \right)^{\frac{\rho}{\rho-1}} \quad (1)$$

$$p_j^f = \left(\sum_{k \in \mathcal{Z}_j} \zeta_{kj}^\rho p_{kj}^{1-\rho} \right)^{\frac{1}{1-\rho}}, \quad (2)$$

where $\rho > 1$ is the (constant) elasticity of substitution between varieties sourced by buyer j , q_{kj} is the quantity of the variety sold from exporter k , ζ_{kj} is k 's demand shifter, and p_{kj} is the price that exporter k and buyer j negotiate, focus of our analysis.

We assume that firm j produces its final output q_j combining the foreign intermediate input with domestic inputs. We let c_j denote the firm's unit cost, and we denote by $\gamma \in (0, 1]$ the elasticity of firm j 's unit cost with respect to the foreign input price:

$$\gamma = \frac{d \ln c_j}{d \ln p_j^f} \in (0, 1]. \quad (3)$$

In the downstream market, firm j faces an iso-elastic demand with associated elasticity

$$\nu = -\frac{d \ln q_j}{d \ln p_j} > 1, \quad (4)$$

where total demand for q_j depends on the price $p_j = \frac{\nu}{\nu-1} c_j$, and (exogenous) shifters.

On the supplier side, we write firm's i total output as $q_i = q_{ij} + q_{i(-j)}$, where $q_{i(-j)}$ is total i 's demand by downstream buyers other than j . We let c_i denote firm i 's marginal cost, and let

$$\frac{1 - \theta}{\theta} = \frac{d \ln c_i}{d \ln q_j} > 0 \quad (5)$$

denote the marginal cost's elasticity to total input supply. The parameter $\theta \in (0, 1]$ governs the returns to scale of firm i 's production. When $\theta \in (0, 1)$, the marginal costs are increasing in total output, which means that upstream production exhibits decreasing returns; conversely, when $\theta = 1$, the supplier's marginal costs are constant, which means that production exhibits constant returns. The formulation in equation (5) implies that we can write firm i 's average costs as $\tilde{c}_i = c_i / \theta$.

We note that our baseline model keeps cross-sectoral parametric heterogeneity to a minimum by letting the elasticity terms ρ, γ, ν and θ be constant across firms. This choice is motivated by the data used in estimation. The analysis can be readily extended to heterogeneity in all parameters, provided relevant variation is available for identification.

2.2 Price Bargaining

Importer j and exporter i engage in bilateral negotiations to determine p_{ij} .³ The outside options of firm i and firm j are taken to be the profits when the $i - j$ link is terminated: exporter i will make fewer sales, while importer j will have higher costs (love-of-variety technology). During negotiations, both the network of firm-to-firm trade and the other nodes' prices are taken as given. We thus leverage the Nash-in-Nash solution concept: the price negotiated between i and j is the pairwise Nash bargaining solution given that all other pairs reach agreement (Horn and Wolinsky, 1988).

The negotiated price p_{ij} between supplier i and buyer j solves:

$$\max_{p_{ij}} \left(\pi_i(p_{ij}) - \tilde{\pi}_{i(-j)} \right)^{1-\phi_{ij}} \left(\pi_j(p_{ij}) - \tilde{\pi}_{j(-i)} \right)^{\phi_{ij}}, \quad (6)$$

where $\pi_i(p_{ij})$ and $\pi_j(p_{ij})$ are the profits to the supplier i and the buyer j if the negotiations succeed, and $\tilde{\pi}_{i(-j)}$ and $\tilde{\pi}_{j(-i)}$ are the disagreement payoffs, which are critical objects determining the parties' endogenous bargaining power. The parameter $\phi_{ij} \in (0, 1)$ captures exogenous determinants of the firms' bargaining ability that might influence the outcome

³In Appendix A.1, we consider the case of bargain over quantities. Both the theoretical discussion, and estimation strategy can be easily extended to this case.

of the negotiation process, such as their information structure, their negotiating strategies or time preference mismatches between the parties (Muthoo, 1999).⁴ In our notation, a higher ϕ_{ij} denotes higher relative bargaining power of importer j .

Taking the FOC with respect to (6) and rearranging terms, it is possible to write the bilateral price p_{ij} as a markup μ_{ij} over the supplier's marginal cost c_i :⁵

$$p_{ij} = \mu_{ij}c_i. \quad (7)$$

We characterize the solution to (6) by considering special limit cases first. In what follows, $s_{ij} \equiv \frac{p_{ij}q_{ij}}{\sum_{k \in \mathcal{Z}_j} p_{kj}q_{kj}}$ denotes the *supplier's share*, i.e., the share of firm i 's sales over firm j 's total imports, $x_{ij} \equiv \frac{q_{ij}}{q_i}$ denotes the *buyer's share*, i.e., the share of units of good purchased by buyer j over the total units supplied by firm i , and $\tilde{\phi}_{ij} \equiv \frac{\phi_{ij}}{1-\phi_{ij}} \in \mathbb{R}_+$ is the relative (exogenous) bargaining power of buyer j over the supplier i .

Special case: when $\tilde{\phi}_{ij} \rightarrow 0$. We first consider the case $\tilde{\phi}_{ij} \rightarrow 0$, that is, bargaining power concentrated on the supplier side. The assumption of price-setting suppliers is common in the international literature. In this case, the solution to (6) simplifies to a standard Nash-Bertrand solution, with:

$$\mu_{ij} \mid_{\tilde{\phi}_{ij} \rightarrow 0} = \mu_{ij}^{oligopoly} \equiv \frac{\varepsilon_{ij}}{\varepsilon_{ij} - 1} \geq 1 \quad (8)$$

$$\varepsilon_{ij} = \rho (1 - s_{ij}) + \tilde{v}s_{ij}, \quad (9)$$

where ε_{ij} is a demand elasticity term, and $\tilde{v} = 1 - \gamma + v\gamma$ is a parameter that depends on the downstream demand elasticity v and the cost elasticity γ . As in standard models of oligopolistic competition, the demand elasticity ε_{ij} is a function of the supplier's share s_{ij} (Atkeson and Burstein, 2008). When the supplier's share is tiny ($s_{ij} \rightarrow 0$) the demand elasticity ε_{ij} collapses to ρ , the substitution elasticity across foreign varieties. When the supplier's share is close to one ($s_{ij} \rightarrow 1$) the demand elasticity ε_{ij} converges to \tilde{v} . We note that with $\rho > \tilde{v}$, the elasticity (markup) is a decreasing (increasing) function of the firm's market share s_{ij} . That is, larger suppliers charge higher markups as long as the input demand elasticity increases in the "upstreamness" of the production stage.⁶

⁴In the empirical analysis, we will posit that we can capture these exogenous sources of the firms' relative bargaining position as a function of relationship tenure, firms' age, and firm size.

⁵See Appendix A.2 for the detailed derivations of this expression.

⁶The condition $\rho > \tilde{v}$ is standard in theoretical trade models, and typically validated in empirical work. See, e.g., Atkeson and Burstein (2008).

Special case: when $\tilde{\phi}_{ij} \rightarrow \infty$. We then consider the case $\tilde{\phi}_{ij} \rightarrow \infty$, that is, bargaining power concentrated on the buyer side. In this case, the bilateral markup reads:

$$\mu_{ij} |_{\tilde{\phi}_{ij} \rightarrow \infty} = \mu^{oligopsony} \equiv \theta \left(\frac{1 - (1 - x_{ij})^{\frac{1}{\theta}}}{x_{ij}} \right) \leq 1. \quad (10)$$

When firm i 's marginal cost is constant, i.e., when $\theta = 1$, full buyer's bargaining power always coincides with marginal cost pricing, i.e., $p_{ij} = c_i$ and $\mu_{ij}^{oligopoly} = 1 \forall x_{ij} \in (0, 1)$. Buyer power plays a non-trivial role for bilateral prices when marginal costs are increasing, i.e., when $\theta < 1$. With increasing marginal costs, there exist rents in upstream production. Concentrated buyers are able to extract some of these rents by negotiating a markup below marginal cost ($\mu_{ij}^{oligopsony} \in [\theta, 1]$). The markup will now be a *decreasing* function of the buyer's share. When the buyer's share is tiny ($x_{ij} \rightarrow 0$), then $\mu_{ij}^{oligopsony} \rightarrow 1$. Conversely, when firm j is the sole buyer to i ($x_{ij} \rightarrow 1$), then $\mu_{ij}^{oligopsony} \rightarrow \theta < 1$, such that price equals *average* cost $p_{ij} = \tilde{c}_i = \frac{c_i}{\theta}$. Notice that since the buyer has all the bargaining power, the supplier never charges any markup above the marginal cost. In other words, the supplier cannot earn any rents besides technological ones.

General case: $\tilde{\phi}_{ij} \in \mathbb{R}_+$. Let us now consider the general case where both the buyer and the supplier have some bargaining power ($\tilde{\phi}_{ij} \in \mathbb{R}_+$). The following proposition characterizes the Nash-in-Nash solution.

Proposition 1 *The bilateral markup negotiated by supplier i and buyer j when j 's relative bargaining power is $\tilde{\phi}_{ij} \in \mathbb{R}_+$ becomes*

$$\mu_{ij} = (1 - \omega_{ij}) \cdot \mu_{ij}^{oligopoly} + \omega_{ij} \cdot \mu_{ij}^{oligopsony}, \quad (11)$$

$$\text{where } \omega_{ij} \equiv \frac{\tilde{\phi}_{ij} \lambda_{ij}^{bgn}}{\tilde{\phi}_{ij} \lambda_{ij}^{bgn} + \varepsilon_{ij} - 1} \in (0, 1), \lambda_{ij}^{bgn} \equiv \frac{s_{ij}(\tilde{\nu} - 1)}{1 - \hat{\pi}_j} \geq 0, \text{ and } \hat{\pi}_j \equiv \frac{\tilde{\pi}_{j(-i)}}{\pi_j}.$$

In the general case, the bilateral markup μ_{ij} can be written as a weighted average between the pure oligopoly markup in equation (8) and the pure oligopsony markdown in equation (10). The weighting factor ω_{ij} is increasing in $\tilde{\phi}_{ij} \lambda_{ij}^{bgn}$ – the product of the exogenous bargaining term ($\tilde{\phi}_{ij}$), and a term, λ_{ij}^{bgn} , which is increasing in the buyer's outside option $\hat{\pi}_j \equiv \frac{\pi_j - \tilde{\pi}_{j(-i)}}{\pi_j}$. We refer to $\tilde{\phi}_{ij} \lambda_{ij}^{bgn}$ as the *effective* buyer's bargaining position. The larger $\tilde{\phi}_{ij} \lambda_{ij}^{bgn}$, the larger ω_{ij} , the closer is the bilateral markup μ_{ij} to the oligopsony markup.

2.3 Discussion

In our baseline model, we maintain the assumption of an exogenous network of firm-to-firm trade, which implies, among other things, that we do not allow for renegotiations in case of disagreement. Under this assumption, the disagreement payoffs coincide with the firms' profits in other (pre-existing) network nodes. In Appendix A.3, we show that our main result in Proposition 1 is robust to relaxing this strong assumption. In the case of a failed negotiation, we assume there that the profits of buyer j and supplier i change by an exogenous factor ϱ_{ij} and ς_{ij} , respectively. We show that the generalized model yields an equilibrium price that is isomorphic to equation (11).

Importantly, we argue that our assumption on the firms' outside options does not fundamentally affect our estimates. Equation (11) shows an isomorphism between the buyer's endogenous outside option λ_{ij}^{bgn} and the exogenous bargaining power $\tilde{\phi}_{ij}$. Thus, as long as the estimates of $\tilde{\phi}_{ij}$ capture the unobserved differences in the agents' outside options, we can avoid a model's misspecification bias in estimation. We will return to this isomorphism below when discussing the estimation of $\tilde{\phi}_{ij}$.

3 Pass-Through

We now investigate the role of two-sided market power in determining the import price response (pass-through elasticity) of aggregate cost shocks. We consider a generic shock at the pair-level, which we denote as ϑ_{ij} . Throughout, we assume that the shock ϑ_{ij} only affect the pair $i - j$, such that $\frac{d \ln p_{kj}}{d \ln \vartheta_{ij}} = 0, \forall k \neq i$ and $\frac{d \ln q_{iz}}{d \ln \vartheta_{ij}} = 0 \forall z \neq j$.

Log-differentiating equation (7), and using the result in Proposition 1, we have that the log change in price, $d \ln p_{ij}$, can be written as:

$$d \ln p_{ij} = \Gamma_{ij}^s d \ln s_{ij} - \Gamma_{ij}^x d \ln x_{ij} + d \ln c_i + d \ln \vartheta_{ij}, \quad (12)$$

where we have defined $\Gamma_{ij}^s \equiv \frac{\partial \ln \mu_{ij}}{\partial \ln s_{ij}} > 0$ as the partial elasticity of bilateral markups with respect to the supplier's share s_{ij} , and $\Gamma_{ij}^x \equiv -\frac{\partial \ln \mu_{ij}}{\partial \ln x_{ij}} > 0$ as the partial elasticity of bilateral markups with respect to the buyer share x_{ij} . Using the definitions of the supplier's and buyer's shares, we can write:⁷

$$d \ln s_{ij} = -(\rho - 1)(1 - s_{ij})d \ln p_{ij} \quad (13)$$

$$d \ln x_{ij} = -\varepsilon_{ij}(1 - x_{ij})d \ln p_{ij}, \quad (14)$$

where ε_{ij} is as in equation (9). We also obtain:

$$d \ln c_i = -\frac{1 - \theta}{\theta} x_{ij} \varepsilon_{ij} d \ln p_{ij}. \quad (15)$$

Substituting equations (13)- (15) into (12), it is possible to write the log change in the bilateral price p_{ij} as a function of bilateral shares, and fundamentals. The following proposition characterizes the pass-through of a cost-shock into the price p_{ij} .

Proposition 1 : *The pass-through of a shock ϑ_{ij} to the bilateral price p_{ij} when $d \ln p_{kj} = 0, \forall k \neq i$ and $d \ln q_{iz} = 0 \forall z \neq j$ is given by:*

$$\Phi_{ij} \equiv \frac{d \ln p_{ij}}{d \ln \vartheta_{ij}} = \frac{1}{\underbrace{1 + \Gamma_{ij}^s (\rho - 1)(1 - s_{ij}) - \Gamma_{ij}^x \varepsilon_{ij}(1 - x_{ij})}_{\text{markup channel}(+/-)} + \underbrace{\frac{1 - \theta}{\theta} x_{ij} \varepsilon_{ij}}_{\text{cost channel}(+)}}. \quad (16)$$

⁷These shares are defined as $s_{ij} = c_{ij}^\rho (p_{ij}/p_j^f)^{1-\rho}$ and $x_{ij} = q_{ij}/q_j$, respectively.

Equation (16) indicates that the import price pass-through elasticity in a bargaining model with two-sided market power can be written as a function of the two observed bilateral shares, s_{ij} and x_{ij} , and the parameter vector $\beta = \{\gamma, \nu, \rho, \theta\}$.

Equation (16) provides a useful way of summarizing the response of border prices to cost-push shocks, assuming either that the shock affects the pair $i - j$ only, or that changes in prices in other network nodes, namely, $d \ln p_{kj} \forall k \neq i$ and $d \ln q_{iz} \forall z \neq j$, can be controlled for in pass-through regressions. This type of exercise is feasible in our case due to the availability of data on bilateral transactions and two-sided heterogeneity.⁸ We refer to Appendix A.4 to discuss a more general pass-through equation that considers the "indirect" (general equilibrium) effects. We illustrate next the individual forces affecting pass-through, again starting from special limit cases.

Special case: when $\tilde{\phi}_{ij} \rightarrow 0$ When the supplier has all the bargaining power, equation (16) simplifies to:

$$\Phi_{ij} |_{\tilde{\phi}_{ij} \rightarrow 0} = \frac{1}{\underbrace{1 + \Gamma_{ij}^s (\rho - 1)(1 - s_{ij})}_{\text{markup channel}(+)} + \underbrace{\frac{1 - \theta}{\theta} x_{ij} \varepsilon_{ij}}_{\text{cost channel}(+)}} \quad (17)$$

where $\Gamma_{ij}^s = -\frac{\varepsilon_{ij} - \rho}{\varepsilon_{ij}(\varepsilon_{ij} - 1)} > 0$. The pass-through elasticity depends on a *markup* and a *cost* channel. The top three panels of Figure 1 plot the contours of the pass-through Φ_{ij} for different values of s_{ij} and x_{ij} . Panel 1a focuses on the markup channel; Panel 1b isolates the cost channel; Panel 1c presents the overall pass-through elasticity when both channels are considered. Panel 1a shows a pass-through elasticity always below one: following a positive cost shock, the supplier will reduce the markup to prevent the buyer from substituting away from its variety. The markup channel in equation (17) thus captures strategic complementarities in price-setting, a standard source of incomplete pass-through in the international literature (Burstein and Gopinath, 2014; Amiti et al., 2014, 2018). Notably, the response of import prices to cost shocks is *U-shaped* in the supplier's market share (Auer and Schoenle, 2016; Goldberg and Tille, 2013). When the supplier's share is either tiny ($s_{ij} \rightarrow 0$) or very large ($s_{ij} \rightarrow 1$), the scope for strategic complementarities in pricing is reduced, leading to a lesser impact of the shock on the negotiated markup.

⁸Concretely, our dataset reports information on the quantity sold by a given exporter i to all its U.S. buyers, which makes it possible to control for $d \ln q_{iz} \forall z \neq j$. Similarly, we observe the import price at the firm-variety level, which allows to control for $d \ln p_{kj} \forall k \neq i$.

The cost channel in Panel 1b captures the price response due to changes in the supplier's average cost. This effect is positive and increases in the buyer's share: when the bilateral price increases due to the shock, a standard demand effect leads the buyer to demand less of supplier i 's variety. When $\theta < 1$, lower demand decreases the average production cost, lowering the price. The larger the buyer, the more substantial the cost (and price) reduction. Therefore, the cost channel acts as to lower the overall pass-through of the shock ϑ_j into the bilateral price. This can be observed in Panel 1c.

Special case: when $\tilde{\phi}_{ij} \rightarrow \infty$ When the buyer has all the bargaining power, the pass-through in equation (16) becomes:

$$\Phi_{ij} |_{\tilde{\phi}_{ij} \rightarrow \infty} = \frac{1}{\underbrace{1 - \Gamma_{ij}^x \varepsilon_{ij} (1 - x_{ij})}_{\text{markup channel}(-)} + \underbrace{\frac{1 - \theta}{\theta} x_{ij} \varepsilon_{ij}}_{\text{cost channel}(+)}} \quad (18)$$

where, in this case, the elasticity $\Gamma_{ij}^x = 1 - \frac{(1 - x_{ij})^{\frac{1 - \theta}{\theta}}}{\mu_{ij}^{\text{oligopoly}}} \geq 0$. As in the previous case, we can decompose the overall pass-through effect into a markup and a cost channel. We plot the markup, cost, and combined pass-through effects in the center row of Figure 1.

The cost channel acts as in the previous case (Panel 1e). The pass-through elasticity is always above one due to the markup channel, and is *hump-shaped* in the buyer's output share x_{ij} (Panel 1d). The source of the more-than-complete pass-through is an endogenous response of the buyer's market power to the shock. A cost shock reduces the buyer's demand q_{ij} by increasing the bilateral price p_{ij} . The larger the demand elasticity ε_{ij} , the larger the demand response to the shock. As the buyer's share decreases with the buyer's demand, the negotiated markup increases, leading to a more-than-complete pass-through.⁹ The elasticity of the buyer's share to changes in demand is small when the share is either tiny ($x_{ij} \rightarrow 0$) or very large ($x_{ij} \rightarrow 1$), whence the hump-shape response.

Combining the markup with the cost channel leads to Panel 1f. The pass-through is monotonically decreasing in the buyer share, due to the effect of x_{ij} on both markups and costs. The pass-through elasticity is close to one in a large portion of the bilateral shares space, especially in the region where the buyer's share is small.

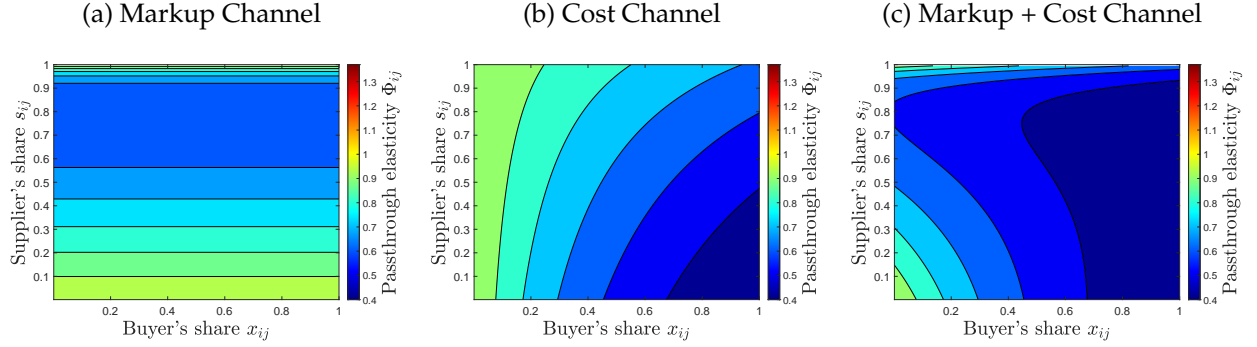
⁹As explained earlier, here we consider the "direct" pass-through in which we take as fixed the supplier's sales quantities to other buyers.

General case When both the buyer and the supplier have some bargaining power, the pass-through elasticity is summarized by equation (16). The bottom three panels of Figure 1 display the pass-through's contour plot in this general case, assigning an equal bargaining power to the two agents ($\tilde{\phi}_{ij} = 1$). In the general case, the sign of the markup channel is in principle ambiguous due to the contrasting role of the buyer's and supplier's market power. This is shown in Panel 1g of Figure 1, which shows pass-through rates both below and above one.

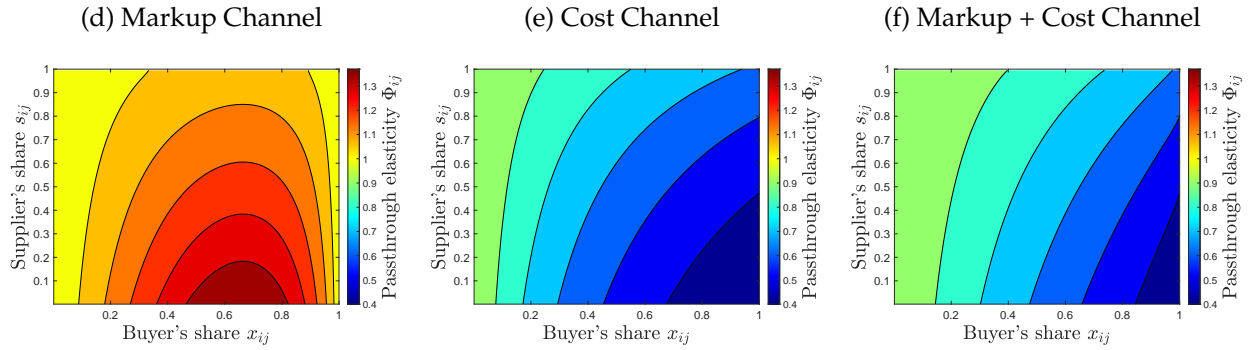
Figure 1 provides a visual representation of the considerable heterogeneity in pass-through that can arise in contexts where firms are granular and enjoy market power, like that of global value chains. Notably, when market power on both sides of the market is allowed for, high pass-through rates are more frequent than in models where market power is concentrated on the supplier's side only. In the following sections, we bring this model to the data to empirically test its ability to rationalize import prices' behavior.

Figure 1: Pass-through Heterogeneity

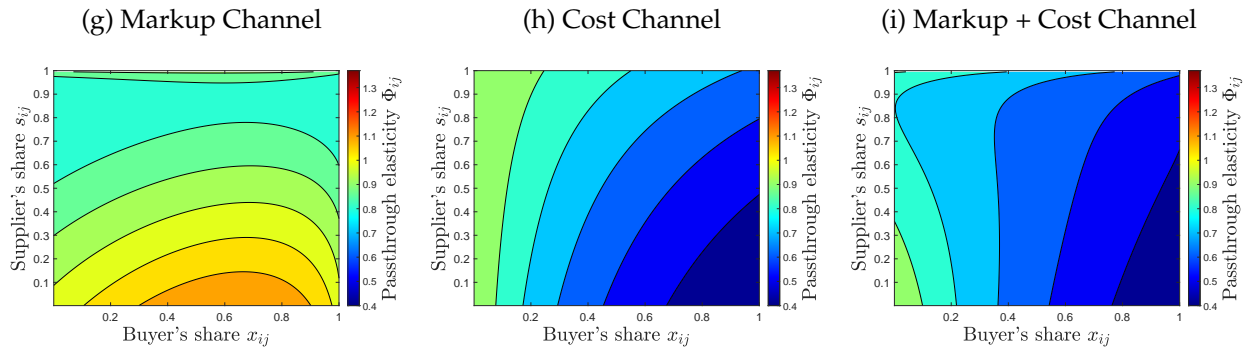
PRICE-TAKING BUYERS ($\tilde{\phi}_{ij} \rightarrow 0$)



PRICE-TAKING SUPPLIERS ($\tilde{\phi}_{ij} \rightarrow \infty$)



SYMMETRIC BARGAINING POWER ($\tilde{\phi}_{ij} = 1$)



Notes: The figure displays the degree of price pass-through, Φ_{ij} , with respect to the two bilateral shares, s_{ij} and x_{ij} . The top three panels impose price-taking behavior on the buyer's side, such that $\tilde{\phi}_{ij} \rightarrow 0$. The middle three panels show the case when the buyer has full bargaining power ($\tilde{\phi}_{ij} \rightarrow \infty$). The bottom three panels display the intermediate case, where agents' bargaining power is symmetric ($\tilde{\phi}_{ij} = 1$). In all zeros, the left panel plots Φ_{ij} when we set the cost channel equal to zero; in the middle panel we set the markup channel equal to zero, while the right panel restores both channels. Note that the 'cost channel' graph is identical in all three rows as it does not depend on the value of $\tilde{\phi}_{ij}$. For other parameters, we use $\gamma = 0.5, \rho = 10, \nu = 4$, and $\theta = 0.85$.

4 Data and Stylized Facts

One of the challenges of studying two-sided market power is that detailed information on outcomes of bilateral transactions (i.e., prices and quantities) between buyers and suppliers and on characteristics of contracting parties (e.g., size and market shares) are usually hard to obtain. We confront this challenge by constructing a novel dataset matching the U.S. Census Linked/Longitudinal Firm Trade Transaction Database (LFTTD) with the Longitudinal Business Dataset (LBD), the Census of Manufacturers (CM), and the ORBIS dataset.

The LFTTD dataset contains information on the universe of cross-border trade transactions between U.S. importers and foreign exporters during 1992-2016. This dataset is constructed from customs declaration forms collected by the U.S. Customs and Border Protection (CBP). For each import transaction, the LFTTD reports the value and quantity shipped (in U.S. dollars), the shipment date, the 10-digit Harmonized System (HS10) code of the product traded, and the transportation mode. Notably, for each transaction, the LFTTD includes a manufacturing ID (MID) identifying relevant foreign supplier characteristics, including nationality, name, address, and city.

We combine the LFTTD data with ORBIS data, a worldwide firm-level dataset maintained by Bureau van Dijk. This dataset includes comprehensive information on listed and unlisted companies' financials, such as revenues, assets, employment, cost of materials, and wage bill, among others. Most importantly, ORBIS provides information on both firms' names and addresses, making it possible to construct an ORBIS-MID variable that can be matched with the LFTTD-MID of the foreign exporter (Alviarez et al., 2019).¹⁰

Information about the domestic activity of U.S. importers is collected from the LBD. The LBD provides information on employment and payroll for U.S. establishments covering all industries and all U.S. States. For manufacturing firms, we also utilize data from the CM. The CM provides statistics on employment, payroll, supplemental labor costs, cost of materials consumed, operating expenses, the value of shipments, value added by manufacturing, detailed capital expenditures, fuels and electric energy used, and inventories. Both datasets are linked to the LFTTD through a firm ID. We describe how we use these datasets to measure the critical variables implied from the model in Section 4.3.

¹⁰See Appendix B.1 for more details on the construction of the MID variable.

Table 1: Summary Statistics

Variable	Mean	Std
Panel A. Intensive Margin		
s_{ijht}	0.15	0.22
x_{ijht}	0.28	0.30
$\ln p_{ijht}$	3.52	2.48
Panel B. Extensive Margin		
Suppliers per buyer (HS10)	10.16	36.27
Buyers per supplier (HS10)	9.59	25.08
Buyer experience (tenure)	7.44	4.38
Supplier experience (tenure)	5.87	3.92
Age of the relationship	3.05	2.71

Note: The table shows mean and standard deviation for several variables, where s_{ijht} is the share of supplier i on buyer's j imports of product h at time t ; x_{ijht} is the share of buyer j on supplier's i imports of product h at time t ; supplier (buyers) experience is measure by the number of years since the supplier (buyer) starting supplying (sourcing) product h ; Age of the relationship is measure by number of years since the supplier serves the buyer with product h . The sample excludes related party transactions and covers the period (2001-2016).

4.1 Selection

We use the following criteria to construct our estimation sample. To ensure that the selection of foreign suppliers represented in the ORBIS dataset covers a sizable fraction of the aggregate economy, we only select foreign countries whose firm coverage in ORBIS accounts for more than 50 percent of sales reported in KLEMS/OECD, in 2016. We then select those transactions for which we observe the foreign exporter's sales, wage bill, and material input costs. We focus on bilateral trade transactions at "arm's length", that is, where a business relationship does not exist between the exporter and importer. To do so, we leverage the information on ownership relationships from both the LFTTD and ORBIS.¹¹ Also, we select only those exporters that sell a given product to two or more U.S. (arm's-length) importers. To ensure we have enough variation within each estimation category, we focus on country-product pairs in which there are at least three exporters.

4.2 Descriptive statistics

Table 1 reports some summary statistics on our sample of firm-to-firm trade. Panel A. reports statistics about the intensive margin of trade, specifically bilateral prices and mar-

¹¹See Appendix B.2 for details.

ket shares, where the latter are constructed at the firm-HS10 product level. Dispersion in bilateral prices is very large, as expected with this type of data (Fontaine et al., 2020; Heise, 2019). Concentration among buyers and suppliers is substantial: the average exporter has a supplier share of 15%, with substantial heterogeneity across exporters; the average buyer share is about 30%, with substantial heterogeneity across observations.

Panel B. reports statistics about the extensive margin, showing evidence of both granularity and market power of firms in international trade. Both buyers and suppliers are connected to a limited number of partners in a given year. Moreover, firms' tenure in international trade is quite large, with an average of about 6 years of experience. Relationships between buyers and suppliers are sticky, even at the HS10 product level, with firms trading the same HS10 products for 3 consecutive years (Monarch, 2020).

4.3 Measuring key variables of the model

With our dataset, it is possible to measure the relevant shares for markups and pass-through elasticities. To do so, we restore multiple products, where a product is defined at the HS 10-digit level and is denoted by h . We assume that when a firm imports multiple foreign input bundles, it combines them in a Cobb-Douglas fashion. Equation (3) thus becomes:

$$\alpha_{jh}\gamma = \frac{d \ln c_j}{d \ln p_j^{f,h}} \in (0, 1], \quad (19)$$

where $\alpha_{j,h}$ is the (observed) Cobb-Douglas share of input HS10 input h on total j 's imports of intermediates.

With multiple products, the supplier's share is $s_{ij}^h = \frac{p_{ij}^h q_{ij}^h}{\sum_{k \in Z_j^h} p_{kj}^h q_{kj}^h}$. We construct the numerator of this expression by taking all imports of firm j from firm i (a MID in our dataset) within product category h during the year; the denominator adds product-specific imports across all j 's trading partners in all countries.

Unlike the supplier's share, the buyer's share $x_{ij}^h \equiv \frac{q_{ij}^h}{q_i^h}$ is defined in terms of quantities. We assume that firm i 's production consists of product-destination specific production lines, and define the denominator q_i^h as exporter i 's total quantity of product h sold to the United States, namely, $q_i^h = \sum_{j \in US} q_{ij}^h$.

4.4 Stylized facts

We now show that the features of our two-sided trade dataset reflect in large part our modeling assumptions. We do so by establishing the following stylized facts.

Fact 1 : *Firm-to-firm trade largely consists of connected bipartite sets.*

Fact 2 : *Relationship-product specific component account for a large variations in prices.*

Fact 3 : *The pair specific component in price dispersion is significantly correlated with (i) the supplier's share and (ii) the buyer's share.*

Fact 4 : *The pass-through of cost shocks on pair specific prices depends on (i) the supplier's share and (ii) the buyer's share in a way that is consistent with the model.*

Fact 1: Firm-to-firm trade largely consists of connected bipartite sets Table 2 shows the prevalence of many-to-many linkages in our two-sided trade dataset.¹² About one quarter of the buyer-supplier relationships across products and years and among customers and suppliers have multiple partners; they represent about 43% of the value of US imports of goods. This means that there is substantial heterogeneity in firm-to-firm trade, which we capture in our pricing framework by letting buyers and suppliers have match-specific market shares.

Table 2: Prevalence of m:m linkages.

	1:1	1:m	m:1	m:m
% of links	0.19	0.106	0.465	0.24
% of import value	0.07	0.05	0.45	0.43

Note: The table shows the economic relevance of four mutually-exclusive subsets of relationship-HS10 product triplets: (1:1) both in the relationship have no other partners; (1:m): buyer has only one supplier but the supplier has multiple buyers; (m:1): supplier has only one buyer but the buyer has multiple suppliers; (m:m): both in the pair have multiple partners.

Fact 2: Relationship-product specific component account for a large variations in prices

We consider the following statistical decomposition of price dispersion

$$\ln p_{ijt}^h = FE_i + FE_j + FE_{ht} + \beta \mathbf{X}_{ijt}^h + \varepsilon_{ijt}^h \quad (20)$$

¹²Note that to create this table, we include all observed firm-to-firm linkages excluding related-party trade.

Table 3: Fixed-effect decomposition of price dispersion

	(1)	(2)
Panel A. Overall price dispersion		
Observable		-0.0006
HS10 x year FE	0.5190	0.5200
Supplier FE	0.3360	0.3360
Buyer FE	0.0630	0.0628
Match residual	0.0818	0.0818
Panel B. Within supplier-product dispersion		
Observables		0.001
Buyer FE	0.115	0.115
Match residual	0.885	0.884

Notes: The table reports the results of estimating equation (20), over the period 2001-2016. The last two panels are variance decomposition of observed price dispersion into the fixed effect components, in the entire sample and within supplier-HS10-year triplets. Controls in the Column (2) include the value of the transaction, the longevity of the relationship measure by number of years since the supplier serves the buyer with a given HS10 product; and the relative network of the supplier and buyer measure as the ratio of the number of buyers the suppliers supplies to and the number of suppliers the buyers source from within a given HS10 product. Number of observations: 9,568,000; R^2 : 0.92.

where X_{ijt}^h is the set of control variables, FE_i is a supplier fixed effect, FE_j is a buyer fixed effect, and ε_{ijt}^h is the residual that captures the unexplained dispersion of prices within a given relationship.¹³

This type of equations can be estimated whenever the underlying bipartite graph is connected, such that the estimated fixed effects are comparable (Fontaine et al., 2020). Our sample satisfies the two critical requirements: (i) all suppliers and buyer have multiple partners, and (ii) each buyer shares at least one supplier with another buyer, and each supplier shares at least one customer with another supplier. Therefore the largest connected set component is the entire sample.

The results are presented in Table 3 controlling for fixed effects only (column (1)), and also adding a set of relevant controls (column (2)). The simplest specification captures more than 91% of the price dispersion, and it is almost invariant to the inclusion of controls. In Panel A. of Table 3 shows that more than half of the price dispersion (52%) is attributed to the HS10-year fixed effects. The unobserved product heterogeneity and market power differences across suppliers account for almost 34% of the variance, whereas the unob-

¹³The residual reflects any idiosyncratic shock, but also any “matched effects” or systematic differences in prices coming from bilateral market power, after controlling for the supplier’s market power that is common across all buyers, and the buyer’s market power that is common across all suppliers.

served heterogeneity in good valuation among buyers and differences in bargaining market power account for a much smaller share of the variance (6%). The matched residual accounts for about 8% of the price dispersion. Very similar patterns have been shown for firm-to-firm price information of French exports (Fontaine et al., 2020).

Since we want to understand the price dispersion across buyers for a given firm-HS10 product pair, Panel B. of Table 3 reports how much of the dispersion in prices within a supplier-HS10-year is attributable to the buyer fixed effects and the residual component.¹⁴ More than 88% of the variance it remains specific to the buyer-supplier relationship for a given product and year.

Fact 3: *The pair specific component in price dispersion is significantly correlated with (i) the supplier’s share and (ii) the buyer’s share* We now investigate whether within-product-time variation in prices can be attributed to measures of concentration among buyers and suppliers described in the previous paragraph. We exploit variation in prices across-firms within a market, as defined by a HS10 product-year. We run the following specification:

$$\ln p_{ijt}^h = \beta_s s_{ijt}^h + \beta_x x_{ijt}^h + FE_{iht} + FE_{jht} + v_{ijt}^h, \quad (21)$$

which augments equation (20) by adding two terms relating to the supplier’s and buyer’s market share, respectively. Our coefficient of interests are β_s and β_x . Our theory predicts that the former should be positive, namely, prices should increase with the supplier’s market share in the relationship; the second coefficient should instead be negative, as prices should be lower whenever the buyer accounts for a larger share of total supplier’s exports.

Since the specification involves regressing prices on market shares, which themselves are a function of prices, we need to deal with a critical endogeneity issue typical of this type of regressions (Bresnahan, 1989). We deal this issue by constructing instrumental variables for supplier’s and buyer’s market shares. We exploit the structure of the network and construct these IVs so that they are correlated with the bilateral shares through shocks on other firms that are neither the supplier nor the buyer of focus. For the supplier’s share s_{ijt}^h , we consider the sales of j ’s other suppliers to buyers other than j , and for the buyer share x_{ijt}^h , we consider the purchases of i ’s other buyers from suppliers other than i . The regression specification includes different sets of product-level fixed effects in order

¹⁴In the bottom panel the buyer and matched components are regressed on normalized log prices, where prices are normalized in the supplier-HS10-year dimension.

Table 4: Bilateral concentration and match-specific residual.

	$FE_i + FE_j + FE_{ht}$			$FE_{iht} + FE_{jht}$		
	OLS (1)	OLS (2)	IV (3)	OLS (4)	OLS (5)	IV (6)
s_{ijt}^h	0.226*** [0.00611]	0.227*** [0.00609]	0.519*** [0.0339]	0.442*** [0.0133]	0.442*** [0.0133]	0.397*** [0.00819]
x_{ijt}^h	-0.567*** [0.00994]	-0.566*** [0.00995]	-0.100*** [0.0187]	-0.673*** [0.0152]	-0.673*** [0.0152]	-0.586*** [0.00909]
Age of the relationship		-0.00702*** [0.000971]	-0.0433*** [0.00199]		0.00122 [0.00101]	-0.00342*** [0.00124]
Observations	9,568,000	9,568,000	9,568,000	9,568,000	9,568,000	9,568,000
R-squared	0.921	0.921		0.974	0.974	
F stat			3,137			18,740
SWF stat (s_{ijt}^h)			9,347			31,500
SWF stat (x_{ijt}^h)			6,885			41,240

Notes: Columns (1)-(2) and (4)-(5) reports the OLS estimates from equation (21). Columns (3) and (6) report the IV estimates, along with the corresponding F-stat and SW Fstat. The age of the relationship is measured as the number of years the buyer-seller pair has trade with each other. Significance: * 0.10, ** 0.05, and *** 0.01.

to control for correlated shocks across firms within the same sector. Table 4 reports the results from both OLS and IV regressions.

As expected from the theory, we find that bilateral prices increase with the supplier's market share and decrease with the buyer's market share. The coefficient are both statistically and economically significant. They are also robust to consider a stringent fixed-effect specification where we control form the supplier's marginal costs with supplier-product-time fixed effects. Overall, the evidence is consistent with concentration among firms and two-sided market power to play an important role in determining variation in prices.

Fact 4: *The pass-through of cost shocks on pair specific prices depends on (i) the supplier's share and (ii) the buyer's share in a way that is consistent with the model* In Section 3 we outlined how the pass-through of cost shocks on pair-specific prices are influenced by different values of the two bilateral shares, s_{ij} and x_{ij} . To explore these patterns we exploite the sizable increase in import tariff imposed by the U.S. on selected products and trade partners in 2018, after several decades of low and stable tariff rates.¹⁵ The statutory

¹⁵In 2019 U.S. import tariff did experience further increases, but we do not analyze it here since LFTTD last available year is 2018.

tariff data we use is from [Fajgelbaum et al. \(2020\)](#) and we identify the set of HS8 products subject to increases in tariffs in 2018, the set of countries affected for each product, the effective application dates for the tariff changes, and the percentage point tariff increases.

Based on the analysis conducted in section 3 we regress the observed change in log prices—at the supplier i -buyer j -HS10 product-level—against the changes in the import tariff rates that took place between 2017 and 2018. Distinctively, our regressions also include the change in tariff interacted with the buyer’s share in supplier’s exports (x_{ijt}^h), as well as interacted with the supplier’s share in buyer’s purchases (s_{ijt}^h). Since in the theoretical analysis we have assumed that both the quantities exporter i sells to other buyers ($-j$), $\Delta \ln q_{i(-j)t}$, and the prices that other suppliers ($-i$) charge to firm j , $\Delta \ln p_{(-i)jt}^h$, do not change, we construct these variables in our data and include them as controls in our regression.¹⁶ Finally, the specification controls for sector, country, and importer fixed effects and we arrive at the following:

$$\begin{aligned} \Delta \ln p_{ijt}^h = & \alpha_0 + \alpha_1 \Delta (1 + \tau_{it}^h) + \alpha_x \Delta (1 + \tau_{it}^h) \times x_{ijt}^h + \alpha_s \Delta (1 + \tau_{it}^h) \times s_{ijt}^h \\ & + \alpha_q \Delta \ln q_{i(-j)t}^h + \alpha_p \Delta \ln p_{(-i)jt}^h + \delta_j + \delta_s + \delta_c + \epsilon_{ijt}^h. \end{aligned}$$

The first three columns of Table 5 show results where we run pass-through regressions solely on the change in tariff—excluding the interaction terms—in the spirit of [Fajgelbaum et al. \(2020\)](#). Consistent with their findings, we find complete pass-through on average: we find coefficients close to zero when regressing prices before duties on the statutory tariff rates (column (1)) or when regressing prices before duties on applied tariffs, instrumented by the statutory rates (column (2)), and we find a coefficient close to one when regressing duty-inclusive price on applied tariffs with the same instruments (column (3)). As in [Fajgelbaum et al. \(2020\)](#), we find a coefficient lower than one when regressing duty-inclusive price on the statutory tariff rates (column (4)).¹⁷ These similarities in the average pass-through results with those from [Fajgelbaum et al. \(2020\)](#) are remarkable despite the differences between the two settings. First, our datasets differ in their

¹⁶Future versions of this paper will use a comprehensive data on anti-dumping/countervailing duty episodes (currently in the last stages of construction). Unlike import tariffs, the anti-dumping/countervailing duties can vary at the firm level, thus the assumption that prices of other suppliers to firm j do not change is satisfied and there is not need to control for $\Delta \ln p_{(-i)jt}^h$.

¹⁷Notice that the coefficient in (4) is not 1 plus the coefficient in column (1) because the duty inclusive unit value is constructed using actual duties collected by the U.S. custom data. As expected, the coefficient on duty-inclusive prices in column (3) is 1 plus the coefficient in (column 2), since these are regressed on applied tariff.

frequency. Fajgelbaum et al. (2020) use monthly data whereas we use annual changes. Second, we record the observed price changes within a given supplier-buyer-product triplet, instead of at the country-product level, compelling us to use only supplier-buyer pairs that trade the same HS10 product, more than once and consecutively, in the years 2017 and 2018.

In the last column of Table 5, we add terms that interact statutory tariff rates with the supplier and buyer shares. We find that the magnitude of the pass-through diminishes as the pair has larger buyer share x_{ij} . This is consistent with the model as shown in Panel 1i of Figure 1: in a setting where both the supplier and the buyer have bargaining power, the magnitude of the pass-through is decreasing in the buyer share. In contrast, we also find that the magnitude of the pass-through increases as the pair has larger supplier share, though the coefficient is not significant. This is also consistent with the model where both the supplier and the buyer have bargaining power: the magnitude of the pass-through is increasing in the supplier share s_{ij} when the supplier share is small, and decreasing in the supplier share when it is large.¹⁸

¹⁸In Appendix B.3 we plot the heat map that shows the distribution of pairs with different values of s_{ij} and x_{ij} . We find that significant fraction of pairs have supplier shares close to 1.

Table 5: Pass-through and bilateral shares, x_{ij} and s_{ij}

	$\Delta \ln p_{ijt}^*$ (1)	$\Delta \ln p_{ijt}^*$ (IV) (2)	$\Delta \ln p_{ijt}$ (IV) (3)	$\Delta \ln p_{ijt}$ (4)	$\Delta \ln p_{ijt}$ (5)
$\Delta \ln(1 + \tau_{cht})$	0.00467 [0.0531]			0.153** [0.0659]	0.232** [0.0944]
$\Delta \ln(1 + \tau_{cht}^{app})$		0.0315 [0.357]	1.031*** [0.357]		
$\Delta \ln(1 + \tau_{cht}) \cdot x_{ijt}^h$					-0.187** [0.0950]
$\Delta \ln(1 + \tau_{cht}) \cdot s_{ijt}^h$					0.0946 [0.0982]
Country FE	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes
Buyer FE	Yes	Yes	Yes	Yes	Yes
Observations	955,000	955,000	955,000	955,000	955,000
R-squared	0.086	-	-	0.087	0.087
F stat		20.75	20.75		

Notes: Table reports the response of prices (p_{ijt}^h) to changes in import tariff during the period 2017-2018. In column (1)-(2) the dependent variable is the before duty unit values, and in column (3)-(5) the dependent variable is the duty-inclusive unit values. Column (1), (4) and (5) report before and after duty unit values regressed on the statutory tariff rate, $\Delta \ln(1 + \tau_{cht})$. Column (2) and (3) report the reduce-form outcomes of before and after duty unit values regressed on the applied tariff, $\Delta \ln(1 + \tau_{cht}^{app})$, where $\Delta \ln(1 + \tau_{cht}^{app})$ is instrumented by the statutory tariff rate, $\Delta \ln(1 + \tau_{cht})$. Notice that the coefficient in (4) is not 1 plus the coefficient in column (1) because the duty inclusive unit value is constructed using actual duties collected by the U.S. custom data. But the coefficient on duty-inclusive prices in column (3) is as expected 1 plus the coefficient in (column 2), since these are regressed on applied tariff. The coefficient from a bivariate regression of applied tariff and statutory tariff is 0.148 and significant at 0.01 level. All regressions control for: (a) the number of years the buyer-seller relationship has last (age of the relationship); (b) the change in the quantities exporter i sells to other buyers but j , $\Delta \ln q_{i(-)t} = \Delta \ln(q_{it} - q_{ijt})$; and (c) the weighted average of the change in prices of other suppliers ($-i$) to firm j , $\Delta \ln p_{(-i)jt}^h = \sum_{k \neq i} s_{kj(t-1)}^h \Delta \ln p_{kjt}^h$, with weights given by the relative importance of other sellers ($-i$) in j 's imports of product h at the beginning of the period, $s_{kj(t-1)}^h$. All regressions include buyer, industry and country fixed effects. Standard errors are clustered by country and industry. Significance: * 0.10, ** 0.05, and *** 0.01.

5 Estimation

In this section, we discuss how we recover the primitive parameters, $\beta = \{\rho, \gamma, \nu, \theta\}$, together with the bilateral bargaining terms, ϕ_{ijt} , by leveraging the model's price and markup equations. First, we pick a value for the demand elasticity that importers face, ν , equal to 2.85. We calibrate this value from estimates of the U.S. downstream import demand elasticity in [Soderbery \(2018\)](#), who follows the methodology in [Feenstra \(1994\)](#); [Broda and Weinstein \(2006\)](#). Appendix C.1.1 provides more details on the calibration. We then assume that the price of foreign intermediates has a complete pass-through on importers' marginal cost of production, i.e., $\gamma = 1$.

5.1 Import elasticity of substitution ρ

We start by estimating ρ , which represents the elasticity of substitution across foreign varieties of a given HS-10 product. Equations (1) and (2) imply the following relationship between bilateral trade flows (r_{ijt}) and prices:

$$r_{ijt}^h = \zeta_{ijt}^\rho p_{ijt}^{h(1-\rho)} \left(p_{jt}^{f,h}\right)^\rho q_{jt}^{f,h}. \quad (22)$$

By taking logs and collecting terms, we can write equation (22) as:

$$\Delta \ln r_{ijt}^h = (1 - \rho) \Delta \ln p_{ijt}^h + \tilde{\zeta}_{jht} + \varepsilon_{ijht}, \quad (23)$$

where $\tilde{\zeta}_{jht} \equiv \ln \left(\left(p_{jt}^{f,h}\right)^{\rho-1} p_{jt}^{f,h} q_{jt}^{f,h} \right)$ and $\varepsilon_{ijht} = \rho \Delta \ln \zeta_{ijht} + e_{ijht}$, e_{ijht} indicates a zero-mean i.i.d. idiosyncratic shocks or measurement error, and where we defined the Δ operator on any given variable x as: $\Delta \ln x_{ijt} \equiv \ln x_{ijt} - \ln x_{ijt-1}$. Equation (23) relates bilateral trade flows to bilateral prices, and buyer-product-time fixed effects. We consider an IV-OLS regressions on equation (23), where we instrument prices with bilateral trade shifters, such as tariffs or exchange-rate shocks. Our identifying assumptions simply requires that bilateral trade shifters are exogenous to the preference shocks ζ_{ijht} . We also add product h -level fixed effects, so that we recover the average elasticities across sectors.

5.2 Estimation of parameters θ and ϕ_{ij}

In order to estimate the remaining parameters, θ and ϕ_{ij} , we first assume that the bilateral bargaining terms $\tilde{\phi}_{ijt}$ can be written as a monotonic function of a vector of covariates \mathbf{X}_{ijt} with parameter vector $\boldsymbol{\kappa}$ to be estimated:

$$\tilde{\phi}_{ijt} = f(\mathbf{X}_{ijt} \mid \boldsymbol{\kappa}). \quad (24)$$

The vector of covariates \mathbf{X}_{ijt} may include variables that are likely related to the bargaining power of the firms, such as the age of the $i - j$ relationship, relative age of firm i over the age of firm j , and relative size of firm i over that of firm j .¹⁹

The (log) bilateral prices can be written as:

$$\ln p_{ijt} = \ln \mu_{ijt}(\boldsymbol{\kappa}, \theta) + \ln c_{ijt}, \quad (25)$$

where $\mu_{ijt}(\boldsymbol{\kappa}, \theta)$ is the bilateral markup that, given the observed shares and estimates of ρ , γ and ν , can be written as a function of the parameters of interest, and c_{ijt} is the unobserved marginal cost, that potentially varies at the pair-level.

For estimation, we construct moments by taking the price differences across buyers within a supplier-product-year. Define the operator Δ^{jk} as one that takes differences across the buyer dimension.²⁰ The moments we construct are:

$$g_{ijkt}(\vec{\kappa}, \theta) = \Delta^{jk} \ln p_{ijt} - \Delta^{jk} \ln \mu_{ijt}(\boldsymbol{\kappa}, \theta). \quad (26)$$

Given equation (25), it follows that g_{ijkt} represents unobserved cost differentials across buyers. The latter may originate from either horizontal or vertical product differentiation. In order to account for these unobserved cost differentials, we include in the vector of instruments \mathbf{Z} variables such as the number of importers and exporters in the product market, quantile distributions of the bilateral shares s_{ij} and x_{ij} (excluding the shares for the $i - j$ and $i - k$ pairs).

Importantly, one can show identification of both $\boldsymbol{\kappa}$ and θ from the structure of pair-level

¹⁹To be precise, we assume that the the function $f(\cdot)$ is an exponential function. As discussed in Section 2.3, the endogenous outside option λ_{ijt}^{bgn} and the exogenous bargaining power $\tilde{\phi}_{ijt}$ enter multiplicatively in the pricing equation. Therefore one can allow for a more general structure in firms' outside options by defining the term $\tilde{\phi}_{ijt}\lambda_{ijt}^{bgn}$ as $f(\mathbf{X}_{ijt})$, where the vector \mathbf{X}_{ijt} now includes polynomials of bilateral shares s_{ijt}^f and x_{ijt} .

²⁰ $\Delta^{jk}a_{ijt} = a_{ijt} - a_{ikt}$, where both j and k are buyers of firm i .

prices in equation (7). Identification of $\vec{\kappa}$ can be established from the fact that the weighting factor in the price, ω_{ijt} , is monotonically increasing in $\tilde{\phi}_{ijt}$. One can also show that according to the definition of equation (10) for any given μ_{ij}^{int} , there exists a unique θ . We operationalize the estimation by solving for the following minimization problem:

$$\min_{\vec{\kappa}, \theta} g(\kappa, \theta) \mathbf{Z}' \mathbf{W} \mathbf{Z} g(\kappa, \theta)', \quad (27)$$

where \mathbf{W} is a weighting matrix.²¹ In the estimation, we control for year fixed effects. We also present estimation results in which we do not use instrumental variables. This case is consistent with an assumption of a supplier's marginal cost to produce a given good being common across different buyers in a given country.

²¹One can also consider an alternative estimation strategy in which instead of taking cross-buyer price differentials one takes cross-time price differentials within pairs. We discuss this alternative method to estimate θ and ϕ_{ij} in Appendix C.2.

6 Results

6.1 Estimation results

The following table reports the parameters' estimates.

[Table 5 here]

6.2 Model validation

To evaluate the model's performance, we consider the following exercise. As before, we identify in the data episodes of U.S. import tariff changes and restrict the sample to the years 2017-2018, when frequent and large tariff changes are observed. We compute in the data the log change in the bilateral prices at the supplier i -importer j -HS10 product-level before and after the tariff change. Proposition 2, duly amended to consider multi-product imports, summarizes the model-implied log change in bilateral price following a tariff shock of size ϑ_{ij} . Notice that equation (3) only depends on observed buyer and supplier's shares, and elasticity parameters. Given the estimates in Table 5, we can thus construct in our data the predicted log-price change implied by our model.

Notably, our model tractably nests traditional frameworks in the international literature. This means that we could also construct the predicted price changes under more traditional assumptions on price-setting behavior in international trade. We can then run a horse race between all these models to validate our model's performance. We consider two popular alternatives: (1) the standard [Atkeson and Burstein \(2008\)](#) model, which corresponds to the case where the supplier sets prices unilaterally ($\tilde{\phi}_{ij} \rightarrow 0$), buyers imperfectly substitute across upstream input variety ($\rho > 1$ and $\gamma = 1$), and production is constant returns ($\theta = 1$). (2) We also consider the bargaining price-setting model in [Gopinath and Itskhoki \(2011\)](#), where buyers and suppliers negotiate over the input price ($\tilde{\phi} \in \mathbb{R}_+$), but production is constant returns ($\theta = 1$), so there is no scope for buyer power.

We denote by $d \ln \hat{p}_{ij}^m$ the predicted log price changes under our baseline model ($m = 0$) and under these alternative scenarios $m = 1, 2$. We then run the following regression:

$$d \ln p_{ijht}^h = \beta_m d \ln \hat{p}_{ijht}^m + \gamma_i + \rho_h + \delta_t + u_{ijt}^h \text{ for } m = 0, 1, 2.$$

We consider the coefficient $\hat{\beta}^m$ as our measure of goodness-of-fit of the different models:

Table 6: Model Performance

	$\phi_{ij} = 0.5$		$\phi_{ij} = 0.25$		$\phi_{ij} = 0.75$	
	(1)	(2)	(3)	(4)	(5)	(6)
Baseline model: $0 < \phi_{ij} < 1, \theta < 1$	0.506*** [0.129]	0.415*** [0.133]	0.542*** [0.144]	0.445*** [0.147]	0.470*** [0.119]	0.386*** [0.122]
Model 1: $\phi_{ij} \rightarrow 0, \theta = 1$	0.172** [0.0809]	0.0991 [0.0833]	—	—	—	—
Model 2: $0 < \phi_{ij} < 1, \theta = 1$	0.191*** [0.0676]	0.128* [0.0701]	0.187** [0.0744]	0.119 [0.0771]	0.189*** [0.0618]	0.131** [0.0640]
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Buyer FE		Yes		Yes		Yes
Observations	955,000	955,000	955,000	955,000	955,000	955,000

Notes: Table reports the OLS coefficient of a bivariate regressions between the observed and the predicted change in log prices, under four different models during the period 2017-2018. The first row represents our baseline model where buyers and suppliers negotiate over the input price ($0 < \phi_{ij} < 1$), and production is decreasing returns ($\theta < 1$). Model 1 (Atkeson and Burstein, 2008) represents the case in which buyers are price-takers ($\phi_{ij} \rightarrow 0$) and production is constant returns ($\theta = 1$). Model 2 (Gopinath and Itskhoki, 2011) represents the case in which both buyers and suppliers have bargaining power ($\phi_{ij} \rightarrow 1$), but production is constant returns ($\theta = 1$). The value of θ for the baseline model is 0.6 in all columns. In columns (1)-(2) buyers and suppliers have symmetric bargaining power, in column (3)-(4) most of the bargaining power is on the seller; and in column (5-6) most of the bargaining power is on the buyer. Standard errors are clustered by country and industry. Significance: * 0.10, ** 0.05, and *** 0.01.

the higher $\hat{\beta}^m$, the more the observed changes in prices co-move with the predicted ones.

We report the results in Table 6. Note that the change in the value of ϕ_{ij} across columns only affect results for the baseline model and of model 2. We find that the baseline model performs better in predicting observed price changes compared to models in which buyer shares do not play a role (Models 1 and 2). This result highlights the need of jointly accounting for two-sided bargaining and market power as in our model, in analyzing the determinant of pair-specific prices and pass-through.

7 Conclusions

Understanding movements in international prices is a central question in international economics. Yet, traditional pricing frameworks neglect relevant features of international trade and global value chains (GVCs). Notably, existing models postulate that prices are set unilaterally by suppliers in anonymous markets and are determined by market-clearing conditions. A key aspect of GVCs, however, is that the combination of incomplete contract enforcement and the lock-in effects give rise to transaction prices that tend to be bilaterally negotiated between buyers and sellers exercising two-sided market power.

In this paper, we bridge the gap between theoretical and empirical work in the trade literature by building a pricing framework for firm-to-firm trade with two-sided market power. To bring the model to the data, we constructed a novel two-sided trade dataset where firm-to-firm trade data are matched to bilateral characteristics of both buyers and suppliers. We also developed a novel identification strategy for the Nash bargaining weights determining negotiations, a key parameter to predict bilateral markups and pass-through elasticity in buyer-supplier matches.

We show that our model can predict more accurately changes in bilateral prices following tariff shocks than traditional pricing frameworks. In particular, we show that accounting for the relevant features of GVCs goes a long way in reconciling puzzling estimates of near-complete pass-through elasticity of tariffs into import prices (Amiti et al., 2019; Cavallo et al., 2020; Fajgelbaum et al., 2020; Flaaen et al., 2020; Amiti et al., 2020).

Despite the model's complexity, our framework is extremely tractable. It provides a formula relating the pass-through elasticity at the buyer-supplier to a few sufficient statistics: the buyer's market share, the supplier's market share, and the relative bargaining weight. Thus, it is valuable for the optimal design of trade policies, helping policy-makers predict more accurately the behavior of international prices.

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A Derivations and additional theoretical results

A.1 Quantity bargaining

In Section 2 we characterized the pricing equation under which firms bargain over prices. Here we characterize the analogous pricing equation when firms bargain over quantities. Instead of (6), we now have the following Nash bargaining problem

$$\max_{q_{ij}} \left(\pi_i - \tilde{\pi}_{i(-j)} \right)^{\phi_{ij}} \left(\pi_j - \tilde{\pi}_{j(-i)} \right)^{1-\phi_{ij}}.$$

As in Section 2.1, we solve for the FOCs taking as given firm i 's unit cost c_i . We obtain the following optimal price:

$$p_{ij} = \left[\left(1 - \bar{\omega}_{ij}(\tilde{\phi}_{ij}) \right) \frac{\bar{\varepsilon}_{ij}}{\bar{\varepsilon}_{ij} - 1} + \bar{\omega}_{ij}(\tilde{\phi}_{ij}) \mu_{ij}^{oligopsony} \right] \frac{c_i}{\theta},$$

where $\bar{\varepsilon}_{ij}^{-1} = \frac{1}{\rho} \left(1 - s_{ij} \right) + \left(1 - \gamma + \frac{1}{\nu} \gamma \right) s_{ij}$ and $\bar{\omega}_{ij}(\tilde{\phi}_{ij}) \equiv \frac{\bar{\varepsilon}_{ij} \tilde{\phi}_{ij} \lambda_{ij}^{bgn} / \nu}{\bar{\varepsilon}_{ij} (1 + \tilde{\phi}_{ij} \lambda_{ij}^{bgn} / \nu) - 1} \in (0, 1)$ is the effective buyer's relative bargaining power in this model. The price above has a similar structure as in equation (11). It is a weighted average between a standard oligopoly (Cournot) markup, $\frac{\bar{\varepsilon}_{ij}}{\bar{\varepsilon}_{ij} - 1}$, and the markup term $\mu_{ij}^{oligopsony}$. The oligopoly markup depends in this case on the elasticity $\bar{\varepsilon}_{ij}$, which is a harmonic weighted average of elasticities ν and ρ as in [Atkeson and Burstein \(2008\)](#).

A.2 Derivation of equation (7)

Here we outline the derivation of equation (7). We solve for the FOCs of (6) by first listing each of its four elements $\left\{ \pi_i, \pi_j, \tilde{\pi}_{i(-j)}, \tilde{\pi}_{j(-i)} \right\}$, and then taking derivatives with respect to p_{ij} .

Profit of firm i , π_i Firm i 's profit can be expressed as

$$\pi_i = p_{ij} q_{ij} + \sum_{k \neq j} p_{ik} q_{ik} - p_I L_i.$$

Recall that $I_i = \varphi_i^{-\frac{1}{\theta}} q_i^{\frac{1}{\theta}}$. Using the derivatives of $\frac{dq_{ij}}{dp_{ij}} \frac{p_{ij}}{q_{ij}} = -\varepsilon_{ij}$ and

$$\begin{aligned} \frac{dI_i}{dp_{ij}} \frac{p_{ij}}{I_i} &= \frac{dI_i}{dq_i} \frac{q_i}{I_i} \frac{dq_i}{dq_{ij}} \frac{q_{ij}}{q_i} \frac{dq_{ij}}{dp_{ij}} \frac{p_{ij}}{q_{ij}} \\ &= -\varepsilon_{ij} \frac{1}{\theta} \frac{q_{ij}}{q_i}, \end{aligned}$$

we can express the derivative of π_i as

$$\begin{aligned} \frac{d\pi_i}{dp_{ij}} &= q_{ij} + p_{ij} \frac{dq_{ij}}{dp_{ij}} - p_I \frac{dI_i}{dp_{ij}} \\ &= \frac{q_{ij}}{p_{ij}} \left(p_{ij} (1 - \varepsilon_{ij}) + c_i \varepsilon_{ij} \frac{1}{\theta} \right). \end{aligned}$$

Profit of firm j , π_j Firm j 's profit can be expressed as

$$\pi_j = (\mu_j - 1) c_j^{1-\nu} \mu_j^{-\nu} D_j.$$

Using the derivatives of $\frac{dc_j}{dp_{ij}} \frac{p_{ij}}{c_j} = \alpha_{fj} s_{ij}$, we can express the derivative of π_j as

$$\frac{d\pi_j}{dp_{ij}} = -(\mu_j - 1) (\nu - 1) q_{ij}.$$

Outside profits, $\tilde{\pi}_{i(-j)}$ and $\tilde{\pi}_{j(-i)}$ The outside profit of firm i , $\tilde{\pi}_{i(-j)}$, is

$$\tilde{\pi}_{i(-j)} = \sum_{k \neq j} p_{ik} q_{ik} - p_I \tilde{I}_i,$$

where

$$\tilde{I}_i = \varphi_i^{-\frac{1}{\theta}} \left(\sum_{k \neq j} q_{ik} \right)^{\frac{1}{\theta}}.$$

The term $\pi_i - \tilde{\pi}_{i(-j)}$ can then be expressed as

$$\begin{aligned} \pi_i - \tilde{\pi}_{i(-j)} &= p_{ij} q_{ij} - p_I I_i + p_I \tilde{I}_i \\ &= q_{ij} \left[p_{ij} - \frac{c_i}{\theta} \mu_{ij}^{oligopsony} \right], \end{aligned}$$

where $\mu_{ij}^{oligopsony} \equiv \theta x_{ij}^{-1} \left(1 - (1 - x_{ij})^{\frac{1}{\theta}} \right)$.

The outside profit of firm j , $\tilde{\pi}_{j(-i)}$, is

$$\tilde{\pi}_{j(-i)} = \mu_j^{1-\nu} \tilde{c}_j^{1-\nu} D_j - w_H \tilde{l}_j - \sum_{k \in Z_j, k \neq i} p_{kj} \tilde{q}_{kj} - p_d \tilde{q}_{dj},$$

where

$$\begin{aligned} \tilde{q}_j &= \tilde{c}_j^{-\nu} D_j \\ \tilde{c}_j &= \varphi_j^{-1} \Omega_j w^{\alpha_j^l} (p^d)^{\alpha_j^d} (\tilde{p}_j^f)^{\gamma_j} \\ \tilde{p}_j^f &= \left(\sum_{k \in Z_j, k \neq i} \zeta_{kj}^\rho p_{kj}^{1-\rho} \right)^{\frac{1}{1-\rho}}. \end{aligned}$$

The term $\pi_j - \tilde{\pi}_{j(-i)}$ can then be expressed as

$$\pi_j - \tilde{\pi}_{j(-i)} = (\mu_j - 1) c_j q_j (1 - A_{ij}),$$

where

$$A_{ij} = \left(1 - s_{ij} \right)^{\frac{1-\nu}{1-\rho} \gamma_j}.$$

First order conditions With the ingredients derived above, we now solve for the FOC,

$$\begin{aligned} FOC = 0 &= \frac{d}{dp_{ij}} \left(\pi_i - \tilde{\pi}_{i(-j)} \right)^{1-\phi_{ij}} \left(\pi_j - \tilde{\pi}_{j(-i)} \right)^{\phi_{ij}} \\ &= (1 - \phi_{ij}) \left(\pi_j - \tilde{\pi}_{j(-i)} \right) \frac{d\pi_i}{dp_{ij}} + \phi_{ij} \left(\pi_i - \tilde{\pi}_{i(-j)} \right) \frac{d\pi_j}{dp_{ij}} \end{aligned}$$

Rearranging the above yields

$$p_{ij} = \mu_{ij} \frac{c_i}{\theta},$$

where

$$\mu_{ij} = (1 - \omega_{ij}(\tilde{\phi}_{ij})) \cdot \frac{\varepsilon_{ij}}{\varepsilon_{ij} - 1} + \omega_{ij}(\tilde{\phi}_{ij}) \cdot \mu_{ij}^{oligopsony}, \quad (28)$$

where $\omega_{ij}(\tilde{\phi}_{ij}) \equiv \frac{\tilde{\phi}_{ij} \lambda_{ij}^{bgn}}{\tilde{\phi}_{ij} \lambda_{ij}^{bgn} + \varepsilon_{ij} - 1} \in (0, 1)$.

A.3 Generalized outside option

Here we consider a model in which we impose less structure on the firms' outside options. In particular, we assume that in the case of a failed negotiation the profit of buyer j decreases by a factor of q_{ij} , and that the supplier's total cost increases by a factor of ζ_{ij} in addition to supplier i losing its sales to j . Under this generalized setup, we can write the changes in firm i and j 's profits as follows:

$$\begin{aligned}\pi_i - \tilde{\pi}_{i(-j)} &= p_{ij}q_{ij} - c_i q_i \zeta_{ij} \\ &= q_{ij} \left(p_{ij} - \frac{c_i}{\theta} \bar{\mu}_{ij}^{oligopsony} \right),\end{aligned}$$

$$\begin{aligned}\pi_j - \tilde{\pi}_{j(-i)} &= \pi_j q_{ij} \\ &= (\mu_j - 1) c_j q_j q_{ij},\end{aligned}$$

where $\bar{\mu}_{ij}^{int} = \theta \frac{\zeta_{ij}}{x_{ij}}$.

The first order conditions under these changes in profits yield:

$$p_{ij} = \left(\frac{\varepsilon_{ij} - 1}{\varepsilon_{ij} + \bar{\lambda}_{ij}^{bgn} \tilde{\Phi}_{ij} - 1} \frac{\varepsilon_{ij}}{\varepsilon_{ij} - 1} + \frac{\bar{\lambda}_{ij}^{bgn} \tilde{\Phi}_{ij}}{\varepsilon_{ij} + \bar{\lambda}_{ij}^{bgn} \tilde{\Phi}_{ij} - 1} \bar{\mu}_{ij}^{oligopsony} \right) \frac{c_i}{\theta},$$

where $\bar{\lambda}_{ij}^{bgn} = \frac{s_{ij}(\tilde{\nu}_j - 1)}{q_{ij}}$.

A.4 Pass-Through - Derivations and General Results

We consider the elasticity of bilateral price p_{ij} with respect the cost shock of ϑ_{ij} , where one can write

$$\Phi_{ij} \equiv \frac{d \ln p_{ij}}{d \ln \vartheta_{ij}} = \Gamma_{ij}^s \frac{d \ln s_{ij}}{d \ln \vartheta_{ij}} - \Gamma_{ij}^x \frac{d \ln x_{ij}}{d \ln \vartheta_{ij}} + \frac{1 - \theta}{\theta} \frac{d \ln q_i}{d \ln \vartheta_{ij}} + 1.$$

The elasticity of the supplier share s_{ij} , $\frac{d \ln s_{ij}}{d \ln \vartheta_{ij}}$, can be derived as

$$\frac{d \ln s_{ij}}{d \ln \vartheta_{ij}} = (1 - \rho) (1 - s_{ij}) \frac{d \ln p_{ij}}{d \ln \vartheta_{ij}}.$$

The elasticity of the buyer share x_{ij} , $\frac{d \ln x_{ij}}{d \ln \vartheta_{ij}}$, can be derived as

$$\frac{d \ln x_{ij}}{d \ln \vartheta_{ij}} = -\varepsilon_{ij} (1 - x_{ij}) \frac{d \ln p_{ij}}{d \ln \vartheta_{ij}} + (1 - x_{ij}) \varepsilon_i,$$

where we denote the demand elasticity that firm i faces by other firms by $\varepsilon_i \equiv -\frac{d \ln q_i}{d \ln \vartheta_{ij}}$, with $q_i \equiv q_i - q_{ij}$.

The term $\Gamma_{ij}^s = \frac{d \ln \mu_{ij}}{d \ln s_{ij}}$, is computed as

$$\Gamma_{ij}^s = \frac{\partial \ln \mu_{ij}}{\partial \ln \varepsilon_{ij}} \frac{\partial \ln \varepsilon_{ij}}{\partial \ln s_{ij}} + \frac{\partial \ln \mu_{ij}}{\partial \ln \lambda_{ij}^{bgn}} \frac{\partial \ln \lambda_{ij}^{bgn}}{\partial \ln s_{ij}},$$

where

$$\begin{aligned} \frac{\partial \ln \mu_{ij}}{\partial \ln \varepsilon_{ij}} &= \frac{\varepsilon_{ij}}{\varepsilon_{ij} + \tilde{\phi}_{ij} \lambda_{ij}^{bgn} \mu_{ij}^{oligopsony}} - \frac{\varepsilon_{ij}}{\varepsilon_{ij} + \tilde{\phi}_{ij} \lambda_{ij}^{bgn} - 1} \\ \frac{\partial \ln \varepsilon_{ij}}{\partial \ln s_{ij}} &= \frac{\varepsilon_{ij} - \rho}{\varepsilon_{ij}} \\ \frac{\partial \ln \mu_{ij}}{\partial \ln \lambda_{ij}^{bgn}} &= \frac{\tilde{\phi}_{ij} \lambda_{ij}^{bgn} \mu_{ij}^{oligopsony}}{\varepsilon_{ij} + \tilde{\phi}_{ij} \lambda_{ij}^{bgn} \mu_{ij}^{oligopsony}} - \frac{\tilde{\phi}_{ij} \lambda_{ij}^{bgn}}{\varepsilon_{ij} + \tilde{\phi}_{ij} \lambda_{ij}^{bgn} - 1} \\ \frac{\partial \ln \lambda_{ij}^{bgn}}{\partial \ln s_{ij}} &= 1 - \frac{1}{\rho - 1} \left(1 - s_{ij}\right)^{\frac{\tilde{v}_j}{\rho - 1} - 1} \lambda_{ij}^{bgn}. \end{aligned}$$

The term $\Gamma_{ij}^x = -\frac{d \ln \mu_{ij}}{d \ln x_{ij}}$, is computed as

$$\Gamma_{ij}^x = -\frac{\partial \ln \mu_{ij}}{\partial \ln \mu_{ij}^{oligopsony}} \frac{\partial \ln \mu_{ij}^{oligopsony}}{\partial \ln x_{ij}},$$

where

$$\begin{aligned} \frac{\partial \ln \mu_{ij}}{\partial \ln \mu_{ij}^{oligopsony}} &= \frac{\tilde{\phi}_{ij} \lambda_{ij}^{bgn} \mu_{ij}^{oligopsony}}{\varepsilon_{ij} + \tilde{\phi}_{ij} \lambda_{ij}^{bgn} \mu_{ij}^{oligopsony}} \\ \frac{\partial \ln \mu_{ij}^{oligopsony}}{\partial \ln x_{ij}} &= \frac{(1 - x_{ij})^{\frac{1-\theta}{\theta}}}{\mu_{ij}^{oligopsony}} - 1. \end{aligned}$$

Putting all together, one can obtain the pass-through equation of

$$\Phi_{ij} = \frac{-\Gamma_{ij}^x (1 - x_{ij}) \epsilon_i - \frac{1-\theta}{\theta} (1 - x_{ij}) \epsilon_i + 1}{1 + \Gamma_{ij}^s (\rho - 1) (1 - s_{ij}) - \Gamma_{ij}^x (1 - x_{ij}) \epsilon_{ij} + \frac{1-\theta}{\theta} x_{ij} \epsilon_{ij}}.$$

The pass-through equation above captures two sets of forces that affect the bilateral price. The first set of forces is the one operating through the changes in the two bilateral shares. A cost increase of the supplier reduces the supplier share s_{ij} as the buyer substitutes away from the supplier's good, inducing the supplier to reduce its markup (the term $\Gamma_{ij}^s (\rho - 1) (1 - s_{ij})$). The same shock would also change the buyer share x_{ij} , depending on the relative demand elasticities the supplier faces from its buyer and from its other buyers (the terms $\Gamma_{ij}^x (1 - x_{ij}) \epsilon_i$ and $\Gamma_{ij}^x (1 - x_{ij}) \epsilon_{ij}$). For example, if the buyer has more elastic demand ($\epsilon_{ij} > \epsilon_i$), then the buyer share x_{ij} will decrease. Under decreasing returns to scale technology the markup would increase, hence increasing the price pass-through.

The second set of forces are the ones operating through the change in scale of the supplier. A positive cost shock on the supplier reduces its scale, and if the production technology exhibits decreasing returns it would decrease its cost, dampening the magnitude of the price pass-through. The reduction in scale can come through the reduction of sales to the buyer (the term $\frac{1-\theta}{\theta} x_{ij} \epsilon_{ij}$) or through the reduction of sales to other buyers (the term $\frac{1-\theta}{\theta} (1 - x_{ij}) \epsilon_i$).

To be consistent with the empirical exercise we primarily consider the "direct" pass-through (Burstein and Gopinath, 2015) where we assume $\Delta p_{ik} = \Delta q_{kj} = 0$. In this case we can turn off the effects that operate through changes in other buyers' demand and through changes in overall scale, leading to the following pass-through equation:

$$\Phi_{ij} = \frac{1}{1 + \Gamma_{ij}^s (\rho - 1) (1 - s_{ij}) - \Gamma_{ij}^x (1 - x_{ij}) \epsilon_{ij} + \frac{1-\theta}{\theta} x_{ij} \epsilon_{ij}}.$$

B Data appendix

B.1 Merging foreign exporter ID with ORBIS data

The matching between ORBIS and LFTTD is possible since ORBIS contains names and addresses for the large majority of firms in the dataset, which we can use to construct the equivalent of the manufacturing ID in the LFTTD. In this section we describe some of the

instructions provided by the U.S. Census on how to construct the MID variable and then we provide an overview of the matching procedure between LFTTD and ORBIS using the constructed MID.

The general procedure to construct an identified code for a manufacturer using its name and address is as follows. (1) The first two characters of the MID are formed by the iso code of the actual country of origin of the goods, being the only exception to the rule Canada, for which each Canadian Province has their own code. (2) The next six characters of the MID are formed by the first three letters of the first and second words of the company name, or by the first three letters if the name of the company has a single word. (3) The MID uses the first four numbers of the largest number on the street address line. (4) Finally, the last three characters are formed by the first three alpha characters from the city name.²²

The matching is conducted as follows. First, we match the name part of the manufacturer's ID in LFTTD with the name part in ORBIS. Second, we construct a location matching score for the manufacturer's ID based on an indicator variable which is equal to 1 if the city of the exporter as reported in LFTTD corresponds to the set of cities reported in ORBIS. Finally, we construct a product matching score based on an indicator variable which checks whether the NAICS6 industry classification in ORBIS corresponds to the HS6 code product recorded in the customs data, using the concordance developed by [Pierce and Schott \(2009\)](#). We drop from the sample all manufacturer's ID assigned to a firm in ORBIS whose location and product matching scores are less than 90%. We also drop from the matched data any firm in ORBIS with less than five transactions in total, to eliminate spurious exporters from the database.

The LFTTD MID variable has recently been used in academic research papers to identify buyer-supplier relationships (see [Eaton et al., 2012](#); [Kamal and Sundaram, 2012](#); [Kamal and Krizan, 2013](#); [Kamal and Monarch, 2018](#); [Monarch, 2020](#)). There are some challenges associated with its use, regarding the uniqueness and accuracy in the identification of foreign exporters. We can overcome some of those limitations since we can directly assess the uniqueness of the MID in our Census-ORBIS matched data. This is, we observe when a given MID corresponds to more than one company in ORBIS and we proceed to

²²Other general rules also apply. For example, english words such as "a", "an", "and", "the" and also hyphens should be ignored from the company's name. Common prefixes such as "OOO", "OAO", "ISC", or "ZAO" in Russia, or "PT" in Indonesia, should be ignored for the purpose of constructing the MID. The next six characters of the MID are formed by the first three letters of the first and second words of the company name, or by the first three letters if the name of the company has a single word. In constructing the MID all punctuation, such as commas, periods, apostrophes, as well as single character initials should be ignored.

exclude these observation from the dataset unless these companies are part of the same corporation as measured by ORBIS ownership linkages. Another common concern in using MID as an identifier of foreign exporters is that, they can reflect intermediaries rather than the actual exporter.²³ Since we know the NAICS code of the firms in ORBIS, we have excluded retailers and wholesalers from the matched Census-ORBIS dataset.

B.2 Related party trade measured by ORBIS

One of the main advantage of ORBIS is the scope and accuracy of its ownership information: it details the full lists of direct and indirect subsidiaries and shareholders of each company in the dataset, along with a company's degree of independence, its global ultimate owner and other companies in the same corporate family. This information allows us to build linkages between affiliates of the same firm, including cases in which the affiliates and the parent are in different countries. We specify that a parent should own at least 50% of an affiliate to identify an ownership link between the two firms.

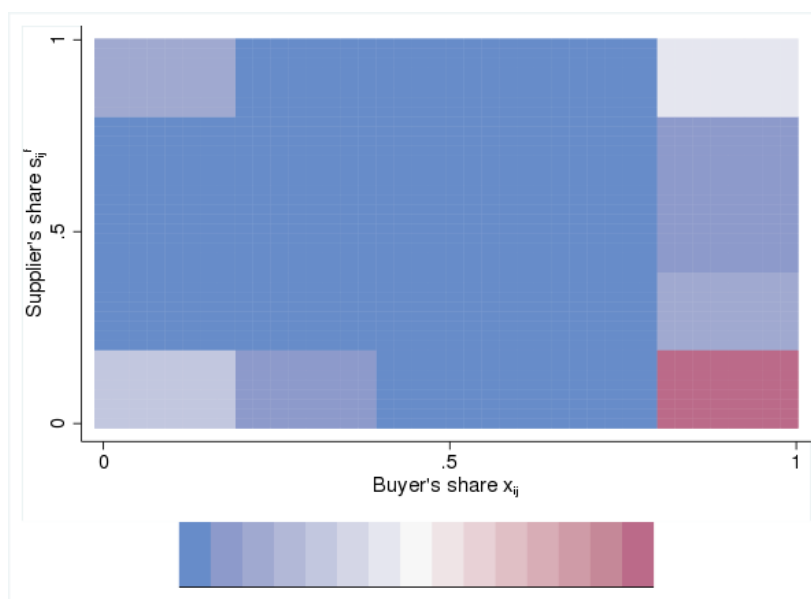
Merging U.S. Census and ORBIS datasets has been possible by matching the name and address of the U.S. based firms in the U.S Business Register and in ORBIS. This has been accomplished by applying the latest probabilistic record matching techniques and global position data (GPS), together with extensive manual checks, which has allowed us to achieve a large rate of successful matches. This dataset allows us to identify the U.S. firms and establishments that are part of a larger multinational operation – either majority-owned U.S. affiliates of foreign multinational firms or U.S. parent firms that have majority-owned operations overseas. Therefore, we can assess whether the trade transactions take place with parents or majority owned affiliates without relying in the related party trade indicator which may generate false-positives as multinationals identifier since the ownership threshold for related-party trade is 6% or higher for imports, well below majority ownership or even levels that would confer sufficient control rights.

B.3 Distribution of s_{ij} and x_{ij}

In Figure 2 we plot a heat map that shows the joint distribution of the two bilateral shares, s_{ij} and x_{ij} . The figure reveals that buyer-supplier relationships are not concentrated in one particular corner of the graph, namely in regions where relationships can be represented

²³The law requires the importer to declare the MID of the manufacturer exporter, not the intermediary, but complacency of this rule is hardly enforceable.

Figure 2: Supplier's share (s_{ij}) and buyer's share (x_{ij}) distribution



Notes: The figure displays the share of buyer-supplier-hs10 observations, with respect to the supplier's share (s_{ij}) and buyer's share (x_{ij}).

by models with one-sided heterogeneity. There are significant number of relationships where either or both supplier and buyer shares are close to 0 or 1, but in order to analyze all the combinations of the two bilateral shares one needs a model with two-sided heterogeneity and market power.

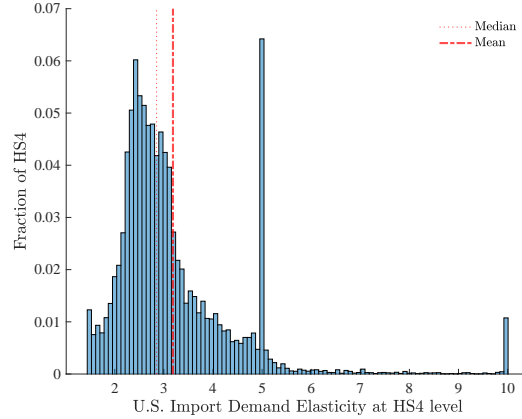
C Estimation appendix

C.1 Elasticity estimates

C.1.1 Demand elasticity downstream - ν

Following Broda and Weinstein (2006), we assume that buyer j sells its output q_j to downstream customers in different countries. A representative consumer in each country maximizes her utility by choosing imports and domestic consumption. Following the standard in the literature, consumers aggregate over the composite domestic and imported goods. The subutility derived from the composite imported good will be given by a CES aggregation across imported varieties with a good-importer specific elasticity of substitution given by σ_g^I , where I denotes the import market. Soderbery (2018) provides estimates of the elasticity σ_g^I , at the HS4 good g -importer country I level. The plot below shows the

Figure 3: Downstream Demand Elasticity



Notes: The figure displays the estimates of the import demand elasticity σ_8^I , where $I = USA$. These estimates are taken from Soderbery (2018). The mean and median value of σ_8^{US} is 3.2 and 2.85, respectively. Estimates are truncated above at 10.

distribution of these elasticities when the exporter country I is the U.S.. We use these elasticities to calibrate a value of ν in our model. For our baseline estimation, we consider the median value of 2.85, which we see as a conservative choice.

C.2 Alternative method to estimate θ and ϕ_{ij}

Here we present an alternative method to estimate θ and ϕ_{ij} , by exploiting the panel dimension of the data. Instead of taking the price differentials across buyers, here we consider price differentials across time. Define the operator Δ^t as one that takes differences across the time dimension. The moment we consider here becomes:

$$h_{ijt}(\vec{\kappa}, \theta) = \Delta^t \ln p_{ijt} - \Delta^t \mu_{ijt}(\vec{\kappa}, \theta), \quad (29)$$

where h_{ijt} represents unobserved cost changes over time within firm-pairs. The instrumental variables we include here are lagged bilateral shares s_{ijt-1} and x_{ijt-1} , the number of importers and exporters in the product market, quantile distributions of the bilateral shares (excluding the sharers for the $i - j$ pair). With these variables we solve the following minimization problem:

$$\min_{\vec{\kappa}, \theta} h(\vec{\kappa}, \theta)' \mathbf{Z}' \mathbf{W} \mathbf{Z} h(\vec{\kappa}, \theta)', \quad (30)$$

where \mathbf{W} is a weighting matrix.