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

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Abstract

Firms in global value chains are granular and exert bargaining power over the terms of trade. We develop a novel theory of international prices with two-sided granularity and market power, and illustrate how these features affect pass-through elasticities onto import prices. We build a new dataset merging transaction-level U.S. import data with balance sheet data for U.S. importers and foreign exporters to test the model's predictions. Our pricing framework enhances state-of-the-art frameworks in accurately predicting price changes following tariff changes. Our results shed light on the role of firms in determining tariff pass-through elasticities.

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1 Introduction

The recent wave of protectionist trade policies has spurred new interest in the tariff pass-through literature. The extent to which the incidence of tariffs falls on domestic consumers depends crucially on what happens to import prices. In the case of the 2018 U.S.-China trade war, these effects were largely unanticipated: While conventional trade theory has long held that the tariffs applied by a large country should cause foreign firms to lower prices, this has been the case only in a few industries, such as steel, whereas the vast majority of sectors saw a near-complete tariff pass-through into U.S. import prices, ending in substantial welfare losses for U.S. consumers.[1] What explains these seemingly surprising and heterogeneous patterns? Was the trade war a special episode, or do traditional pricing frameworks miss relevant channels of trade shock transmission? As the uncertainty surrounding trade remains high, a reassessment of theories of tariff incidence becomes a priority for both economists and policymakers.

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 the key characteristics of GVCs. Prominent among those is that intermediate input purchases involve significant "lock-in" effects, resulting in transaction prices between buyers and suppliers being bilaterally negotiated (Antras, 2015). Moreover, GVCs are dominated by granular firms, which are large enough to shape aggregate trade patterns (Gaubert and Itskhoki, 2020), and enjoy substantial bargaining power over the terms of trade (Morlacco, 2019).

Despite their empirical relevance, little is known about the price and pass-through implications of bargaining and bilateral market power in firm-to-firm trade. This paper contributes to bridging the gap between the theoretical and empirical trade literature with a novel theory of prices in GVCs and novel evidence from firm-to-firm trade and production data for the U.S.. We show that accounting for the salient characteristics of GVCs is essential to understanding the variation in international prices and pass-through elasticities, both at the firm and aggregate level. Moreover, we show that our model enhances state-of-the-art frameworks in accurately predicting price changes following tariff shocks. On the positive side, this paper sheds light on the role of firms in determining import price pass-through elasticities. On the normative side, this study is valuable for the optimal design of trade policies, by helping policy-makers predict the behavior of aggregate prices.

Section 2 develops a new partial equilibrium pricing model of GVCs. Each exporter-importer pair negotiates over the pair-specific price of an intermediate input, taking as given market conditions and negotiated outcomes in other links in the network.[2] Both exporters and importers are concentrated and wield market power over the terms of trade. The source of exporters' market power is the imperfect substitutability across foreign input varieties, allowing each exporter to exert bargaining power in negotiations, provided it has a substantial share in the importer's input expenditures. The

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

[2] Specifically, we leverage the Nash-in-Nash solution concept to solve for prices: the negotiated price is the Nash bargaining solution for that pair, given that all other pairs are in equilibrium (Horn and Wolinsky, 1988).

source of importers' market power is an upward-sloping exporter's supply curve: Since the marginal unit of input purchased costs more than the average unit, the importer can exert bargaining power in negotiations, provided it accounts for a substantial share of the exporter's total output. The relative bargaining power of the contracting parties depends on their respective (match-specific) bargaining weight and outside option.

The negotiated markup (and price) depends on the relative market share and bargaining power of the contracting parties. We show that the markup can be written as a weighted average between an oligopoly markup *above* marginal cost and an oligopsony markdown *below* marginal cost. When the exporters have full bargaining power, the markup converges to the oligopoly markup, increasing in the exporter's bilateral market share as in standard oligopolistic competition models (Atkeson and Burstein, 2008; Dhyne et al., 2022). When the importers have full bargaining power, the markup converges to the oligopsony markdown, taking values less or equal to one and decreasing in the importer's bilateral market share (Morlacco, 2019).[3] When both firms have negotiating power, ceteris paribus, the markup decreases in the importer's relative bargaining weight.

Our pricing framework helps shedding new light on the micro-level determinants of the pass-through elasticity of cost shocks into import prices. Notably, the model captures both traditional and novel sources of pass-through heterogeneity across firms. First, it captures *strategic complementarities* among exporters, a well-known source of incomplete pass-through whereby foreign exporters lower their markups following an import tariff surge due to the threat of trade diversion (Gopinath and Itskhoki, 2011; Burstein and Gopinath, 2014; Amiti et al., 2014, 2018). Market power among importers entail a novel source of more-than-complete tariff pass-through into import prices, which is related to *strategic substitutabilities* among importers. This effect follows from the importer decreasing its input demand when the price increases in response to the tariff surge: Lower importer's demand reduces the importer's bilateral market share, raising markups and pass-through. A third and final source of pass-through variation in our framework is related to a *cost channel*: When the importer's demand decreases following the tariff surge, marginal costs also decrease, lowering prices and pass-through. The absolute and relative strength of the different channels in determining pass-through rates depends on the agents' relative market shares and bargaining power.

The importance of *real* rigidities has long been recognized in the international trade and pass-through literature (Gopinath and Itskhoki, 2011; Burstein and Gopinath, 2014; Amiti et al., 2014).[4] Our price theory contributes to this literature by investigating the pass-through implications of endogenous markup negotiations in GVCs. In doing so, we abstract from any source of *nominal* rigidities, such as the menu cost of changing prices or fixed-price contracts. This choice is motivated by at least two observations: First, nominal rigidities such as menu costs are likely to be more

[3] Note that because the marginal cost increases in output, the equilibrium price can be below marginal costs, as long as it is above average costs. If the supplier's marginal costs were constant, the markup would be bounded below at one. See Section 2 for more details.

[4] Real rigidities are mechanisms that dampen price responses of firms because of factors such as strategic complementarities in price setting, real wage rigidity, the dependence of costs on input prices that have yet to adjust, among others (Gopinath and Itskhoki, 2011).

relevant for temporary shocks, such as exchange-rate fluctuations, than permanent shocks, such as tariffs and anti-dumping duties, which are the focus of this paper.[5] Second, recent evidence from the U.S.-China trade war shows that short- and long-run tariff pass-through on import prices were not substantially different, suggesting that nominal rigidities may have played a limited role in pass-through determination (Amiti et al., 2020).[6]

Section 3 brings our model to the data. One of the challenges of studying two-sided market power is that detailed information on outcomes of bilateral transactions (e.g., prices and quantities) and the characteristics of contracting parties (e.g., size and market shares) are usually hard to obtain. To this end, we construct a novel dataset containing bilateral price and quantity for each exporter-importer pair and their firm-level 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 1992-2016. Balance sheet information on U.S. importers is retrieved from the Longitudinal Business Database (LBD); information on foreign exporters comes from the ORBIS database.

We complement the above dataset with information on pair-level cost shocks incurred by the foreign suppliers. In particular, we construct a novel dataset covering the universe of anti-dumping (AD) investigations conducted by the U.S. government on foreign suppliers over the period of 2001- 2018. Unlike tariff shocks, anti-dumping rates have the added benefit of varying at the level of exporter-product-year, providing a richer source of variation. Nonetheless, for some exercises we also take advantage of the sizable increase in tariff imposed by the U.S. on selected products and trade partners during the period 2017-2018, for which we use the statutory tariff data from Fajgelbaum et al. (2020).

We use the data to test our main theoretical predictions on how bilateral shares are related with bilateral prices. We show that bilateral prices increase with the exporter's supplier share and decrease with the importer's buyer share, both coefficients being statistically and economically significant. In testing these price relationships, we address an endogeneity issue that is typical of regressions of prices on market shares. We do so by exploiting the firm-to-firm trade network structure and construct instrumental variables that are correlated with the bilateral shares of the buyer-supplier pair through shocks that hit other firms that are indirectly connected with the firm-pair.

In Section 4, we structurally estimate the main parameters affecting bilateral markups and prices. We provide an identification strategy for the model's main parameters that leverages the full dimensionality of our dataset. To estimate the exogenous bilateral bargaining weights at the pair-level, we posit that they can be written as a log linear function of a vector of observables that are found

[5] We shall notice that our theoretical results extend to any "cost-push" shock to the exporter's marginal costs. Therefore, our theory can also be used to study the (long-run) effects of exchange-rate pass-through into import prices.

[6] Using the U.S. import data as in this paper, Heise (2019) shows that pass-through rates tend to be higher in long-term relationships, which presumably are more likely to use either implicit or explicit contracts.

to be correlated with bilateral prices in the exercise above. 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. The bilateral bargaining weights are consistently estimated inside the range where both firms have some price-setting abilities.[7] Moreover, the estimated returns to scale parameter in the exporter's production—or their short run cost elasticity—is well below one, 0.43, a necessary condition for the importer's buyer share to play a meaningful role in equilibrium.

Lastly, we apply our estimated model and conduct counterfactual exercises in Section 5. We first evaluate the model's performance in predicting bilateral price changes. We assess 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 bilateral market shares and estimated 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 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 understand and accurately predict the behavior of aggregate import prices.

Related Literature This paper contributes to several related literatures. First and foremost, it contributes to an extensive literature studying the firm-level determinants of pass-through heterogeneity. Atkeson and Burstein (2008) and Auer and Schoenle (2016) relate the pass-through elasticity to market structure and the exporter's market share; Amiti et al. (2014) show that the exchange-rate pass-through decreases in the exporter's shares and imported share of inputs, while Berman et al. (2012) show that the pass-through is decreasing in the exporter's size. The pricing framework in this paper 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. We contribute to this set of papers by theoretically and empirically characterizing the role of bilateral concentration for international prices.

We also contribute to a growing empirical literature on the tariff pass-through elasticities with our data and evidence. While there is burgeoning evidence on the price response to exchange-rate shocks, studies investigating the pass-through of tariffs into import and export prices, particularly those using time-series variation to identify responses, are much scarcer (Fitzgerald and Haller, 2018; Berthou and Fontagné, 2016; Fontagné et al., 2018). Understanding the sources of

[7] We find that on average the bilateral bargaining weights are allocated towards the importers. The mean of the bilateral bargaining weights (with 0 when exporters have all the bargaining power and 1 when importers have all the bargaining power) is 0.76 with a standard deviation of 0.09.

(a)symmetries between exchange-rate and tariff pass-through is an important open question in international macroeconomics. The results in this paper can inform on that debate by providing novel insights on the sources of real rigidities in firm-to-firm trade.

This paper also belongs to a trade literature investigating the role of network heterogeneity for firm-level outcomes, particularly markups and prices. Cajal-Grossi et al. (2019) use data on Bangladeshi exporters to show that suppliers' markups are higher on orders produced for relational buyers compared to spot buyers. Using U.S. import transaction data, Heise (2019) shows that the exchange-rate pass-through increases in the longevity of the relationship, rationalizing the finding through a theory in which relationships accumulate relationship capital to lower production costs. Using French export transaction data, Fontaine et al. (2020) show that large multi-product exporters adopt more discriminatory pricing strategies, and that price discrimination is stronger for more differentiated and more durable products. Similarly, Ignatenko (2019) shows that the ability to backwards integrate allows larger buyers to obtain lower input prices in trade data from Paraguay. Our findings resonate with these studies, to which we contribute with a theory of markup and pass-through heterogeneity based on bilateral concentration and market power in firm-to-firm trade.

Our theoretical model belongs to the literature on the role of input-output networks in propagating and amplifying shocks. We most closely relate to studies on the role of firm-level interactions for shock transmission (Taschereau-Dumouchel, 2018; Acemoglu and Tahbaz-Salehi, 2020; Dhyne et al., 2021, 2022). Our main contribution to this literature is to characterize analytically the role of bilateral oligopolies and firm granularity for the intensive-margin pass-through elasticity of an exporter's cost shock to the negotiated price.

Related to our paper is a recent work by 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.

2 Theory

This section sets out a theory of prices in firm-to-firm trade with two-sided concentration and 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 in an importer-exporter $(i - j)$ 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 importer j, or the importer's *sourcing strategy*. Importer j imperfectly substitutes across foreign input varieties. The foreign intermediate input's quantity and price are defined as:

$$q_j^f = \left(\sum_{i \in \mathcal{Z}_j} \varsigma_{ij} \left(q_{ij} \right)^{\frac{\rho-1}{\rho}} \right)^{\frac{\rho}{\rho-1}} \quad \text{and} \quad p_j^f = \left(\sum_{i \in \mathcal{Z}_j} \varsigma_{ij}^{\rho} p_{ij}^{1-\rho} \right)^{\frac{1}{1-\rho}}, \tag{1}$$

where $\rho > 1$ is the elasticity of substitution between varieties sourced by importer j, q_{ij} is the quantity of variety (exporter) i sourced by importer j, ς_{ij} is the saliency term for exporter i's variety, and p_{ij} is the price that exporter i and importer j negotiate, which is the focus of our analysis.

We assume that firm (importer) j produces its final output q_j combining the foreign intermediate input with domestic inputs. We let c_j denote firm j'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 index:

$$\gamma = \frac{d \ln c_j}{d \ln p_j^f} \in (0, 1]. \tag{2}$$

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

$$\nu = -\frac{d \ln q_j}{d \ln p_j} > 1, \tag{3}$$

where total demand for q_j depends on the price p_j and (exogenous) shifters.

On the exporter side, we let $\mathcal{J}_i$ denote the set of buyers of exporter i's variety. Exporter i's total output can be written as $q_i = \sum_{k \in \mathcal{J}_i} q_{ik} = q_{ij} + q_{i(-j)}$, where $q_{i(-j)} \equiv \sum_{k \neq j} q_{ik}$ is total i's demand by downstream importers other than j. We let c_i denote exporter i's marginal cost, and let

$$\frac{1-\theta}{\theta} = \frac{d \ln c_i}{d \ln q_i} \geq 0 \tag{4}$$

denote i's marginal cost elasticity to total input supply, such that can write firm i's average costs as θc_i .The parameter $\theta \in (0, 1]$ can capture returns to scale of exporter i's production. When $\theta \in (0, 1)$, the marginal costs are increasing in total output, which means that upstream production features decreasing returns; conversely, when $\theta = 1$, the exporter's marginal costs are constant, which means that production features constant returns. Alternatively, one can interpret θ as firm i's relevant cost elasticity during negotiations if the exporter's technology features constant returns and some inputs are held fixed during negotiations.[8]

[8] Consider, for example, the simple case of a Cobb-Douglas CRS technology for firm i's , given by $q_i = m_i^{\theta} k_i^{1-\theta}$, where m_i denotes static inputs and k_i denotes dynamic inputs. As described below, firms enter the bargaining game

2.2 Price Bargaining

Importer j and exporter i determine p_{ij} via bilateral negotiations. For tractability, we assume that the input quantity is pinned down by the importer's demand function, once the price is determined. This assumption resonates with the fact that the contracts governing firm-to-firm relationships in GVCs have limited enforceability and thus are highly incomplete (Antràs, 2020).[9]

To tractably analyze the division of surplus, we leverage the Nash-in-Nash solution concept: The price negotiated between firms i and j is the pairwise Nash bargaining solution given that all other pairs reach agreement (Horn and Wolinsky, 1988). We assume that during negotiations the two firms hold fixed the network of firm-to-firm trade, which means that they do not consider the possibility of renewed search of alternative buyers or suppliers in their outside option, which in our baseline model is given by the profits when the $i-j$ link is terminated, i.e., the "disagreement profits".[10]

The negotiated price p_{ij} solves:

$$\max_{p_{ij}} \left(\pi_i(p_{ij}) - \tilde{\pi}_{i(-j)}\right)^{1-\phi_{ij}} \left(\pi_j(p_{ij}) - \tilde{\pi}_{j(-i)}\right)^{\phi_{ij}}, \tag{5}$$

where $\pi_i(p_{ij})$ and $\pi_j(p_{ij})$ are the profits to the exporter i and the importer j if the negotiations succeed, and $\tilde{\pi}_{i(-j)}$ and $\tilde{\pi}_{j(-i)}$ are the disagreement profits, 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 of the negotiation process, such as their information structure, their negotiating strategies or time preference mismatches between the parties (Muthoo, 1999). In our notation, a higher ϕ_{ij} denotes higher relative bargaining power of importer j.

Taking the first-order condition with respect to (5) and rearranging terms, it is possible to write the bilateral price p_{ij} as a markup μ_{ij} over the exporter's marginal cost c_i:[11]

$$p_{ij} = \mu_{ij} c_i. \tag{6}$$

We characterize the markup in equation (5) by considering special limit cases first. In what follows, we denote by $s_{ij} \equiv \frac{p_{ij}q_{ij}}{\sum_{k\in\mathcal{Z}_j} p_{kj}q_{kj}} \in (0,1)$ the *exporter's supplier share*, i.e., the share of i's sales over importer j's total imports, by $x_{ij} \equiv \frac{q_{ij}}{\sum_{k\in\mathcal{J}_i} q_{ik}} \in (0,1)$ the *importer's buyer share*, i.e., the share of importer j's imported units over the total units of the good supplied by exporter i, and by $\tilde{\phi}_{ij} \equiv \frac{\phi_{ij}}{1-\phi_{ij}} \in \mathbb{R}_+$ the relative (exogenous) bargaining power of j.

by taking as given their dynamic inputs, chosen in advance. This means that firm i take k_i as constant during negotiations, making production effectively decreasing returns in its flexible inputs.

[9] In Appendix A.2, we consider the case of bargain over quantities. Both the theoretical discussion, and estimation strategy can be easily extended to this case.

[10] Below, we discuss how the model can we extended to allow the possibility of renewed search to affect the players' outside options.

[11] See Appendix A.1 for the detailed derivations of this expression.

Special case: When $\tilde{\phi}_{ij} \to 0$. When $\tilde{\phi}_{ij} \to 0$, the bargaining power is concentrated on the exporter's side, and the importer acts as a price taker. In this case, the solution to (5) simplifies to a standard Nash-Bertrand solution, with:

$$\mu_{ij} \mid_{\tilde{\phi}_{ij} \to 0} = \mu_{ij}^{oligopoly} \equiv \frac{\varepsilon_{ij}}{\varepsilon_{ij} - 1} \geq 1, \tag{7}$$

$$\varepsilon_{ij} = \rho \left(1 - s_{ij}\right) + \tilde{\nu} s_{ij}, \tag{8}$$

where ε_{ij} is a demand elasticity term, and $\tilde{\nu} = 1 - \gamma + \nu\gamma$ is a parameter that depends on the downstream demand elasticity ν and the cost elasticity γ. As in standard models of oligopolistic competition, the demand elasticity ε_{ij} is a function of the supplier share s_{ij} (Atkeson and Burstein, 2008).[12] When this share is infinitesimal ($s_{ij} \to 0$), the demand elasticity ε_{ij} collapses to ρ, the substitution elasticity across foreign varieties. When the share is close to one ($s_{ij} \to 1$) the demand elasticity ε_{ij} converges to $\tilde{\nu}$. We note that with $\rho > \tilde{\nu}$, the elasticity (markup) is a decreasing (increasing) function of s_{ij}. That is, larger exporters charge higher markups as long as the input demand elasticity increases in the "upstreamness" of the production stage.[13]

Special case: When $\tilde{\phi}_{ij} \to \infty$. When $\tilde{\phi}_{ij} \to \infty$, the bargaining power is concentrated on the importer's side, such that the exporter acts as a price taker. In this case, the bilateral markup over marginal cost reads:

$$\mu_{ij} \mid_{\tilde{\phi}_{ij} \to \infty} = \mu^{oligopsony} \equiv \theta \left(\frac{1 - (1 - x_{ij})^{\frac{1}{\theta}}}{x_{ij}} \right) \leq 1. \tag{9}$$

The markup over the marginal cost is the product of the returns to scale parameter θ, and the markup over the *average* cost.[14] The markup over the average cost is capped by $1/\theta$, which is larger than unity under decreasing returns to scale, $\theta < 1$. Equation (9) thus shows that the negotiated markup can take values below unity. Moreover, the markup further decreases with the importer's buyer share x_{ij}. The intuition is that when marginal costs increase in total output, the cost of the last output unit produced, i.e., the marginal cost of output, is higher than the cost of all the infra-marginal units (and the average cost of output) generating rents accruing to the exporter.[15] Large importers understand the effect of their input demand on the exporters' costs, and they can extract some of these rents by negotiating a markup below marginal cost (and above average cost). The larger the importer, the larger the gap between the average and the marginal cost of output purchased, the lower the negotiated markup. Conversely, when $\theta = 1$, marginal and average costs

[12] Note that, unlike standard models, the supplier share is defined at the match level in our model of firm-to-firm trade, rather than at the firm level.

[13] The condition $\rho > \tilde{\nu}$ is standard in theoretical trade models, and typically validated in empirical work. See, e.g., Atkeson and Burstein (2008); Dhyne et al. (2022).

[14] Note that this follows from the fact that average costs are equal to θc_i.

[15] Notice that, when the importer has all the bargaining power, the exporter never charges any markup above the marginal cost. In other words, the exporter cannot earn any rents besides technological ones.

always coincide, such that full importer's bargaining power always coincides with marginal cost pricing, i.e., $\mu^{oligopsony} = 1 \; \forall \; x_{ij} \in [0,1]$.

General case: When $\tilde{\phi}_{ij} \in \mathbb{R}_+$. The following proposition characterizes the Nash-in-Nash solution in the general case where both the importer and the exporter have some bargaining power ($\tilde{\phi}_{ij} \in \mathbb{R}_+$).

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

$$\mu_{ij} = (1 - \omega_{ij}) \cdot \mu_{ij}^{oligopoly} + \omega_{ij} \cdot \mu_{ij}^{oligopsony}, \tag{10}$$

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

In the general case, the markup μ_{ij} can be written as a weighted average between the oligopoly markup in equation (7) and the oligopsony markdown in equation (9). The weighting factor ω_{ij} is an increasing function of $\tilde{\phi}_{ij}\lambda_{ij}$, the product of the exogenous bargaining term $\left(\tilde{\phi}_{ij}\right)$, and a term (λ_{ij}) that increases in the buyer's outside option $\hat{\pi}_{j(-i)} \equiv \frac{\tilde{\pi}_{j(-i)}}{\pi_j} = (1 - s_{ij})^{\frac{1-\nu}{1-\rho}\gamma}$. We refer to $\tilde{\phi}_{ij}\lambda_{ij}$ as the *effective* buyer's bargaining position. The larger the $\tilde{\phi}_{ij}\lambda_{ij}$, the larger ω_{ij}, hence the closer is the bilateral markup μ_{ij} to the oligopsony markup.

Notice that, for given levels of ω_{ij}, the markup in equation (10) depends on the two shares s_{ij} and x_{ij} only through their effect on $\mu_{ij}^{oligopoly}$ and $\mu_{ij}^{oligopsony}$, respectively. While the weight ω_{ij} itself depends on the supplier's share s_{ij}, we show in the appendix that in a large range of the parameter space it is quite inelastic to the level of the supplier's share, such that we can reasonably approximate $\frac{d \ln \omega_{ij}}{d \ln s_{ij}} \simeq 0$. It follows that the markup in the general case inherits the properties of that in the special cases: it increases in the exporter's share s_{ij} and it decreases in the importer's share x_{ij}. Section 3.4 brings these predictions to the data, and shows that they are largely satisfied in the context of U.S. firm-to-firm imports.

Generalization The model's results hold under general specifications of the exporter's technology and market structure upstream and the importer's technology and market structure downstream. The important assumption in deriving equation (10) is that both importers and exporters take as given market conditions in other links in the network, such that the negotiated input price affects profits only through its effect on marginal costs. These effects are governed by the vector of elasticities $\beta = \{\rho, \gamma, \nu, \theta\}$. Our baseline model keeps cross-sectoral parametric heterogeneity to a minimum by letting these elasticities be constant across firms. While 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.

In our baseline model, we maintain the assumption that the network of firm-to-firm trade is fixed during negotiations. This assumption implies, among other things, that the players do not consider renegotiations in case of disagreement, such that the disagreement payoffs coincide with the firms' profits originating from other (pre-existing) network nodes.

In Appendix A.3, we show that our main result in Proposition 1 can be generalized to the case of renegotiations. In the case of a failed negotiation, we assume there that the profits of buyer j and the total cost of exporter i change to ϱ_{ij} and ς_{ij} respectively, both varying at the pair-level. This generalization allows us to capture arbitrary form of renegotiations. For example, the former can capture the potential change in the profit of j through its new supplier that it additionally sources from, and the latter can capture the cost of i in establishing trade relationships with new buyers. We show that the generalized model yields an equilibrium price that is very similar to equation (10), with two notable differences. The first is that the term λ_{ij} in equation (10) is now a function of the importer's outside option ϱ_{ij}. The second is that the oligopsony markup is now a function of the exporter's outside option ς_{ij}. These imply that while the result in Appendix A.3 offers a rich interpretation on how firms' renegotiation opportunities can affect bilateral prices, one needs detailed information on how the two firms' bilateral outside options, ϱ_{ij} and ς_{ij}, are set, in order to conduct quantitative analyses. For this reason we maintain the assumption of fixed network throughout the paper.

2.3 Pass-Through

In this section we investigate the role of bargaining and bilateral concentration in determining the pass-through elasticity of cost shocks into import prices. We first consider a pair-level permanent shock to the exporter's cost c_i, which we denote by ϑ_{ij}. We illustrate how this pair-level shock affects the price p_{ij}, by characterizing the price pass-through elasticity to the shock, $\Phi_{ij} \equiv \frac{d \ln p_{ij}}{d \ln \vartheta_{ij}}$. In doing so, we focus on the direct channel in which the shock affects the price p_{ij}, by assuming that the shock on the $i-j$ pair does not affect the quantities sold in other nodes, $d \ln q_{iz} = 0 \; \forall z \neq j$. Using these pair-level pass-through elasticities, we then illustrate how cost shocks that vary at the exporter-level—akin to import tariff shocks—affect pair-level prices p_{ij}. When shocks vary at the exporter-level, multiple buyers supplying from the same exporter gets hit by the same shock. Hence one needs to take into account the indirect effects of the shock on p_{ij}, whereby the change in quantity sold to other buyers affect p_{ij} through the change in the buyer share x_{ij} and through supplier i's scale.

We start by log-differentiating equations (6) and (10), to write the log change in price, $d \ln p_{ij}$, as:

$$d \ln p_{ij} = \Gamma_{ij}^{s} d \ln s_{ij} + \Gamma_{ij}^{x} d \ln x_{ij} + d \ln c_i + d \ln \vartheta_{ij}, \tag{11}$$

where $\Gamma_{ij}^{s} \equiv \frac{\partial \ln \mu_{ij}}{\partial \ln s_{ij}} > 0$ denotes the partial elasticity of bilateral markups with respect to the exporter's supplier share s_{ij}, which is a function of the supplier share and parameters $\left(\Gamma_{ij}^{s} = \Gamma^{s}(s_{ij}, \tilde{\phi}_{ij}; \beta)\right)$, while $\Gamma^x_{ij} \equiv \frac{\partial \ln \mu_{ij}}{\partial \ln x_{ij}} < 0$ is the partial elasticity of bilateral markups with respect to the importer's buyer share x_{ij}, a function of the buyer share and parameters $\left(\Gamma^x_{ij} = \Gamma^x(x_{ij}, \tilde{\phi}_{ij}; \beta)\right)$.[16]

Using the definitions of the two bilateral shares, we can write:

$$d \ln s_{ij} = -\,(\rho - 1)(1 - s_{ij}) d \ln p_{ij} \tag{12}$$

$$d \ln x_{ij} = -\,\varepsilon_{ij}(1 - x_{ij}) d \ln p_{ij}, \tag{13}$$

where ε_{ij} is as in equation (8). In turn, the change in exporter i's marginal costs as a function of the log price change is:

$$d \ln c_i = -\frac{1-\theta}{\theta} x_{ij} \varepsilon_{ij} d \ln p_{ij}. \tag{14}$$

Substituting equations (12) to (14) into (11), we derive the following proposition:

Proposition 2. *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:*

$$\Phi_{ij} \equiv \frac{d \ln p_{ij}}{d \ln \vartheta_{ij}} = \frac{1}{1 + \Gamma^s_{ij}(\rho - 1)(1 - s_{ij}) + \Gamma^x_{ij}\varepsilon_{ij}(1 - x_{ij}) + \frac{1-\theta}{\theta} x_{ij}\varepsilon_{ij}}. \tag{15}$$

Equation (15) indicates that just like the markup, the import price pass-through elasticity in a bargaining model with bilateral market power can be written as a function of the bilateral shares s_{ij} and x_{ij}, the relative bargaining power $\tilde{\phi}_{ij}$, and the parameter vector $\boldsymbol{\beta} = \{\gamma, \nu, \rho, \theta\}$.

Equation (15) 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 quantities in other network nodes, namely, $d \ln q_{iz}$ $\forall z \neq j$, can be controlled for. We refer to Appendix A.4.1 to discuss an alternative pass-through equation that considers the general equilibrium effects of the cost shock ϑ_{ij} on supplier i's sales to other buyers.

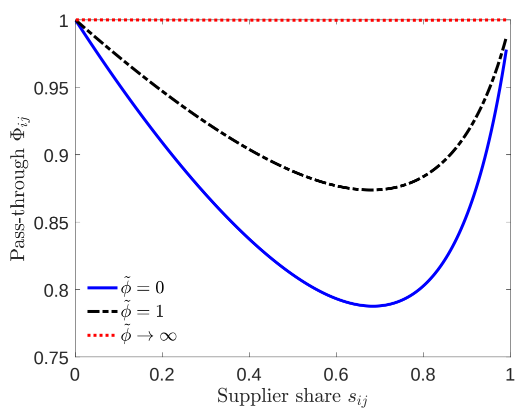
The three terms in the denominator of equation (15) captures three different forces affecting the import price pass-through elasticities in our model. In what follows, we illustrate each of these forces, focusing on their sources and pass-through implications.

Strategic Complementarities among exporters The first term in the denominator of equation (15) reflects the strategic complementarities among exporters, a standard source of incomplete pass-through (Burstein and Gopinath, 2014; Amiti et al., 2014, 2018). This channel prevails when the bargaining power is concentrated on the exporter side and the exporter's marginal costs are constant. Focusing on this channel, the pass-through equation would reduce to $\Phi_{ij} = \frac{1}{1+\Gamma^s_{ij}(\rho-1)(1-s_{ij})} \in$

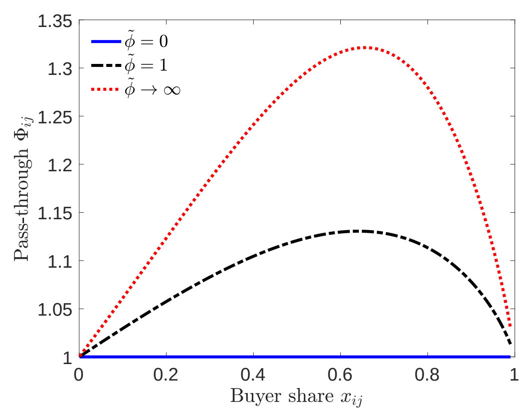
[16] As shown in Appendix A.4.1, when deriving Γ^s_{ij} we approximate $\frac{\partial \ln(1-\omega_{ij})}{\partial \ln s_{ij}} = \frac{\partial \ln(\omega_{ij})}{\partial \ln s_{ij}} \simeq 0$ by treating ω_{ij} as constants.

Figure 1: Pass-through elasticities: Channels

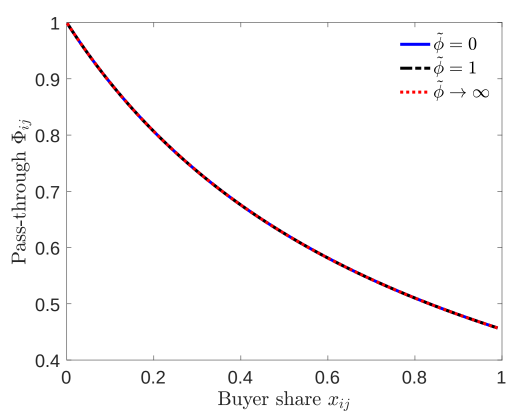
(a) Strategic complementarities



(b) Strategic substitutabilities



(c) Cost channel



$(0,1)$.[17] Panel 1a of Figure 1 shows the pass-through effects of the exporters' strategic complementarity channel, for different values of the supplier share and relative bargaining power. Following a cost shock such as a tariff surge, the exporter reduces its markup to prevent the buyer from substituting away from its variety, leading to an *incomplete* pass-through of the tariff shock into the price. The response of import prices to cost shocks is *U-shaped* in the supplier share (Goldberg and Tille, 2013; Auer and Schoenle, 2016). When the exporter's supplier share is either infinitesimal ($s_{ij} \to 0$) or very large ($s_{ij} \to 1$), the scope for strategic complementarities in pricing is reduced, leading to a lesser impact of the shock on the negotiated markup (and price). Similarly, the scope for strategic complementarities *decreases* in the importer's relative bargaining power is high, with $\lim_{\tilde{\phi}_{ij}\to\infty} \Gamma^s_{ij} = 0$ and $\lim_{\tilde{\phi}_{ij}\to\infty} \Phi_{ij} = 1$.

Strategic Substitutabilities among importers The second term in the denominator of equation (15) reflects the strategic substitutabilities among importers. The source of strategic substitutabilities in the model is the increasing exporter's marginal cost: When there is a reduction in the exporter's demand from other buyers (decrease in $q_{i(-j)}$), it's marginal cost decreases and firm j's buyer share (x_{ij}) increases. This lowers the pair-specific markup μ_{ij}, further depressing the price p_{ij} and increasing firm j's purchases of firm i's goods, q_{ij}. Focusing on this channel, the pass-through expression simplifies to $\Phi_{ij} = \frac{1}{1+\Gamma^x_{ij}\varepsilon_{ij}(1-x_{ij})} \geq 1$.[18] Panel 1b of Figure 1 shows that the importers' strategic substitutability channel is a source of more-than-complete pass-through into import prices. The intuition behind this channel is the fact that the bilateral markup increases following a tariff surge, due to the negative effect of the importer's lower demand on the buyer share x_{ij} and negotiating power. The elasticity of the importer's buyer share to changes in demand is small when the share is either infinitesimal ($x_{ij} \to 0$) or very large ($x_{ij} \to 1$), leading to a *hump-shape* response with respect to the buyer share x_{ij}. Unlike the previous case, the scope for strategic complementarities *increases* in the importer's relative bargaining power, with $\lim_{\tilde{\phi}_{ij}\to 0} \Gamma^x_{ij} = 0$ and $\lim_{\tilde{\phi}_{ij}\to 0} \Phi_{ij} = 1$.

Cost channel The third and last term in the denominator of equation (15) captures the cost channel, namely, the price response due to changes in the exporter's marginal cost triggered by the shock. When the price increases due to the shock, a standard demand effect leads the importer to demand less of exporter i's variety. When the technology of the exporter exhibits decreasing returns ($\theta < 1$), the lower demand decreases the marginal cost, lowering the price. The more the importer's demand accounts for in the exporter's output, the more substantial the cost (and price) reduction, the lower the pass-through. Therefore, as seen in Panel 1c of Figure 1, the cost channel

[17] Under this case, the elasticity of markup with respect to the supplier share is $\Gamma^s_{ij} \simeq (1-\omega_{ij}) \frac{\mu^{oligopoly}}{\mu_{ij}} \frac{1}{\varepsilon_{ij}-1} \frac{\rho-\varepsilon_{ij}}{\varepsilon_{ij}}$. See Appendix A.4.1 for details.

[18] Under this case, the elasticity of markup with respect to the buyer share is $\Gamma^x_{ij} = \omega_{ij} \frac{\mu^{oligopsony}}{\mu_{ij}} \left(\frac{\left(1-x_{ij}\right)^{\frac{1-\theta}{\theta}}}{\mu^{oligopsony}_{ij}} - 1 \right)$. See Appendix A.4.1 for details.

acts as a source of incomplete pass-through of shocks into import prices. The strength of the cost channel does not depend on the importer's relative bargaining power.

All things considered, the figure that emerges is one where a large range of values of the pass-through elasticity Φ_{ij} are admissible. Figure 2 in Appendix A.4.1 displays the contour plots of Φ_{ij} for different values of the relative bargaining power, namely $\tilde{\phi}_{ij} \in \{0, 1, \infty\}$. The figure shows that the passthrough elasticity generally takes value below unity, namely, the pass-through is mostly incomplete. Moreover, the pass-through elasticity decreases in the importer's buyer share, due to the cost channel always prevailing over the strategic substitutability channel; the pass-through elasticity is instead *u-shaped* in the exporter's supplier share. In the following sections, we bring this model to the data to empirically test its ability to rationalize the behavior of import prices.[19]

Discussion: pair-level shocks vs. firm-level shocks Proposition 2 focuses on the effects of shocks that vary at the pair-level. In settings of international trade where most cost shocks vary at the product-country-level (import tariffs) or at the exporter-level (AD duties), it is also necessary to account for the effects that these cost shocks have on the pair-level price p_{ij} through exporter i's sales to the other buyers. Consider an exporter-level permanent cost shock ϑ_i. In Appendix A.4.2 we derive the elasticity of price p_{ij} to this cost shock ϑ_i.[20] We show that the elasticity, $\Psi_{ij} \equiv \frac{d \ln p_{ij}}{d \ln \vartheta_i}$, can be written as follows:

$$\Psi_{ij} \equiv \frac{d \ln p_{ij}}{d \ln \vartheta_i} = \Phi_{ij} + \sum_{z \in W_i, z \neq j} \underbrace{\Phi_{iz}}_{\frac{d \ln p_{iz}}{d \ln \vartheta_i}} \underbrace{\varepsilon_{iz}}_{-\frac{d \ln q_{iz}}{d \ln p_{iz}}} \left(\underbrace{x_{iz} \Gamma_{ij}^{x}}_{-\frac{d \ln x_{ij}}{d \ln q_{iz}} \frac{d \ln \mu_{ij}}{d \ln x_{ij}}} - \underbrace{x_{iz} \frac{1-\theta}{\theta}}_{-\frac{d \ln c_i}{d \ln q_{iz}}} \right) \Phi_{ij}, \tag{16}$$

where W_i is the set of buyers of i. The first term in equation (16) shows that the exporter-level cost shock will directly impact the p_{ij} through the channel illustrated with the pass-through elasticity Φ_{ij}. The second term captures the additional effects the exporter-level cost shock will have through the other relationships the exporter i has. The same cost shock ϑ_i affects exporter i's price to the other buyer z with elasticity Φ_{iz}, and the change in p_{iz} will then affect the corresponding quantity with elasticity ε_{iz}. The change in quantity q_{iz} will effectively serve as an additional cost shock to the $i - j$ pair through two channels. First, it will change the buyer share x_{ij} hence affecting the markup μ_{ij} (the term $x_{iz}\Gamma_{ij}^{x}$). Second, it will change the scale of i hence affecting i's marginal cost (the term $x_{iz}\frac{1-\theta}{\theta}$). Equation (16) is useful in settings where only firm-level shocks—but not pair-

[19]In Appendix A.4.1 we also discuss the relevant pass-through elasticity in settings where changes in suppliers' marginal costs can be controlled for. Figure 3 in Appendix A.4.1 displays the contour plots of Φ_{ij} for different values of the relative bargaining power, namely $\tilde{\phi}_{ij} \in \{0, 1, \infty\}$, focusing solely on the markup channels. The figure shows that when only the markup changes are considered, the pass-through elasticity takes values both below and above unity, due to the contributions of the strategic complementarities and strategic substitutabilities channels. In this case, the elasticities of the pass-through to the two bilateral shares vary depending on the values of x_{ij}, s_{ij}, and $\tilde{\phi}_{ij}$. Notably, the figure shows that when market power on both sides of the market is allowed for, high pass-through rates are more frequent than in (conventional) models that assume that the market power is concentrated on exporters.

[20]In Appendix A.4.2 we also derive the elasticity of price p_{ij} on an importer-level permanent cost shock ϑ_j.

level shocks—are observable to researchers. We later use this equation in Section 5 to construct model predicted price changes to observed AD duty shocks.

3 Data and Stylized Facts

3.1 Data sources

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 importers and exporters 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 custom 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 exporter 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 bills, 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).[21]

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 complement the above merged dataset with information on relationship-level cost shocks incurred by the foreign suppliers. In particular, we construct a novel dataset covering the universe of AD investigations conducted by the U.S. government on foreign suppliers over the period of

[21] See Appendix B.1 for more details on the construction of the MID variable.

2001-2018.[22] Unlike trade tariffs, which apply to all firms from a given country and product, AD margins vary at the level of the exporter, providing richer variation for identification of the effects of interest. The AD cases often state different margins for a set of individual exporters, and a common margin applying "all other" firms in the same country-HS10 pair. We merge our constructed AD dataset with the LFTTD by using the information of the HS10 product and foreign exporter's name subject to the AD investigations.

We further complement our analysis with data on trade tariffs, particularly in the period of 2017-2018. The import tariffs imposed by the U.S. on selected products and trade partners have experienced a sizable increase after several decades of low and stable tariff rates. The statutory 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.

3.2 Measuring key variables of the model

We measure the key variables of the model exploiting the unique features of our data described above. To do so, we introduce multiple products to the model, 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 (2) thus becomes:

$$\alpha_j^h \gamma = \frac{d \ln c_j}{d \ln p_j^{f,h}} \in (0, 1], \tag{17}$$

where α_j^h is the (observed) Cobb-Douglas share of the HS10 input h on j's total imports of intermediates.

We define the exporter's supplier share for product h as $s_{ij}^h = \frac{p_{ij}^h q_{ij}^h}{\sum_{k \in Z_j^h} p_{kj}^h q_{kj}^h}$. We construct the numerator of this share by summing up all imports of j from exporter i (a MID in our dataset) of product h during the year; the denominator adds all the imports of product h across all the foreign suppliers that supply to j.

Unlike the exporter's supplier share, the importer's buyer 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 export quantity of product h sold to the U.S.

[22] For each AD case activated by the U.S. government, the Federal Register publishes the names of foreign exporters subject to tariff, the list of HS10 codes corresponding to the set of products covered, the imposed AD margins, and the dates of the initiation of the investigation, activation and revocation of the AD duties. Details on the construction of the AD dataset are presented in Appendix B.2.

3.3 Selection and summary statistics

We use the following criteria to construct our estimation sample. To ensure that the selection of foreign exporters 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 transactions between foreign exporters and U.S. importers 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 there is no ownership relationship between the exporter and importer. To do so, we leverage the information on ownership relationships from both the LFTTD and ORBIS.[23] Further, we select exporters that sell a given product (HS10) to two or more U.S. 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.

We report the summary statistics on our sample in Table 1. Panel A reports the statistics on the intensive margin of trade, specifically on the bilateral prices and market 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 importers and exporters 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. In Panel B we report the statistics on the extensive margin, showing evidence of both granularity and market power of firms in international trade. Both importers and exporters are connected to a limited number of partners in a given year. Moreover, firms' tenure in international trade is long, with an average of about 6 years of experience. Relationships between importers and exporters are sticky even at the HS10 product level, with an average pair trading the same HS10 product for 3 consecutive years (Monarch, 2020).

[23] See Appendix B.3 for details.

Table 1: Summary statistics

Variable	**Mean**	**Std.**
Panel A. Intensive Margin		
s_{ijt}^h	0.15	0.22
x_{ijt}^h	0.28	0.30
$\ln p_{ijt}^h$	3.52	2.48
Panel B. Extensive Margin		
Exporters per importer (HS10)	10.16	36.27
Importers per exporter (HS10)	9.59	25.08
Importer experience (tenure)	7.44	4.38
Exporter experience (tenure)	5.87	3.92
Age of the relationship	3.05	2.71

Note: The table shows the mean and standard deviation for key variables, where s_{ijt}^h is the share of exporter i on importer j's imports of product h at time t; x_{ijt}^h is the share of importer j in i's total export quantity of product h to the U.S. at time t; exporter (importer) experience is measured as the number of years since the exporter (importer) first started supplying (sourcing) product h; Age of the relationship is measured by the number of years since the exporter first served the importer with product h. The sample excludes related party transactions and covers the period of 2001-2016.

3.4 Stylized facts

We now show that the features of our two-sided trade dataset reflect in large part our modeling assumptions and results. We start by presenting that many-to-many matches account for a significant share in U.S. imports. In the model presented in Sections 2 and 2.3, we have put emphasis on the role of two bilateral shares, s_{ij} and x_{ij}, in determining both the level and changes of bilateral prices, p_{ij}. Hence our model is useful only when there are substantial set of firm-pairs in which both the exporter and the importer have other partners they trade with. If all firm-pairs are ones which both the exporter and the importer trade only with the other, then both bilateral shares s_{ij} and x_{ij} would equal one and there would be no role for two-sided market power to play in determining prices. In Appendix C.1 we report the fraction of U.S. imports—both in terms of the number of links and in terms of import value—accounted for by four mutually exclusive groups: one-to-one linkages where the exporter and the importer only trades with the other, one-to-many linkages where the exporter supplies to other importers but the importer only buys from the exporter, many-to-one linkages where the exporters supply only to one importer but the importer buys from multiple exporters, and many-to-many linkages in which exporters and importers have multiple trading partners. We show that many-to-many linkages account for more than 40 percent in terms of import value, and the share goes up to more than 90 percent once we include links that are characterized as one-to-many and many-to-one linkages.

We then turn to our main theoretical prediction of Proposition 1, which shows how bilateral shares s_{ij} and x_{ij} are key in explaining the variations in bilateral prices. As discussed in Section 2.2, the bilateral markup is increasing in the exporter share s_{ij} and it decreases in the importer share x_{ij}. We take these predictions to the data by considering the following specification that exploits the variation in prices across firm-pairs within a market, as defined by a HS10 product-year:

$$\ln p^h_{ijt} = \beta_s s^h_{ijt} + \beta_x x^h_{ijt} + \beta \boldsymbol{X}^h_{ijt} + \upsilon^h_{ijt}, \tag{18}$$

where X^h_{ijt} represents the set of control variables. In one specification we include FE_i, FE_j, and FE_{ht} as exporter, importer, and product-time fixed effects, and in another specification we include FE_{iht} and FE_{jht} as exporter-product-time and importer-product-time fixed effects, respectively. We additionally control for relationship age. The residual component υ^h_{ijt} captures the unexplained dispersion of prices within a given relationship.[24] Our coefficients of interest are β_s and β_x, where our theory predicts that the former should be positive, namely, prices should increase with the exporter's supplier share in the relationship. Our theory instead predicts that the second coefficient should be negative, as prices should be lower whenever the importer accounts for a larger share of exporter's total exports.

Since the specification involves regressing prices on market shares, which themselves are a function of prices, an ordinary least squares (OLS) specification faces an endogeneity issue typical of this type of regressions (Bresnahan, 1989). We deal this issue by constructing instrumental variables (IV) for exporter's and importer's bilateral 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 exporter nor the importer of focus. For the exporter's supplier share s^h_{ijt}, we consider the sales of j's other exporters to importers other than j, and for the importer's buyer share x^h_{ijt}, we consider the purchases of i's other importers from exporters other than i. Table 2 reports the results from both OLS and IV regressions.

As expected from the theory, we find that bilateral prices increase with the exporter's supplier share and decrease with the importer's buyer share. The first three columns report the results from the specification in which we control for exporter, importer, and product-time fixed effects. The last three columns report the results from the more stringent specification in which we add exporter-product-time and importer-product-time fixed effects, to control for the unobserved marginal costs of the exporters and the unobserved demand conditions of the importer. In both sets of specifications, the coefficients on both the exporter's and importer's bilateral shares are both statistically and economically significant. We find that a one percent increase in the supplier share corresponds to an increase of the bilateral price by around 0.2 to 0.5 log points, and a one percent increase in the buyer share corresponds to a decrease of the bilateral price by around 0.1 to 0.7 log points.

[24] As a prior step, in Appendix C.2 we follow Fontaine et al. (2020) and consider a specification similar to (18) but without regressing on the bilateral shares. We analyze how much variation in bilateral prices is explained by product-specific components (captured by exporter-product-time fixed effects), by importer-specific components (captured by importer fixed effects), and relationship-specific components (captured by the residual term). We find that almost 90 percent of the variation in prices within exporter-product-time pairs are explained by the residual term, and only around 12 percent attributed to importer-specific components.

Table 2: Bilateral concentration and match-specific residual.

	$FE_i + FE_j + FE_{ht}$			$FE_{iht} + FE_{jht}$		
	OLS	OLS	IV	OLS	OLS	IV
	(1)	(2)	(3)	(4)	(5)	(6)
s^h_{ijt}	0.226***	0.227***	0.519***	0.442***	0.442***	0.397***
	[0.00611]	[0.00609]	[0.0339]	[0.0133]	[0.0133]	[0.00819]
x^h_{ijt}	-0.567***	-0.566***	-0.100***	-0.673***	-0.673***	-0.586***
	[0.00994]	[0.00995]	[0.0187]	[0.0152]	[0.0152]	[0.00909]
Age of the relationship		-0.00702***	-0.0433***		0.00122	-0.00342***
		[0.000971]	[0.00199]		[0.00101]	[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	
First stage F stat			3,137			18,740
SWF stat $\left(s^h_{ijt}\right)$			9,347			31,500
SWF stat $\left(x^h_{ijt}\right)$			6,885			41,240

Notes: The first three columns report the results from specification (18). The last three columns report the results from an alternative specification where we have exporter-product-time and importer-product-time fixed effects. Columns (1)-(2) and (4)-(5) report the OLS estimates and columns (3) and (6) report the IV estimates, along with the corresponding F stat and SW F stat. The age of the relationship is measured as the number of years the firm-pair has been trading with each other. Significance: * 0.10, ** 0.05, and *** 0.01.

4 Calibration and Estimation

With the data described in the previous section, in this section we discuss how we recover the primitive parameters, $\boldsymbol{\beta} = \{\rho, \gamma, \nu, \theta\}$, together with the bilateral bargaining terms, ϕ_{ijt}, by leveraging the model's price and markup equations. First, we calibrate the demand elasticity that importers face, ν, to 4. We calibrate this value from the estimates of the U.S. downstream import demand elasticity in Soderbery (2018), who follows the methodology in Feenstra (1994); Broda and Weinstein (2006).[25] Second, we assume that the price of foreign intermediates has a halfway pass-through on importers' marginal cost of production, i.e., $\gamma = 0.5$. Third, we assume that the elasticity of substitution across foreign varieties, ρ, to be 10. The number is motivated by the survey of Anderson and van Wincoop (2004) which finds that the elasticity of substitution across goods within sectors ranges from around 5 to 10 depending on the aggregation. It is also within the range of estimates used by Edmond et al. (2018) that match the average markups in the U.S.

[25] Appendix D.1 provides more details on the calibration.

4.1 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:

$$\tilde{\phi}_{ijt} = f\left(\mathbf{X}_{ijt} \mid \boldsymbol{\kappa}\right). \tag{19}$$

In the baseline estimation, we posit that $f(\cdot)$ is log-linear in all the covariates, i.e., $f\left(\mathbf{X}_{ijt} \mid \boldsymbol{\kappa}\right) = \exp\left(\mathbf{X}'_{ijt}\kappa\right)$. In the vector of covariates $\mathbf{X}_{ijt}$ we include variables that are likely to be related to the bargaining power of the firms in any given year, namely (1) the age of the $i-j$ relationship, (2) the number of transactions that occurred between $i-j$; (3) relative age of firm i over the age of firm j; (4) relative size of the two's network, measured by the ratio between the number of importers buying from the exporter and the number of exporters selling to the importer; and (5) an indicator variable of whether the buyer and seller transact multiple HS10 products.

Given the structure of equation (19), the log bilateral prices can be written as:

$$\ln p_{ijt} = \ln \mu_{ijt}\left(\boldsymbol{\kappa}, \theta\right) + \ln c_{ijt}, \tag{20}$$

where $\mu_{ijt}\left(\boldsymbol{\kappa}, \theta\right)$ 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; c_{ijt} is the unobserved marginal cost, that potentially varies at the pair-level due to unobserved horizontal differences in products.

For estimation, we construct moments by taking the price differences across importers within a exporter-product-year. Define the operator Δ^{jk} as one that takes differences across the importer dimension.[26] The moments we construct are:

$$g_{ijkt}\left(\vec{\kappa}, \theta\right) = \Delta^{jk} \ln p_{ijt} - \Delta^{jk} \ln \mu_{ijt}\left(\boldsymbol{\kappa}, \theta\right). \tag{21}$$

Given equation (20), it follows that g_{ijkt} represents the unobserved cost differentials across importers. One issue we may encounter in the estimation is that these unobserved cost differentials may be correlated with the vector of covariates $\mathbf{X}$ and the bilateral shares. To address this endogeneity concern, we include in the estimation procedure a vector of instrumental variables $\mathbf{Z}$, which satisfies the conditions of being correlated with the vector of covariates $\mathbf{X}$ and the bilateral shares, but uncorrelated with unobserved cost differentials. In the vector $\mathbf{Z}$ we include the total number of exporters in the HS10 product-year, the total number of importers in the HS10 product-year, and the mean and the median of the distributions of bilateral shares x^h_{ijt} and s^h_{ijt} in each year, excluding the shares of the involved pairs $i-j$ and $i-k$. These instruments are correlated with the endogenous explanatory variables through the level of competition within an HS10 product-year , but are not correlated with the specific dealing between pairs $i-j$ and $i-k$.

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

[26] $\Delta^{jk} a_{ijt} = a_{ijt} - a_{ikt}$, where both j and k are importers of firm i.

equation (6). Identification of $\boldsymbol{\kappa}$ 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 (9) for any given $\mu_{ij}^{oligopsony}$, there exists a unique θ. We operationalize the estimation by solving for the following minimization problem:

$$\min_{\boldsymbol{\kappa},\theta} g\left(\boldsymbol{\kappa},\theta\right)\mathbf{Z}^{'}\mathbf{W}\mathbf{Z}g\left(\boldsymbol{\kappa},\theta\right)^{'}, \tag{22}$$

where $\mathbf{W}$ is a weighting matrix.

4.2 Estimation results

We report in Table 3 the calibrated and estimated model's parameters. Panel A shows the value of the calibrated parameters. Panel B reports the results of the GMM estimation that estimates the values of the vector $\boldsymbol{\kappa}$ and the scale parameter θ.[27] Results in Panel B show that the vector of parameters $\boldsymbol{\kappa}$, as well as the return to scale parameter, θ, are precisely estimated and with the expected sign. Longer relationships are associated with lower buyer's bargaining power, a result that is in line with Heise (2019), who finds that older relationships exhibit a higher responsiveness of prices to exchange rate shocks. We find that conditional on longevity, more frequent transactions between the exporter and the importer increase the importer's bargaining power; and the higher the relative experience of the exporter, the lower the bargaining power of the importer. The relative network—as measured by the ratio between the number of importers buying from the exporter and the number of exporters selling to the importer—represents the relative outside options of firms. We find that the more connected the exporter is relative to the importer, the less bargaining power the importer has. Finally, transacting multiple products with an exporter increases the bargaining power of the importer. On the estimate of θ, we find strong evidence of decreasing returns to scale, with θ well below one at 0.43.

With the estimated $\boldsymbol{\kappa}$ vector at hand and the matrix of covariates $\mathbf{X}_{ijt}$, we can fit an exponential function and construct the vector of bilateral bargaining power parameters. Panel C shows two moments of the distribution of the constructed ϕ_{ij}. On average, the U.S. importers tend to have a larger share of the bargaining power against the foreign exporter with the mean of ϕ_{ij} being 0.76 with a standard deviation of 0.09.

[27] In Appendix D.2 we report the analogous results where we estimate $\boldsymbol{\kappa}$ and θ without using instruments, consistent with the assumption that the exporter's marginal cost to produce a given HS10 is the same across U.S. importers.

Table 3: Model parameters

Panel A: Calibrated parameters		
ν	4	
γ	0.5	
ρ	10	
Panel B: Estimated parameters (GMM estimation)		
$\boldsymbol{\kappa}$	Coef.	Std. Err.
Age of the relationship	-0.1502***	0.0158
Number of transactions	0.0802***	0.0050
Relative age	-0.1440***	0.0241
Relative network	-0.1909***	0.0100
Multiple HS10	0.1831***	0.0280
Constant	0.7479***	0.0538
θ	0.4278***	0.0780
Observations	1,376,000	
Panel C: Implied bargaining parameter		
	Mean	Std. Dev.
ϕ_{ij}	0.7636	0.0863

Notes: Panel A shows the value of the calibrated parameters for the price elasticity if downstream demand, ν, the cost elasticity to foreign input prices, γ, and elasticity of substitution across foreign varieties, ρ. Panel B reports the results from the GMM estimation that chooses the vector $\boldsymbol{\kappa}$ and the return to scale parameter θ. The vector of covariates $\mathbf{X}_{ijt}$ include (1) longevity of the $i-j$ relationship, (2) number of transactions have occurred between $i-j$; (3) relative age of firm i over firm j; (4) relative network size of firm i over firm j; and (5) an indicator variable of whether the firm-pair transact multiple HS10 products. The vector of instruments include: (1) total number of exporters in an HS10, (2) total number of importers in an HS10, (3) mean and median of the distribution of bilateral shares x^h_{ijt} and s^h_{ijt}, excluding the shares of the involved pairs $i-j$ and $i-k$. Standard errors are robust. Panel C reports the distribution of the implied bargaining parameter ϕ_{ij} under the estimated parameters.

5 Counterfactual Exercises

In this section, we take the estimated model and study the role of two-sided market power on the price pass-through of cost shocks.

5.1 Pass-through on bilateral prices

We first evaluate the model's predictions on changes in bilateral prices in responses to AD episodes and tariff changes during the period of 2017-2018, when U.S. import tariffs experienced a significant increase. At the same time, we compute from the data the log change in the bilateral prices at the exporter i-importer j-HS10 product-level before and after the tariff changes, $d\ln p^h_{ijt}$. We contrast these price changes that are obtained from the data with the changes in prices that are predicted from our model. Equation (16), duly amended to accommodate multiple products, summarizes the model-implied log changes in bilateral prices following tariff shocks of ϑ_i. Notice that equation (16) only depends on the observed importer's and exporter's bilateral shares, and the estimated elasticity parameters in Table 3.

Notably, our model tractably nests traditional frameworks in the international trade literature. This means that we could also construct the predicted price changes under more conventional assumptions on price-setting behaviors in international trade. We illustrate how important two-sided market power is in predicting price changes by also computing predictions of price changes derived from the special cases in our model. We consider two popular alternatives: The first is the standard Atkeson and Burstein (2008) model, which corresponds to the case where the exporter sets prices unilaterally ($\tilde{\phi}_{ij} \to 0$), importers imperfectly substitute across upstream input varieties ($\rho = 10, \gamma = 0.5$), and upstream production exhibits constant returns ($\theta = 1$). As the second alternative, we consider the bargaining price-setting model in Gopinath and Itskhoki (2010), where importers and exporters negotiate over the input price ($\tilde{\phi}_{ij} \in \mathbb{R}_+$), but production exhibits constant returns ($\theta = 1$) so there is no scope for the importer to wield market power.

We denote by $d \ln \hat{p}_{ij}^{h,m}$ the predicted log price changes under our baseline model ($m = Base$) and under these alternative scenarios: $m = AB$ for Atkeson and Burstein (2008) and $m = GI$ for Gopinath and Itskhoki (2010). We then run the following regression:

$$d \ln p_{ijt}^h = \beta_m d \ln \hat{p}_{ijt}^{h,m} + \gamma_j + \rho_h + \delta_t + u_{ijt}^h \text{ for } m = Base, AB, GI. \tag{23}$$

We consider the estimated coefficient $\hat{\beta}^m$ as our measure of goodness-of-fit of the different models: The higher $\hat{\beta}^m$, the more the observed changes in prices co-move with the predicted ones.

We report the results in Table 4. We find that our baseline model performs better in predicting observed price changes compared to models in which importer's buyer share does not play a role. 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.

Table 4: Responses of bilateral price on model predicted price changes

	Baseline model ($m = Base$)		Atkeson and Burstein (2008) ($m = AB$)		Gopinath and Itskhoki (2010) ($m = GI$)	
	(1)	(2)	(3)	(4)	(5)	(6)
$d \ln \hat{p}_{ijt}^{h,m}$	0.499***	0.423***	0.222***	0.163**	0.204***	0.156**
	[0.130]	[0.132]	[0.0726]	[0.0769]	[0.0599]	[0.0638]
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Importer FE		Yes		Yes		Yes
Observations	955,000	955,000	955,000	955,000	955,000	955,000

Notes: Table reports the OLS coefficient of specification (23) where the observed changes in log prices are regressed on the model predicted changes in log prices. We consider three different models and U.S. tariff changes during the period 2017-2018 as the shock. The columns with $m = Base$ represent our baseline model where importers and exporters negotiate over the input price ($0 < \phi_{ij} < 1$), and production is decreasing returns ($\theta < 1$). Columns with $m = AB$ represent the case in which importers are price-takers ($\phi_{ij} \to 0$) and production is constant returns ($\theta = 1$). Columns with $m = GI$ represent the case in which both importers and exporters have bargaining power ($\phi_{ij} \to 1$), but production is constant returns ($\theta = 1$). Standard errors are clustered by country and industry. Significance: * 0.10, ** 0.05, and *** 0.01.

5.2 Pass-through on aggregate prices

The heterogeneous response of bilateral prices to tariff changes is interesting in itself but also has important aggregate consequences. This section investigates whether heterogeneity in the importers' relative market shares and bargaining power could partially explain the response of aggregate prices to cost push shocks.

To gauge the impact of cost shocks on aggregate prices, we extend our partial equilibrium framework and define a price index for imported goods and final goods. We assume that final demand can be written as an aggregate of a bundle of domestic goods and a bundle of imported goods. The imported goods bundle is an aggregate of the output of U.S. importers. We assume that these aggregations are done through homothetic demand. Assuming away the changes prices of domestic goods and other general equilibrium effects, one can write down the first-order approximated change in the price of final goods, P, as

$$d \ln P = s_{FH} d \ln P_F, \tag{24}$$

where s_{FH} is the share of goods sold by U.S. importers in the final consumption bundle and P_F is the price index of importers' output bundle. The change in this importers' output price index is written as

$$d \ln P_F = \sum_j s_j d \ln p_j, \tag{25}$$

where s_j is the share of firm j's output among all importers. We approximate the changes in the output price of importers by their cost changes, hence we obtain

$$d \ln p_j = \gamma \sum_{i \in \mathcal{Z}_j} s_{ij} \Psi_{ij} d \ln \vartheta_i. \tag{26}$$

Equations (24) to (26) show that one can compute the effects of import tariff shocks $d \ln \vartheta_i$ on final goods price index by using the bilateral pass-through elasticity Ψ_{ij}. As shown in the section above, these pass-through elasticities produce different predictions on bilateral price changes depending on the assumptions made in the model. To investigate how these differences in the bilateral pass-through elasticities generate different predictions on how aggregate prices respond, we consider the import tariff changes during the period of 2017-2018 and compute aggregate price changes of $d \ln P$ and $d \ln P_F$. We illustrate how bilateral market power affect these predictions by first computing the price changes under our baseline model ($m = Base$) and then comparing these with the price changes under alternative scenarios of $m = AB$ and $m = GI$. We note that across all specifications of the model, only the bilateral pass-through elasticities Ψ_{ij} are allowed to differ and all other parameters and shares are the same.

Result TBA.

6 Conclusions

Understanding movements in international prices is a central question in international economics. Yet, traditional pricing frameworks neglect relevant features of international trade and GVCs. Notably, existing models postulate that prices are set unilaterally by exporters 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 importers and exporters exercising two-sided market power.

This paper bridges the gap between the theoretical and empirical works 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, this paper constructs a novel two-sided trade dataset where firm-to-firm trade data are matched to bilateral characteristics of both importers and exporters. This paper also develops a novel identification strategy for the Nash bargaining weights determining negotiations, a key parameter to predict bilateral markups and pass-through elasticity in importer-exporter pairs.

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 a wide range of pass-through estimates across importers and exporters. Notably, it can rationalize higher-than-expected tariff pass-through rates in certain industries and episodes (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 importer-exporter to a few sufficient statistics: The importer's buyer share, the exporter's supplier 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 Derivation of equation (6)

Here we outline the derivation of equation (6). We solve for the first-order conditions of (5) 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}.

Profits of firm i Firm i's profit under a successful negotiation can be expressed as

$$\pi_i = p_{ij}q_{ij} + \sum_{k \neq j} p_{ik}q_{ik} - \theta c_i q_i.$$

The derivative of this profit with respect to p_{ij} is

$$\frac{d\pi_i}{dp_{ij}} = q_{ij}\left(1 - \varepsilon_{ij} + \varepsilon_{ij}\frac{1}{p_{ij}}c_i\right).$$

The outside profit of firm i under a failed negotiation can be expressed as

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

where the marginal cost upon a failed negotiation, $\tilde{c}_i$, can be obtained as follows, from equation (4):

$$\frac{\tilde{c}_i}{c_i} = (1 - x_{ij})^{\frac{1-\theta}{\theta}}.$$

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

$$\pi_i - \tilde{\pi}_{i(-j)} = q_{ij}\left(p_{ij} - c_i \mu_{ij}^{oligopsony}\right),$$

where

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

Profits of firm j Firm j's profit under a successful negotiation can be expressed as

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

where D_j is the exogenous demand shifter firm j faces. The derivative of this profit with respect to p_{ij} is

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

The outside profit of firm j under a failed negotiation is

$$\tilde{\pi}_{j(-i)} = (\mu_j - 1)\, \tilde{c}_j^{1-\nu} \mu_j^{-\nu} D_j,$$

where firm j's marginal cost under a failed negotiation, $\tilde{c}_j$, is expressed as

$$\frac{\tilde{c}_j}{c_j} = (1 - s_{ij})^{\frac{\gamma}{1-\rho}}.$$

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

$$\pi_j - \tilde{\pi}_{j(-i)} = (\mu_j - 1)\, c_j q_j \left(1 - (1 - s_{ij})^{\frac{1-\nu}{1-\rho}\gamma}\right).$$

First order conditions We now solve for the first-order conditions. Note that the two outside profits $\tilde{\pi}_{i(-j)}$ and $\tilde{\pi}_{j(-i)}$ do not depend on the price p_{ij}, hence we treat them as constants. Hence,

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

Plugging in the terms calculated above, we obtain the following price equation:

$$p_{ij} = \left((1 - \omega_{ij}) \frac{\varepsilon_{ij}}{\varepsilon_{ij} - 1} + \omega_{ij} \mu_{ij}^{oligopsony}\right) c_i,$$

where

$$\begin{aligned} \omega_{ij} &= \frac{\tilde{\phi}_{ij} \lambda_{ij}}{\varepsilon_{ij} - 1 + \tilde{\phi}_{ij} \lambda_{ij}} \\ \lambda_{ij} &= \frac{s_{ij} (\tilde{\nu} - 1)}{1 - \hat{\pi}_{j(-i)}}. \end{aligned}$$

Note that the term $\hat{\pi}_{j(-i)}$ represents the ratio of firm j's profits,

$$\hat{\pi}_{j(-i)} \equiv \frac{\tilde{\pi}_{j(-i)}}{\pi_j} = (1 - s_{ij})^{\frac{1-\nu}{1-\rho}\gamma}.$$

A.2 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 (5), 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 first-order conditions taking as given firm i's unit cost c_i. We obtain the following optimal price:

$$p_{ij} = \left(\left(1-\omega_{ij}^q\right)\frac{\varepsilon_{ij}^q}{\varepsilon_{ij}^q - 1} + \omega_{ij}^q \mu_{ij}^{oligopsony}\right) c_i,$$

where the term ω_{ij}^q is the effective importer's relative bargaining power in this model:

$$\omega_{ij}^q \equiv \frac{\frac{1}{\nu}\tilde{\phi}_{ij}\lambda_{ij}}{1-\left(\varepsilon_{ij}^q\right)^{-1} + \frac{1}{\nu}\tilde{\phi}_{ij}\lambda_{ij}} \in (0,1)$$

$$\left(\varepsilon_{ij}^q\right)^{-1} = \frac{1}{\rho}\left(1-s_{ij}\right) + \left(1-\gamma+\frac{1}{\nu}\gamma\right) s_{ij}.$$

The price above has a similar structure as in equation (10). It is a weighted average between a standard oligopoly (Cournot) markup, $\frac{\varepsilon_{ij}^q}{\varepsilon_{ij}^q - 1}$, and the markup term $\mu_{ij}^{oligopsony}$. The oligopoly markup depends in this case on the elasticity ε_{ij}^q, which is a harmonic weighted average of elasticities ν and ρ as in Atkeson and Burstein (2008).

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 total profit of the importer j decreases to ϱ_{ij}, and the exporter i's total cost changes to ς_{ij} in addition to the exporter i losing its sales to j. We let these factors that determine the outside options vary at the pair-level so that they can flexibly capture the value of renegotiating with other firms they already source from or sell to, or the value of additionally sourcing from or sell to firms that were previously not connected. As the term ς_{ij} also captures the degree of returns to scale in the technology of firm i, in this section we set $\theta = 1$. Under this generalized setup, we can write the changes in firm i and j's profits as follows:

$$\begin{aligned} \pi_i - \tilde{\pi}_{i(-j)} &= p_{ij}q_{ij} - c_i q_i + \varsigma_{ij} \\ \pi_j - \tilde{\pi}_{j(-i)} &= \pi_j - \varrho_{ij}. \end{aligned}$$

The first order conditions under these changes in profits yield:

$$p_{ij} = \left(\underbrace{\frac{\varepsilon_{ij}-1}{\varepsilon_{ij}-1+\tilde{\phi}_{ij}\bar{\lambda}_{ij}}}_{1-\bar{\omega}_{ij}} \frac{\varepsilon_{ij}}{\varepsilon_{ij}-1} + \underbrace{\frac{\tilde{\phi}_{ij}\bar{\lambda}_{ij}}{\varepsilon_{ij}-1+\tilde{\phi}_{ij}\bar{\lambda}_{ij}}}_{\bar{\omega}_{ij}} \frac{1}{x_{ij}}\left(1-\frac{\varsigma_{ij}}{c_i q_i}\right)\right) c_i,$$

where $\bar{\lambda}_{ij} = \frac{(\tilde{\nu}-1)s_{ij}}{1-\frac{\varrho_{ij}}{\pi_j}}$. The equation above has the same structure as that of equation (10), with two differences. The first difference is in the weight term $\bar{\omega}_{ij}$. If the importer j's profit does not decrease as much upon a failed negotiation (high $\frac{\varrho_{ij}}{\pi_j}$)—perhaps due to the importer renegotiating with the other suppliers—then it would result in the importer having a larger bargaining power through a larger weight $\bar{\omega}_{ij}$. The second difference is in the markup when the importer has all the bargaining power, $\frac{1}{x_{ij}}\left(1-\frac{\varsigma_{ij}}{c_i q_i}\right)$. To compare with equation (9)—its counterpart in Section 2.2—let us first consider the case where the technology of the supplier i exhibits constant returns to scale and where there are no renegotiations. Under this case, the reduction in firm i's total cost upon a failed negotiation (losing the importer j as a buyer), $1-\frac{\varsigma_{ij}}{c_i q_i}$, would equal the share the buyer j accounts for in firm i's output, x_{ij}. Firm i would then have marginal cost pricing, as what equation (9) implies under $\theta = 1$. When firm i's technology exhibits decreasing returns, then the reduction in the total cost of firm i upon a failed negotiation, $1-\frac{\varsigma_{ij}}{c_i q_i}$, would be larger than the importer j's buyer share, x_{ij}. In this case, the supplier charges a positive markup which is decreasing in the buyer share x_{ji}, as also implied by equation (9). Further, when there are renegotiations allowed, then that may further depress the total cost of firm i upon a failed negotiation with buyer j, ς_{ij}. Taken together, both terms ϱ_{ij} and ς_{ij} allow one to flexibly capture the outside options the two firms have in the bilateral relationship.

A.4 Pass-through

A.4.1 Derivation of Proposition 2 and general results

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

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

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

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

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

$$\frac{d\ln x_{ij}}{d\ln \vartheta_{ij}} = -\varepsilon_{ij}\left(1-x_{ij}\right)\frac{d\ln p_{ij}}{d\ln \vartheta_{ij}} + \left(1-x_{ij}\right)\epsilon_{i\cdot},$$

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

The term $\Gamma^s_{ij} = \frac{\partial \ln \mu_{ij}}{\partial \ln s_{ij}}$ is computed as

$$\Gamma^s_{ij} = (1-\omega_{ij}) \cdot \frac{\mu^{oligopoly}}{\mu_{ij}} \left[\frac{\partial \ln (1-\omega_{ij})}{\partial \ln s_{ij}} + \Gamma^{s,oligopoly}_{ij} \right] + \omega_{ij} \cdot \frac{\mu^{oligopsony}}{\mu_{ij}} \cdot \frac{\partial \ln \omega_{ij}}{\partial \ln s_{ij}},$$

where $\Gamma^{s,oligopoly}_{ij} \equiv \frac{\partial \ln \mu^{oligopoly}_{ij}}{\partial \ln s_{ij}}$. Approximating $\frac{\partial \ln(1-\omega_{ij})}{\partial \ln s_{ij}} = \frac{\partial \ln(\omega_{ij})}{\partial \ln s_{ij}} \simeq 0$, we can write

$$\Gamma^s_{ij} = (1-\omega_{ij}) \cdot \frac{\mu^{oligopoly}}{\mu_{ij}} \Gamma^{s,oligopoly}_{ij}$$

where

$$\Gamma^{s,oligopoly}_{ij} = \frac{1}{\varepsilon_{ij}-1} \frac{\rho - \varepsilon_{ij}}{\varepsilon_{ij}}.$$

Note that with full supplier's bargaining power we get $\omega_{ij} \to 0$ and $\mu_{ij} \to \mu^{oligopoly}$ so that $\Gamma^s_{ij} = \Gamma^{s,oligopoly}_{ij}$. On the other hand, with full buyer's bargaining power, we find $\omega_{ij} \to 1$ and $\Gamma^s_{ij} \to 0$.

Similarly, the term $\Gamma^x_{ij} = \frac{\partial \ln \mu_{ij}}{\partial \ln x_{ij}}$ is computed as

$$\Gamma^x_{ij} = \omega_{ij} \cdot \frac{\mu^{oligopsony}}{\mu_{ij}} \Gamma^{x,oligopsony}_{ij}$$

where

$$\Gamma^{x,oligopsony}_{ij} \equiv \frac{\partial \ln \mu^{oligopsony}_{ij}}{\partial \ln x_{ij}} = \frac{(1-x_{ij})^{\frac{1-\theta}{\theta}}}{\mu^{oligopsony}_{ij}} - 1.$$

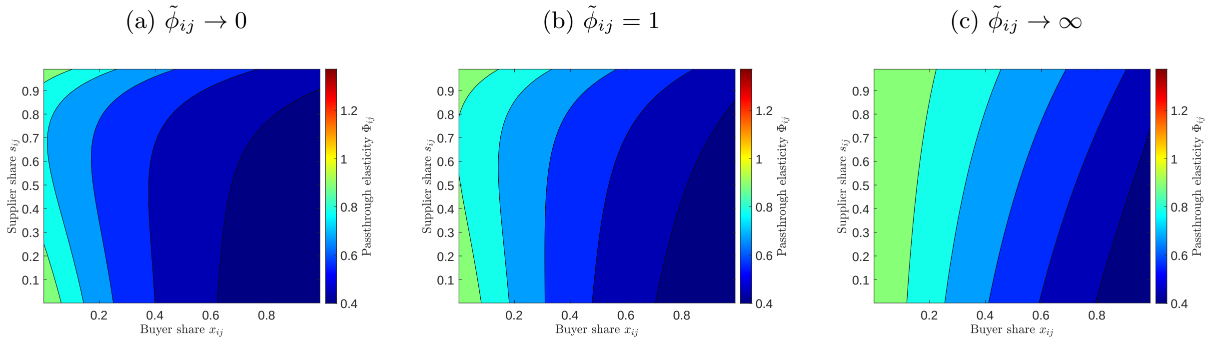
Note that, with full supplier's bargaining power we get $\omega_{ij} \to 0$ and $\mu_{ij} \to \mu^{oligopoly}$ so that $\Gamma^x_{ij} = 0$. On the other hand, with full buyer's bargaining power, we find $\omega_{ij} \to 1$ and $\Gamma^x_{ij} \to \Gamma^{x,oligopsony}_{ij}$.

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

$$\Phi_{ij} = \frac{\Gamma^x_{ij} (1-x_{ij}) \epsilon_{i\cdot} - \frac{1-\theta}{\theta} (1-x_{ij}) \epsilon_{i\cdot} + 1}{1 + \Gamma^s_{ij} (\rho - 1) \left(1 - s_{ij}\right) + \Gamma^x_{ij} (1-x_{ij}) \varepsilon_{ij} + \frac{1-\theta}{\theta} x_{ij} \varepsilon_{ij}}. \tag{27}$$

Equation (27) 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 exporter reduces the exporter's supplier share s_{ij} as the importer substitutes away from the exporter's good, inducing the exporter to reduce its markup (the term $\Gamma^s_{ij} (\rho - 1) \left(1 - s_{ij}\right)$). The same shock would also change the importer's buyer share x_{ij}, depending on the relative demand elasticities the exporter faces from its importer and from its other importers (the terms $\Gamma^x_{ij} (1-x_{ij}) \epsilon_{i\cdot}$ and $\Gamma^x_{ij} (1-x_{ij}) \varepsilon_{ij}$). For example, if the importer has more elastic demand ($\varepsilon_{ij} > \varepsilon_{i\cdot}$), then the buyer share x_{ij} will decrease. Under decreasing returns to scale technology the markup would increase,

Figure 2: Pass-through elasticities: Contour plot



hence increasing the price pass-through.

The second set of forces are the ones operating through the change in scale of the exporter. A positive cost shock on the exporter 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 importer (the term $\frac{1-\theta}{\theta} x_{ij} \varepsilon_{ij}$) or through the reduction of sales to other importers (the term $\frac{1-\theta}{\theta} \left(1 - x_{ij}\right) \epsilon_{i \cdot}$).

The result in Proposition 2 is obtained by setting $d \ln q_{iz} = 0 \; \forall z \neq j$, such that the pass-through elasticity captures only the "direct" effect of the shock on the pair $i - j$. In other words, we turn off the effects that operate through changes in other importers' demand and through changes in overall scale, leading to equation (15).

Figure 2 plots the pass-through elasticities for values of $x_{ij} \in [0, 1]$, $s_{ij} \in [0, 1]$ and $\tilde{\phi}_{ij} \in \{0, 1, \infty\}$. The figure shows that when both markups and cost channels are included, the pass-through elasticity takes value below unity, namely, the pass-through is generally incomplete. Notably, the pass-through elasticity decreases in the importer's buyer share, due to the cost channel always prevailing over the strategic substitutability channel; the pass-through elasticity is instead *u-shaped* in the exporter's supplier share.[28]

In some settings, researchers may find it useful or desirable to focus on the role of markups changes in determining the pass-through elasticities. This is feasible empirically whenever changes in marginal costs can be controlled for in estimation. In such cases the pass-through elasticity is given by:

$$\Phi_{ij}|_{d \ln c_i = 0} = \frac{1}{1 + \Gamma^s_{ij} \left(\rho - 1\right) \left(1 - s_{ij}\right) + \Gamma^x_{ij} \left(1 - x_{ij}\right) \varepsilon_{ij}}. \tag{28}$$

[28] To see this, note that while the cost channel increases linearly in the importer's share, the markup channel decreases less than linearly in the importer's share due to its offsetting effect on Γ^x_{ij}.

Figure 3: Pass-through elasticities: Markup channel

(a) $\tilde{\phi}_{ij} \to 0$ (b) $\tilde{\phi}_{ij} = 1$ (c) $\tilde{\phi}_{ij} \to \infty$

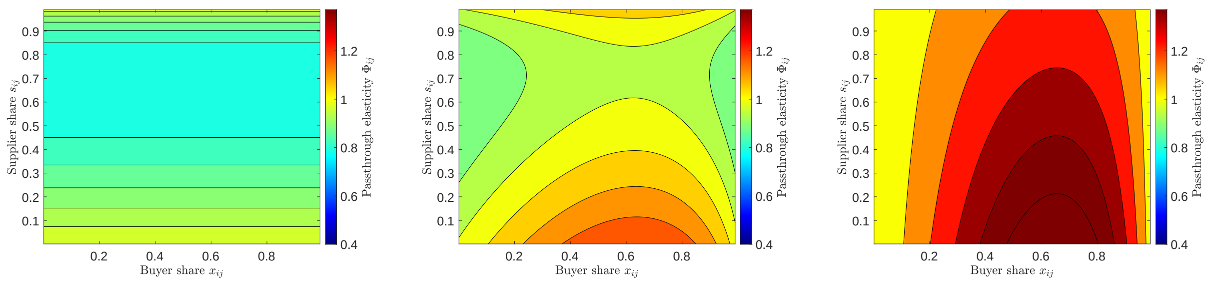


Figure 3 plots the pass-through elasticities for values of $x_{ij} \in [0,1]$, $s_{ij} \in [0,1]$ and $\tilde{\phi}_{ij} \in \{0, 1, \infty\}$, in settings where marginal cost changes can be controlled for. The figure shows that when only the markup channel is considered, the pass-through elasticity takes values both below and above unity, due to the contribution of the strategic complementarities and strategic substitutabilities channel. In this case, the elasticity of the pass-through to buyer's and supplier's share varies depending on the values of x_{ij}, s_{ij} and $\tilde{\phi}_{ij}$. 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 exporter's side only.

A.4.2 Cost shocks at the supplier- or buyer-level

We first consider how generic sets of pair-level shocks affect the price p_{ij}. In particular, we focus on the shock on the $i - j$ pair itself, ϑ_{ij}, the shocks on the importer j and its other suppliers, ϑ_{kj}, and the shocks on the exporter i and its other buyers, ϑ_{iz}. Denoting the elasticity of p_{ij} to ϑ_{kj} by Φ_{kj}^{ij} and the elasticity of p_{ij} to ϑ_{iz} by Φ_{iz}^{ij}, one can write the change in a pair-level price as

$$d \ln p_{ij} = \Phi_{ij} d \ln \vartheta_{ij} + \sum_{k \in Z_j, k \neq i} \Phi_{kj}^{ij} d \ln \vartheta_{kj} + \sum_{z \in W_i, z \neq j} \Phi_{iz}^{ij} d \ln \vartheta_{iz}, \tag{29}$$

where Z_j is the set of suppliers of j, and W_i is the set of buyers of i.

Elasticity Φ_{kj}^{ij} We first derive the elasticity of price p_{ij} with respect to cost shock ϑ_{kj}, where k is another supplier of j. This elasticity can first be written as

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

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

$$\begin{aligned}\frac{d\ln s_{ij}}{d\ln \tau_{kj}} &= (1-\rho)(1-s_{ij})\frac{d\ln p_{ij}}{d\ln \tau_{kj}} - (1-\rho)\, s_{kj}\frac{d\ln p_{kj}}{d\ln \tau_{kj}} \\ &= (1-\rho)(1-s_{ij})\,\Phi_{kj}^{ij} - (1-\rho)\, s_{kj}\Phi_{kj}.\end{aligned}$$

The elasticity of the buyer share $\frac{d\ln x_{ij}}{d\ln \tau_{kj}}$ is computed as

$$\begin{aligned}\frac{d\ln x_{ij}}{d\ln \tau_{kj}} &= \frac{d\ln x_{ij}}{d\ln p_{ij}}\frac{d\ln p_{ij}}{d\ln \tau_{kj}} \\ &= -\varepsilon_{ij}(1-x_{ij})\,\Phi_{kj}^{ij}.\end{aligned}$$

Lastly, we have

$$\begin{aligned}\frac{d\ln q_{i}}{d\ln \tau_{kj}} &= \frac{d\ln q_{i}}{d\ln q_{ij}}\frac{d\ln q_{ij}}{d\ln p_{ij}}\frac{d\ln p_{ij}}{d\ln \tau_{kj}} \\ &= -x_{ij}\varepsilon_{ij}\Phi_{kj}^{ij}.\end{aligned}$$

Hence, rearranging the above, we obtain

$$\begin{aligned}\Phi_{kj}^{ij} &= \Gamma_{ij}^{s}(1-\rho)(1-s_{ij})\,\Phi_{kj}^{ij} - \Gamma_{ij}^{s}(1-\rho)\, s_{kj}\Phi_{kj} - \Gamma_{ij}^{x}\varepsilon_{ij}(1-x_{ij})\,\Phi_{kj}^{ij} - \frac{1-\theta}{\theta}x_{ij}\varepsilon_{ij}\Phi_{kj}^{ij} \\ &= \frac{\Gamma_{ij}^{s}(\rho-1)\, s_{kj}\Phi_{kj}}{1+\Gamma_{ij}^{s}(\rho-1)(1-s_{ij})+\Gamma_{ij}^{x}\varepsilon_{ij}(1-x_{ij})+\frac{1-\theta}{\theta}x_{ij}\varepsilon_{ij}} \\ &= \Phi_{kj}s_{kj}\Gamma_{ij}^{s}(\rho-1)\,\Phi_{ij}. \qquad (30)\end{aligned}$$

Equation (30) captures how the cost shock ϑ_{kj} affects price p_{ij}. First, the term Φ_{kj} captures the effect of the cost shock ϑ_{kj} on the price of the same pair, p_{kj}. The change in p_{kj} will induce the buyer j to substitute from k to i, changing the supplier share s_{ij} (notice that $\Gamma_{ij}^{s} = \frac{d\ln \mu_{ij}}{d\ln s_{ij}}$ and $(\rho-1)\, s_{kj} = \frac{d\ln s_{ij}}{d\ln p_{kj}}$). This shift in the share will act as a cost shock on the $i-j$ pair, hence the last term of Φ_{ij}.

Elasticity Φ_{iz}^{ij} This is the elasticity of price p_{ij} with respect to cost shock ϑ_{iz}, where z is another buyer of i. Analogous to the derivation of Φ_{kj}^{ij} above, we can first write

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

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

$$\frac{d\ln s_{ij}}{d\ln \vartheta_{iz}} = (1-\rho)(1-s_{ij})\,\Phi_{iz}^{ij}.$$

The elasticity of the buyer share $\frac{d\ln x_{ij}}{d\ln\vartheta_{iz}}$ is computed as

$$\begin{aligned}\frac{d\ln x_{ij}}{d\ln\vartheta_{iz}} &= \frac{d\ln x_{ij}}{d\ln p_{ij}}\frac{d\ln p_{ij}}{d\ln\vartheta_{iz}} + \frac{d\ln x_{ij}}{d\ln p_{iz}}\frac{d\ln p_{iz}}{d\ln\vartheta_{iz}} \\ &= -\varepsilon_{ij}\left(1-x_{ij}\right)\Phi_{iz}^{ij} + \frac{d\ln x_{ij}}{d\ln q_i}\frac{d\ln q_i}{d\ln p_{iz}}\Phi_{iz} \\ &= -\varepsilon_{ij}\left(1-x_{ij}\right)\Phi_{iz}^{ij} + \frac{d\ln x_{ij}}{d\ln q_i}\frac{d\ln q_i}{d\ln q_{iz}}\frac{d\ln q_{iz}}{d\ln p_{iz}}\Phi_{iz} \\ &= -\varepsilon_{ij}\left(1-x_{ij}\right)\Phi_{iz}^{ij} + x_{iz}\varepsilon_{iz}\Phi_{iz}.\end{aligned}$$

Lastly, we have

$$\begin{aligned}\frac{d\ln q_i}{d\ln\vartheta_{iz}} &= \frac{d\ln q_i}{d\ln p_{iz}}\frac{d\ln p_{iz}}{d\ln\vartheta_{iz}} + \frac{d\ln q_i}{d\ln p_{ij}}\frac{d\ln p_{ij}}{d\ln\vartheta_{iz}} \\ &= -x_{iz}\varepsilon_{iz}\Phi_{iz} - x_{ij}\varepsilon_{ij}\Phi_{iz}^{ij}.\end{aligned}$$

Hence, rearranging the above, we obtain

$$\begin{aligned}\Phi_{iz}^{ij} &= \Gamma_{ij}^{s}\left(1-\rho\right)\left(1-s_{ij}\right)\Phi_{iz}^{ij} - \Gamma_{ij}^{x}\varepsilon_{ij}\left(1-x_{ij}\right)\Phi_{iz}^{ij} + \Gamma_{ij}^{x}x_{iz}\varepsilon_{iz}\Phi_{iz} - \frac{1-\theta}{\theta}x_{iz}\varepsilon_{iz}\Phi_{iz} - \frac{1-\theta}{\theta}x_{ij}\varepsilon_{ij}\Phi_{iz}^{ij} \\ &= \frac{\left(\Gamma_{ij}^{x} - \frac{1-\theta}{\theta}\right)x_{iz}\varepsilon_{iz}\Phi_{iz}}{1+\Gamma_{ij}^{s}\left(\rho-1\right)\left(1-s_{ij}\right)+\Gamma_{ij}^{x}\varepsilon_{ij}\left(1-x_{ij}\right)+\frac{1-\theta}{\theta}x_{ij}\varepsilon_{ij}} \\ &= \Phi_{iz}x_{iz}\varepsilon_{iz}\left(\Gamma_{ij}^{x}-\frac{1-\theta}{\theta}\right)\Phi_{ij}. \qquad (31)\end{aligned}$$

Equation (31) captures how the cost shock ϑ_{iz} affects price p_{ij}. First, the term Φ_{iz} captures the effect of the cost shock ϑ_{iz} on the price of the same pair, p_{iz}. The change in p_{iz} will induce the buyer i to change the buyer share x_{ij} (of which magnitude is captured by $x_{iz}\varepsilon_{iz} = \frac{d\ln x_{ij}}{d\ln p_{iz}}$). This change in the buyer share x_{ij} will work as i's cost shock, directly through the change in markup $\left(\Gamma_{ij}^{x}\right)$, and indirectly through the change in i's scale $\left(\frac{1-\theta}{\theta}\right)$. They both induce the demand to shift in the $i-j$ pair, hence the term Φ_{ij}.

Combining equations (29)-(31), we have the following equation that illustrates how pair-level shocks $d\ln\vartheta_{ij}$, $d\ln\vartheta_{kj}$, and $d\ln\vartheta_{iz}$ affect the price p_{ij}:

$$\begin{aligned}d\ln p_{ij} =& \Phi_{ij}d\ln\vartheta_{ij} \\ &+ \sum_{k\in Z_j, k\neq i}\Phi_{kj}s_{kj}\Gamma_{ij}^{s}\left(\rho-1\right)\Phi_{ij}d\ln\vartheta_{kj} \\ &+ \sum_{z\in W_i, z\neq j}\Phi_{iz}x_{iz}\varepsilon_{iz}\left(\Gamma_{ij}^{x}-\frac{1-\theta}{\theta}\right)\Phi_{ij}d\ln\vartheta_{iz}. \qquad (32)\end{aligned}$$

Using equation (32) one can derive equation (16), the elasticity of price p_{ij} with respect to exporter-level shocks, $d\ln\vartheta_i$. We obtain Ψ_{ij} by imposing $d\ln\vartheta_i = d\ln\vartheta_{ij} = d\ln\vartheta_{iz}$ and $d\ln\vartheta_{kj} = 0$ in equation (32). We note that how shocks on other nodes affect the price p_{ij} in equation (16) is isomorphic to what is illustrated in equation (27). In equation (27), we took into account the indirect effect the shock ϑ_{ij} has on quantities on other nodes, and how they feed back to the price p_{ij}. Analogously, in equation (16), we have allowed for the shock ϑ_i to directly impact other nodes, and hence allowing them to affect the price p_{ij} in the same way.

Finally, we also consider shocks that vary at the importer-level, ϑ_j, and derive its price elasticity. Imposing $d\ln\vartheta_j = d\ln\vartheta_{ij} = d\ln\vartheta_{kj}$ and $d\ln\vartheta_{iz} = 0$ in equation (32), we obtain

$$\frac{d\ln p_{ij}}{d\ln\vartheta_j} = \Phi_{ij} + \sum_{k\in Z_j, k\neq i} \Phi_{kj}\Gamma^s_{ij}\left(\rho-1\right)s_{kj}\Phi_{ij}. \tag{33}$$

The first term in equation (33) captures the direct effect that the cost shock ϑ_j has on the price p_{ij}. The second term captures the indirect effect it has through j's other suppliers. The same cost shock ϑ_j will first affect price p_{kj} with elasticity Φ_{kj}. The change in price p_{kj} will in turn affect i's supplier share with elasticity $(\rho-1)\,s_{kj}$, changing the markup in the $i-j$ pair. This will effectively work as an additional cost shock to the pair.

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 MID 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.[29]

[29] Other general rules also apply. For example, english words such as "a," "an," "and," "the," and also hyphens are ignored from the company's name. Common prefixes such as "OOO," "OAO," "ISC," or "ZAO" in Russia, or "PT" in Indonesia, are also 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 are to be ignored.

The matching is conducted as follows. First, we match the name part of the MID in LFTTD with the name part in ORBIS. Second, we construct a location matching score for the MID 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 MIDs 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 importer-exporter 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. That is, we observe when a given MID corresponds to more than one company in ORBIS and we proceed to 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.[30] Since we observe the NAICS code of the firms in ORBIS, we have excluded retailers and wholesalers from the matched Census-ORBIS dataset.

B.2 AD dataset

We collect information on firm-level cost shocks incurred by foreign suppliers by focusing on the AD duties imposed by the U.S. government on these foreign suppliers. For each case activated by the U.S. government, the Federal Register publishes announcements that contain the date when the AD investigation was initiated, which U.S. firms were the petitioner for the case, date of AD duty activation, the list of 10-digit Harmonized System codes of the products covered in the case, the names of foreign exporters subject to the AD duties and their corresponding rates, and if the AD case has closed, the date of revocation.

Similar information is collected by Bown (2016), and the key difference is that we cover all AD cases from 1994 to 2020, whereas the dataset of Bown (2016) covers only up to the year 2016. We take the list of all the past and present AD cases from the U.S. International Trade Commission (USITC) website.[31] For each case, we then manually collect the relevant information from the official documents published by the International Trade Administration (ITA) on the Federal Register

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

[31] See http://www.usitc.gov/trade_remedy/documents/orders.xls. The file we use is the one downloaded on October 27th, 2020.

website.[32]

B.3 Related party trade measured by ORBIS

One of the main advantages of the ORBIS dataset 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.

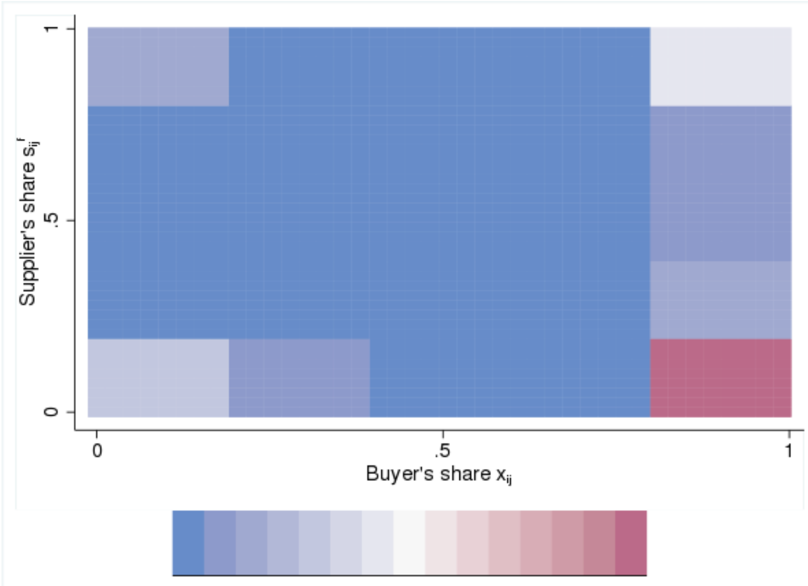
Merging U.S. Census and ORBIS datasets has been possible by matching the name and address of the U.S. based firms in the U.S Business Register and in ORBIS. This has been accomplished by applying the latest probabilistic record matching techniques and global position data (GPS), together with extensive 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. The related party indicator may generate false-positives since the ownership threshold for related-party trade used in generating the indicator is 6% or higher for imports, well below the level required for majority ownership or that would confer sufficient control rights.

B.4 Distribution of the two bilateral shares s_{ij} and x_{ij}

In Figure 4 we plot a heat map that shows the joint distribution of the two bilateral shares, s_{ij} and x_{ij}. The figure reveals that importer-exporter relationships are not concentrated in one particular corner of the graph, namely in regions where relationships can be represented 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.

[32] See https://www.federalregister.gov/.

Figure 4: Joint distribution of the exporter's supplier share (s_{ij}) and the importer's buyer share (x_{ij})



Notes: The figure displays the share of importer-exporter-HS10 observations, with respect to the exporter's supplier share (s_{ij}) and importer's buyer share (x_{ij}).

C Additional Empirical Results

C.1 Structure of U.S. import transactions

Here we show that many-to-many matches account for a significant share in U.S. imports. We classify all firm-to-firm linkages that are at the arm's length relationship in the U.S. import transaction data into four mutually exclusive groups. The first group is the set of one-to-one linkages, where the exporter and the importer only trades with the other. The second is the set of one-to-many linkages, where the exporter supplies to other importers but the importer only buys from the exporter. The third is the set of many-to-one linkages, where the exporters supply only to one importer but the importer buys from multiple exporters. Finally, the last set is the set of many-to-many linkages in which exporters and importers have multiple trading partners. We report the results of the decomposition in Table 5. The table shows that in most of the linkages, either the exporter or the importer, or both of the firms have relationships with other firms. In particular, we find that linkages that can be classified as many-to-many linkages account for around a quarter of the transactions in terms of numbers and around 43% in terms of import value.

Table 5: Prevalence of many-to-many linkages

	1:1	1:m	m:1	m:m
% of links	0.19	0.11	0.47	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 exporter-importer-HS10 product triplets: (1:1) both in the pair have no other partners; (1:m): importer has only one exporter but the exporter has multiple importers; (m:1): exporter has only one importer but the importer has multiple exporters; (m:m): both in the pair have multiple partners.

C.2 Relationship-specific components in bilateral prices

Our model puts emphasis on the role of bilateral bargaining in determining bilateral prices. The resulting price equation illustrates how variables that are determined at the pair-level, such as the exogenous bargaining parameter ϕ_{ij} and the endogenous bilateral shares s_{ij} and x_{ij} are key in explaining the variations in bilateral prices. Here we empirically investigate this theoretical insight by exploring what variables can explain the variations in bilateral prices.

In particular, here we show that firm-level or product-level components cannot capture the full dispersion in bilateral prices. In presenting this fact, we follow Fontaine et al. (2020) and consider the following statistical decomposition of price dispersion:

$$\ln p^h_{ijt} = FE_i + FE_j + FE_{ht} + \beta \boldsymbol{X}^h_{ijt} + \varepsilon^h_{ijt}, \tag{34}$$

where X^h_{ijt} represents the set of control variables, FE_i is an exporter fixed effect, FE_j is an importer fixed effect, and we also control for product-time fixed effects FE_{ht}. This type of two-way fixed effect equations can only be estimated on the largest connected set (LCS), which corresponds to the largest sample where buyers are connected through their shared suppliers, and suppliers are connected through the set of common buyers.[33]Our sample satisfies the two critical requirements: (i) all exporters and importer have multiple partners, and (ii) each importer shares at least one exporter with another importer, and each exporter shares at least one customer with another exporter. Therefore the largest connected set component is the entire sample.

The results are presented in Table 6, where in column (1) we only control for the fixed effects and in column (2) we add a set of relevant controls. In column (1), the set of fixed effects captures more than 91% of the observed price dispersion, and this result is not affected by the inclusion of controls. The results in Panel A show that more than half of the overall price dispersion (52%) is attributed to the HS10-year fixed effects. The exporter fixed effects—which capture the unobserved product heterogeneity and market power differences across exporters—account for almost 34% of the variance, whereas the importer fixed effects—which capture the unobserved heterogeneity in good valuation among importers and differences in importers' firm-level market power—account for

[33]This is because firm fixed effect are estimated relative to a reference firm, with a different reference firm for each connected set. It is therefore meaningless to compare importer and exporter fixed effects across sets.

a much smaller share of the variance (6%). The remaining component, the match 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).

In order to understand the price dispersion across importers for a given exporter-HS10 product pair, Panel B reports how much of the dispersion in prices within an exporter-HS10-year is attributable to the importer fixed effects and the residual component.[34] We find that importer fixed effects can only account for around 12% of the price dispersion within exporter-product-year triplets, and the rest of the variation remains specific to the importer-exporter relationship for a given product and year.

Table 6: Fixed-effect decomposition of price dispersion

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

Note: The table reports the results of estimating equation (34), over the period 2001-2016. We report in the two panels the results of the variance decomposition exercise of decomposing the observed price dispersion into different fixed effect components, in the entire sample and within exporter-HS10-year triplets. Controls used in Column (2) include the value of the transaction, the longevity of the relationship measured by the number of years since the exporter serves the importer with a given HS10 product, and the relative network of the exporter and importer, measured as the ratio of the number of importers the exporters supplies to, and the number of exporters the importers source from within a given HS10 product. Number of observations: 9,568,000; R^2 : 0.92.

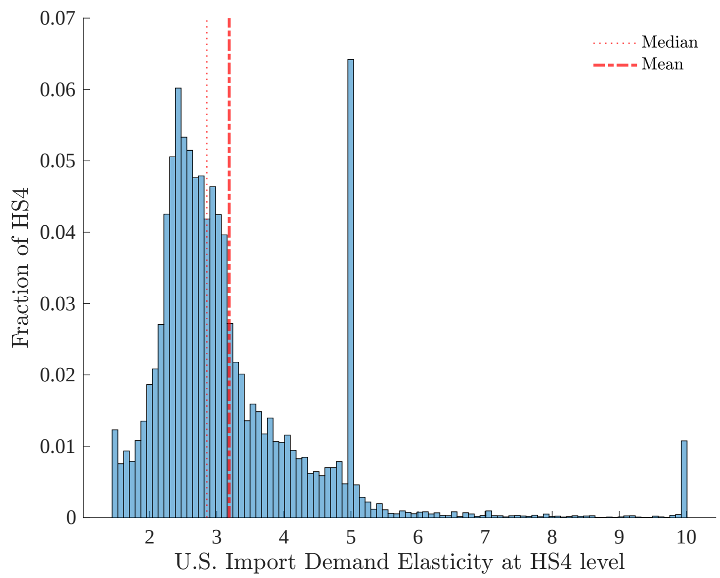
D Estimation Appendix

D.1 Downstream demand elasticity (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 sub-utility derived from the

[34] In Panel B the importer and match residual components are regressed on normalized log prices, where prices are normalized in the exporter-HS10-year dimension.

Figure 5: Downstream demand elasticity



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

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 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.

D.2 Estimates of θ and $\phi_{ij}$when not using instruments

In this section we repeat the GMM estimation of section 4.2 but this time under the assumption that the exporter's marginal cost to produce a given HS10 product is the same across U.S. importers. Under this assumption there are no unobserved cost differences in equation (22) that we need to instrument for. We report in Table 7 the estimation results, corresponding to Panel B of Table 3. The signs and magnitudes of the estimates are largely unaffected by this alternative method of estimation.

Table 7: Estimated parameters (without instruments)

	Coef.	Std. Err.
$\boldsymbol{\kappa}$		
Age of the relationship	-0.1505***	0.0153
Number of transactions	0.0846***	0.0048
Relative age	-0.1467***	0.0233
Relative network	-0.2058***	0.0099
Multiple HS10	0.1859***	0.0273
Constant	0.6831***	0.0534
θ	0.4069***	0.0083
Observations	1,376,000	

Notes: The table reports the results from the GMM regression that chose the vector $\boldsymbol{\kappa}$ and the return to scale upstream parameter θ. In the estimation we assume that the exporter's marginal cost to produce a given HS10 product is the same across U.S. importers, and do not make use of IVs. Standard errors are robust.