THE MARKET POWER OF BUYERS AND SELLERS IN INTERNATIONAL TRADE*

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Abstract

Using uniquely detailed data, I document large within-seller price variation across buyers unexplained by product quality in international trade. I show it is informative of the industry's market structure. I develop a model, which embeds standard imperfectly competitive market structures into a standard trade environment with several sources of firm heterogeneity. Testing their differential implications, I find in most markets price variation is explained by oligopolistic price discrimination rather than oligopsonistic mark-down variation. Using their better outside options, more productive buyers receive lower prices and benefit more from sellers' competition. Unlike previously studied mechanisms, this generates additional gains from exporting.

JEL codes: F10, F11, F14, F23, L11, L13

Key words: price discrimination, oligopoly, oligopsony, bargaining, buyer size, countervailing power, imported inputs

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1 Introduction

In the face of new and more granular firm-level data, a recurring finding is that different buyers pay different prices for the same product of the same seller: a violation of the Law of One Price. Since as early as Robinson (1933), economists in many fields have studied market imperfections that could explain this. Industrial organization economists have explained price variation with seller's market power to price discriminate across buyers that have differing willingness to pay (Borenstein and Rose, 1994; Shepard, 1991; McManus, 2007; Gerardi and Shapiro, 2009). Labor economists, on the other hand, often explain variation in wages, or the price of labor, with differences in buyer's market power across employers (Falch, 2010; Staiger et al., 2010; Ransom and Sims, 2010; Dube et al., 2020). In international markets that predominantly consist of firm-to-firm transactions, both buyers and sellers can have market power. Disentangling them in such complex markets has proved challenging in the absence of detailed product descriptions and both buyer and seller identifiers in standard trade datasets. Yet, it is important for our understanding of the effects of exporting and international competition.

In this paper, I distinguish price discrimination by sellers from mark-down variation across buyers in international markets, using a new and unique dataset from Paraguay. To my knowledge, this is the first trade dataset that provides detailed product descriptions and identifies both buyers and sellers in each transaction. It allows me to document large within-seller price variation across buyers unexplained by product quality which is a conventional explanation for price variation in international trade. Accounting for detailed product descriptions reduces the average coefficient of variation of prices across buyers of the same seller from 38% to 22%.[1] This residual price variation is informative of the sources of market power in individual markets, each of which has distinct implications for gains from trade.

To show this, I develop a model of trade, in which buyers and sellers can have market power and differ in productivity, bargaining abilities and preferences for each other. This comprehensive model encompasses all previously hypothesized market-power mechanisms of price variation under various market structures. Under oligopoly, sellers can price discriminate by charging higher mark-ups to buyers with higher preference for their product as in Dhyne et al. (2022) and lower mark-ups to more productive buyers with better outside options as in Huang et al. (2021). Under oligopsony, more productive buyers choose larger quantities and pay higher (lower) prices if sellers' marginal costs

[1] Fontaine et al. (2020) find similar extent of within-seller price variation in French firm-to-firm data. Yet, without observing detailed product characteristics, they cannot control for quality, which accounts for a half of within-seller price variation in my data.

increase with buyer-specific (total) output, as in Morlacco (2019). Under bilateral bargaining, buyers with better bargaining abilities negotiate lower prices and then purchase larger quantities, as in Alviarez et al. (2021a).

By testing their differentiation implications, I "horse race" these market-power mechanisms of price variation in each market. I find that in most imported goods' markets, the data is consistent with price discrimination on the part of sellers rather than the oligopsony power of buyers or cost variation. Specifically, sellers charge higher prices to buyers with higher expenditure shares of the seller's product, a theoretically consistent measure of their seller preferences. Sellers also charge lower prices to buyers purchasing in larger quantities, a theoretically consistent measure of their productivity. I argue that these findings imply oligopoly, in contrast to previously suggested oligopsony or bilateral bargaining (Morlacco, 2019; Alviarez et al., 2021a).

I show that three alternative mechanisms do not explain away the findings. Firstly, I show that economies of scale cannot fully explain why buyers purchasing larger quantities get lower prices. If true, the level of seller competition should affect prices of all buyers equally. Yet, I find that it leads to larger reductions of prices of larger buyers. Secondly, I show that bargaining abilities cannot fully explain lower prices charged to larger buyers. If true, price should be unaffected by the buyer's output scale. Yet, I find that an increase in firm's export sales results in lower prices for the same input from the same supplier. Thirdly, I show that markdown variation across buyers that internalize their effect on sellers' costs cannot fully explain lower prices paid by larger buyers. If true, prices should not vary with quantities purchased by the seller's only buyer in a market. Yet, I find that, within a relationship, prices fall with quantities purchased by the seller's only buyer in a market. All these findings are in line with price discrimination based on buyer's productivity-dependent outside options rather than the alternative explanations.

Price discrimination based on buyers' productivity-dependent outside options has distinct and quantitatively important implications. Firstly, it gives an additional cost advantage to initially more productive buyers that pay lower prices for the same input from the same supplier. I estimate that firms at the 75th percentile of the distribution of annually purchased quantities in a market, on average, pay 7% lower prices than firms at the 25th percentile in the same industry. Secondly, price discrimination based on buyers' outside options is common across product markets. I find evidence of it in 8 out of 12 markets (metals, plastics, textiles, transport, etc.), whereas oligopsonistic markdown variation is detected in only two markets (food and leather). Thirdly, unlike other mechanisms, price discrimination based on buyer's outside options generates additional gains from exporting. By exporting more, firms can invest in their outside options in inputs markets and get lower input prices.

This paper contributes to several strands of active research. Firstly, it complements existing studies of the sources and consequences of growing firm market power (De Loecker et al., 2020; Morlacco, 2019; Macedoni and Tyazhelnikov, 2019; Huang et al., 2021; Alviarez et al., 2021a; Dhyne et al., 2022). While these studies typically quantify the aggregate implications of a particular source of market power in isolation, I assess their relative importance across markets. For this, I derive differential predictions of oligopoly, oligopsony, and bilateral bargaining, similar to Alviarez et al. (2021a). I extend their framework by allowing buyer productivity to affect prices through endogenous outside options, as in Huang et al. (2021). I then develop reduced-form tests that distinguish among these market structures, whereas Alviarez et al. (2021a) use structural estimation. I separate price discrimination based on buyers' outside options from previously studied mechanisms of price variation and show they imply different effects of exporting on firms' input prices.

Secondly, my findings contribute to the studies of the sources of firm heterogeneity (Kugler and Verhoogen, 2012; Manova and Zhang, 2012; Hottman et al., 2016; Bastos et al., 2018; Blaum et al., 2018; Van Reenen, 2018). They explain the large (and growing) differences in performance across firms within narrow industries with complementarity between quality and productivity. Initially more productive firms are shown to pay higher prices for inputs of higher quality and then charge higher mark-ups for higher quality products that they export. Leveraging the uniquely detailed product descriptions in my data, I control for input quality and document a new source of firm heterogeneity. Due to price discrimination in inputs markets, more productive firms get an additional cost advantage by paying lower input prices for inputs of the same quality. This additional cost advantage increases with the level of seller competition in an input market and when the firm exports more.

Thirdly, this paper contributes to the empirical studies of price discrimination in industrial organization (Shepard, 1991; Borenstein and Rose, 1994; Leslie, 2004; McManus, 2007; Gerardi and Shapiro, 2009; Ellison and Snyder, 2010; Dafny, 2010; Grennan, 2013; Grennan and Swanson, 2018; Boik and Takahashi, 2020; Marshall, 2020; Macedoni and Mattana, 2024). While most of them focus on individual markets consisting of mainly firm-to-consumer transactions, I provide a large-scale evidence of price discrimination in firm-to-firm markets (such as metals, plastics, textiles, and transport). I take advantage of the firm-to-firm nature of international transactions and a detailed transaction-level data, which allows me to control for cost variation. My findings confirm the hypothesis in Katz (1987) that buyers' outside options in firm-to-firm markets reverse the textbook patterns and implications of price discrimination in firm-to-consumer markets.

2 Theoretical Framework

I develop a model of trade, in which both buyers and sellers differ in their productivities and can affect prices of goods they trade. I embed commonly considered imperfectly competitive market structures – oligopoly, oligopsony and bargaining – into a standard trade environment. This allows me to derive differential testable implications of these market structures for price variation and price responses to trade liberalization that I test in Section 4.

2.1 Environment

Consider a country populated by homogeneous consumers who inelastically supply their labor and consume bundles of products from several downstream sectors. Each sector's bundle consists of a continuum of final goods' varieties, each of which is produced by one final goods' producer.

Final goods' producers differ in their productivities and use labor and materials in production. Materials are bundles of inputs from several upstream sectors. In each upstream sector, there is a number of input varieties each supplied by one input producer. Final goods' producers can purchase each input from one or multiple input producers if they pay additional fixed costs. Input producers also differ in their productivities and use only labor in production.

2.2 Preferences

A representative consumer in this country has a Cobb-Douglas utility function over bundles of final goods from S downstream sectors:

$$U = \prod_{s=1}^{S} Q_s^{\beta_s}, \qquad \sum_{s=1}^{S} \beta_s = 1 \tag{1}$$

Each of these bundles consists of product varieties each produced by one of Ω_s final goods' producers with productivity φ and substitutable with constant elasticity of substitution, $\sigma \geq 1$:

$$Q_s = \left(\int_{\varphi \in \Omega_s} q_s(\varphi)^{\frac{\sigma_s - 1}{\sigma_s}} d\varphi \right)^{\frac{\sigma_s}{\sigma_s - 1}} \tag{2}$$

These preferences result in the following demand for variety φ in sector s:

$$q_s(\varphi) = \beta_s E \mathbb{P}_s^{\sigma_s - 1} p_s(\varphi)^{-\sigma_s}, \tag{3}$$

where $\mathbb{P}_s \equiv \left(\int_{\varphi\in\Omega_s} p_s^{1-\sigma_s}(\varphi)d\varphi\right)^{1-\sigma_s}$ is a CES price index in final goods sector s, and $E \equiv wL$ is consumer's income from supplying labor L for wage w.

2.3 Technologies

Final goods' producer with productivity φ from sector s combines labor L and composite material input M using Cobb-Douglas production function:

$$q_s(\varphi) = \varphi {L_s}^{\alpha_s} M_s^{1-\alpha_s} \tag{4}$$

The composite material input in sector s, M_s, consists of N_s inputs from upstream sectors j substitutable with constant elasticity of substitution $\theta_s \geq 1$:

$$M_s(\varphi) = \left(\sum_{j\in N_s} m_j(\varphi)^{\frac{\theta_s-1}{\theta_s}}\right)^{\frac{\theta_s}{\theta_s-1}} \tag{5}$$

Input j can be purchased from either one or multiple suppliers whose varieties have constant elasticity of substitution $\eta_j \geq 1$:

$$m_j(\varphi) = \left(\sum_{k=1}^{N_m} \delta_{jk}(\varphi) m_{jk}(\varphi)^{\frac{\eta_j-1}{\eta_j}}\right)^{\frac{\eta_j}{\eta_j-1}}, \tag{6}$$

where N_m is either 1 or $\bar{N}_m$, and $\delta_{jk}(\varphi)$ is firm φ's preference for producer k in input market j.

In order to have multiple suppliers in input market j, a final goods' producer incurs fixed costs $f_j \geq 0$ capturing search and transaction costs, or costs of backward integration into the input production. If these fixed costs are zero or infinity, the model collapses to a standard model of trade in inputs.

Input j producer k with productivity a_k uses only labor in production according to the following production function:

$$m_{jk}(\varphi) = a_k \left(L_{jk}(\varphi)\right)^{\gamma_j}, \tag{7}$$

where γ_j governs the returns to scale in the input production. When $\gamma_j = 1$, firm k has constant marginal costs of production, w/a_k. When $\gamma_j < 1$, its marginal costs increase with quantity implying diseconomies of scale. When $\gamma_j > 1$, its marginal costs decrease with quantity implying economies of scale.

2.4 Market structures

As in the standard international trade environment, I assume perfect competition in labor markets and monopolistic competition with constant mark-ups in final goods' markets. However, I allow for one of the common imperfectly competitive market structures to arise in each input market, depending on the technological parameters. If inputs are not perfectly substitutable ($0 < \eta_j < +\infty$) and their producers realize the effect of their pricing decisions on the final goods' producers' costs, this results in differentiated Bertrand oligopoly.[2] If, in contrast, inputs are perfectly substitutable ($\eta_j \rightarrow +\infty$) and there are diseconomies of scale in their production ($\gamma_j < 1$), this gives rise to classic oligopsony. Finally, a combination of the two market structures arises if both final goods' and input producers engage in bargaining with non-zero bargaining abilities $\kappa_k(\varphi)$ and $1 - \kappa_k(\varphi) \in (0,1)$, respectively. Below, I derive and compare patterns of equilibrium price variation across these market structures.

2.5 Equilibrium input price variation

2.5.1 Oligopoly

Under Bertrand oligopoly, sellers with market power charge buyer-specific markups over marginal costs:

$$p_{jk}(\varphi) = \underbrace{\frac{\zeta_{jk}(\varphi)}{\zeta_{jk}(\varphi) - 1}}_{markup_{jk}(\varphi)} \times mc_{jk}(\varphi), \tag{8}$$

where $\zeta_{jk}(\varphi)$ is the absolute value of buyer φ's input demand elasticity for supplier k's product. This expression implies that within-seller price variation can arise through two distinct channels: variation in sellers' marginal costs or variation in markups. I first discuss them separately and then account for their simultaneous presence in the empirical analysis.

Buyer-specific economies or diseconomies of scale. Even when markups are constant across buyers, prices can vary because of cost differences. If sellers face buyer-specific economies ($\gamma_j > 1$) or diseconomies ($\gamma_j < 1$) of scale, supplying larger buyers lowers or raises marginal costs. In this case, more productive buyers large buyer quantities and pay pay lower or higher prices for purely technological reasons.

[2] The results are qualitatively the same if, instead, in differentiated markets sellers compete in quantities (see Atkeson and Burstein (2008) and Dhyne et al. (2022)).

Price discrimination. Alternatively, if sellers' marginal costs are constant across buyers, within-seller price variation reflects markup variation across buyers, if arbitrage between buyers is costly or infeasible.[3] Specifically, sellers engage in price discrimination by charging lower markups to buyers with more elastic demand.

Under the production technology in (4)–(6), buyer φ's input demand elasticity for supplier k's product is:

$$\zeta_{jk}(\varphi) = \eta_j - (\eta_j - \theta_s)s^J_{jk}(\varphi) - (\theta_s - 1 - (1-\alpha_s)(1-\sigma_s))s^J_{jk}(\varphi)s^M_j(\varphi), \tag{9}$$

where

$$s^J_{jk}(\varphi) = \frac{\delta^{\eta_j}_{jk}(\varphi)p^{1-\eta_j}_{jk}(\varphi)}{\sum_{n=1}^{N_j(\varphi)} \delta^{\eta_j}_{jn}(\varphi)p^{1-\eta_j}_{jn}(\varphi)}, \qquad s^M_j(\varphi) = \frac{\mathbb{P}^{1-\theta_s}_j(\varphi)}{\sum_{i \in N_s} \mathbb{P}^{1-\theta_s}_i(\varphi)}. \tag{10}$$

The term $s^J_{jk}(\varphi)$ is supplier k's share in buyer φ's expenditures on input j, while $s^M_j(\varphi)$ is input j's share in the buyer's total material expenditures. Under the standard assumption that inputs are more substitutable than final goods ($\eta_j \geq \theta_s \geq \sigma_s$), demand elasticity decreases in both shares. Sellers therefore charge higher markups to buyers that rely more heavily on their product.

These expenditure shares vary systematically across buyers. Buyers with stronger preferences for a supplier's product spend more on that supplier and have less elastic demand. Similarly, firms in industries that require fewer intermediate inputs spend a larger share of total material expenditures on each input and therefore also have less elastic demand.

Importantly, buyers' productivity can affect prices through outside options. Suppose that maintaining multiple suppliers requires paying fixed costs $f_j > 0$. More productive firms are then more likely to source from multiple suppliers because the gains from additional sourcing relationships increase with firm productivity:

$$B_s \varphi^{\sigma_s - 1} \mathbb{J}'_s(\varphi)^{(1-\alpha_s)(1-\sigma_s)} \left[\left(\frac{\mathbb{J}''_s(\varphi)}{\mathbb{J}'_s(\varphi)} \right)^{(1-\alpha_s)(1-\sigma_s)} - 1 \right] > f_j w, \tag{11}$$

where $\mathbb{J}'_s(\varphi)$ and $\mathbb{J}''_s(\varphi)$ are the buyer's input price indexes with one and multiple suppliers, respectively.

As a result, more productive buyers have better outside options and more elastic demand for each supplier's product. Sellers therefore charge them lower markups. This

[3] Boik (2017) shows that arbitrage opportunities limit the extent of price discrimination. In Section 4, I show that geographic distance between buyers increases the extent of price discrimination by making arbitrage more costly.

mechanism operates only when multiple suppliers exist in the market. If there is only one supplier, even highly productive buyers have no alternative sourcing options. When additional suppliers enter the market, outside options improve disproportionately for larger buyers, inducing incumbent sellers to offer them larger price reductions. In contrast, if within-seller price variation reflects only buyer-specific economies or diseconomies of scale, seller competition should affect prices of all buyers similarly.

Figure 1a illustrates how firm's preferences for the input supplier, sector-specific input requirements and productivity affect its input demand elasticity and prices of price discriminating sellers. Firm with higher preferences for supplier, fewer input requirements and lower productivity have both higher demand for the supplier's product and lower input demand elasticity. Taking advantage of their market power, price discriminating suppliers charge these firms higher mark-ups.

Proposition 1 *If input sellers have market power and engage in price discrimination, they charge higher markups to buyers with (i) stronger preferences for the seller's product, (ii) fewer input requirements, and (iii) worse outside options. In contrast, if within-seller price variation reflects buyer-specific economies or diseconomies of scale, larger buyers pay lower or higher prices because of differences in suppliers' marginal costs.*

Proof. See Appendix A.1. ∎

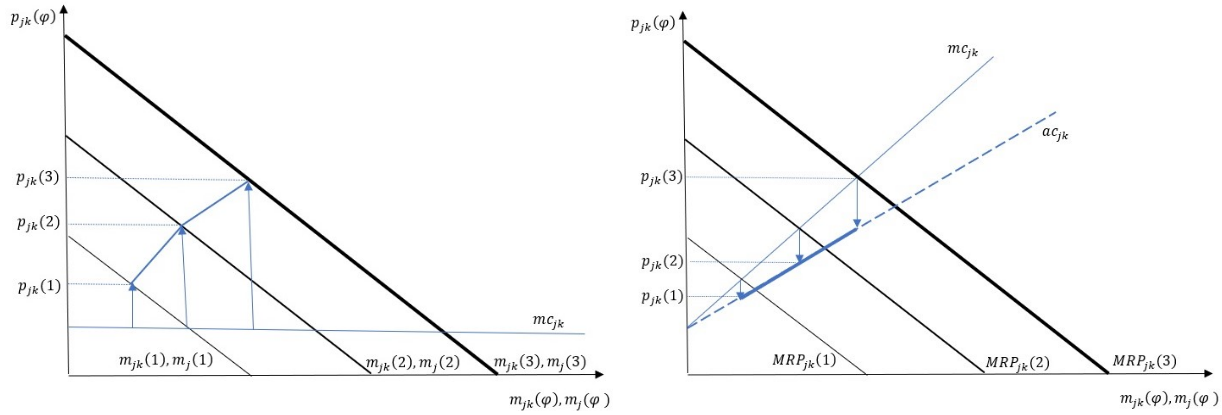
Lemma 1 *In response to greater seller competition, price-discriminating sellers offer larger price reductions to buyers with better outside options, while non-discriminating sellers adjust prices similarly across buyers.*

2.5.2 Oligopsony

Under classic oligopsony with perfectly competitive input suppliers, final goods' producer φ buys input j at a price equal to the supplier's average cost, which can be expressed as a mark-down over the supplier's marginal cost:

$$p_{jk}(\varphi) = \left(\underbrace{1 + \frac{\partial mc_{jk}(\tilde{\varphi})}{\partial m_{jk}(\tilde{\varphi})} \frac{m_{jk}(\tilde{\varphi})}{mc_{jk}(\tilde{\varphi})}}_{markdown_{jk}(\tilde{\varphi})} \right)^{-1} \times mc_{jk}(\varphi) \tag{12}$$

This pricing equation highlights two potential sources of input price variation across oligopsonistic producers of final goods: markdowns and marginal costs. Marginal costs



(a) An oligopolist charges larger buyers higher prices

(b) More productive oligopsonists pay higher prices

Figure 1. Price Variation Across Buyers under Oligopoly and Oligopsony

Notes: The downward sloping lines depict total and seller-specific demand and marginal revenue product for good j of different downstream firms 1, 2, and 3. Firms are indexed in order of increasing total input demand. Equilibrium buyer-specific prices are labeled on the vertical axis. Under oligopoly in Figure 1a, prices equalize seller's marginal revenue and marginal costs for each buyer. Under oligopsony in Figure 1b, prices are equal to seller's average cost and equalize buyer's marginal revenue product and seller's marginal costs. Arrows depict absolute mark-ups and mark-downs as the difference between equilibrium prices and seller's marginal costs.

increase with buyer's productivity because of the diseconomies of scale behind the upward sloping marginal cost curve. Mark-downs increase with buyer's quantity share in the supplier's output: $(\frac{1}{\gamma_j} - 1)\frac{m_{jk}(\varphi)}{M_{jk}}$. Despite this, equilibrium prices increase in the buyer's productivity, because they belong to the average cost curve, which, by assumption, is upward sloping.[4]

Figure 1b illustrates equilibrium price variation under classic oligopsony. It depicts an exogenous increase in buyer's productivity φ as an outward shift of the buyer's marginal revenue product. Since equilibrium prices lie on the upward sloping average cost curve, this results in higher equilibrium prices, despite the higher markdowns. Importantly, this mechanism predicts the same patterns of price variation both across oligopsonistic buyers and within one monopsonist over time. In other words, under classic oligopsony, more productive buyers pay higher prices, and higher productivity of a given buyer implies higher price. I state this prediction in the next Proposition.

Proposition 2 *If firms have oligopsony power in inputs markets and input suppliers have buyer-specific costs or only one buyer, then more productive buyers pay higher input prices.*

[4] Berger et al. (2019) obtain the same predictions in a framework where the upward sloping (labor) supply curve is derived endogenously from heterogeneous seller's preferences for the buyer.

Proof. See above and Appendix A.2 for details. ■

These predictions of classic oligopsony differ from those in Alviarez et al. (2021a) because of two key modeling assumptions. First, Alviarez et al. (2021a) assume that sellers' marginal and average costs depend on total output rather than buyer-specific quantities. As a result, cost variation across buyers of the same seller is ruled out and can be absorbed by seller-product fixed effects. Second, prices are determined by the intersection of buyers' marginal revenue product and sellers' average costs. In contrast, under classic oligopsony, equilibrium quantities are determined at the intersection of marginal revenue product and marginal costs, while equilibrium prices equal average costs evaluated at those quantities. Consequently, prices in Alviarez et al. (2021a) lie on the downward-sloping demand (marginal revenue product) curve, whereas under classic oligopsony they lie on the upward-sloping average-cost curve (see Figure A1).

These assumptions imply different predictions for cross-sectional price variation across buyers. Unlike Proposition 2, the framework in Alviarez et al. (2021a) predicts that buyers with larger quantity shares in a seller's output pay lower prices because they move further down the demand curve. The monopsonist pays the lowest price, equal to the seller's average costs, while infinitesimally small buyers pay prices close to marginal costs.

At the same time, the two frameworks make a similar prediction for within-buyer price variation over time. If a monopsonist becomes more productive while remaining the seller's only buyer, its demand expands and increases the seller's total output. This raises the seller's average costs and hence equilibrium prices (see Figure A2.) I test this additional prediction that is not tested in Alviarez et al. (2021a) in Section 4.

2.5.3 Bilateral bargaining

The pricing patterns described under oligopoly and oligopsony can also arise in a Nash-in-Nash bilateral bargaining framework. Multiple buyers and suppliers simultaneously bargain over bilateral prices, taking all other trading relationships as given. If negotiations between buyer φ and supplier k fail, the buyer continues sourcing from alternative suppliers while the supplier continues selling to its remaining buyers. Disagreement payoffs are therefore generally non-zero for both parties.

Consider a final-goods producer φ and input supplier k bargaining over the price of input j. Let $\kappa_k(\varphi)$ denote the buyer's bargaining ability and $1 - \kappa_k(\varphi)$ the supplier's bargaining ability. Given all other trading relationships, the negotiated price solves:

$$\max_{p_{jk}} \Bigg[\underbrace{\Pi^B(N_j;\varphi) - \Pi^B(N_j\backslash k;\varphi)}_{\Delta\Pi^B(p_{jk};\varphi)} \Bigg]^{\kappa_k(\varphi)} \Bigg[\underbrace{\Pi^S(\Omega_k;a_k) - \Pi^S(\Omega_k\backslash\varphi;a_k)}_{\Delta\Pi^S(p_{jk};a_k)} \Bigg]^{1-\kappa_k(\varphi)}, \tag{13}$$

where $\Delta\Pi^B(p_{jk};\varphi)$ and $\Delta\Pi^S(p_{jk};a_k)$ denote the buyer's and supplier's surpluses from reaching an agreement. The buyer's surplus comes from lower costs of using multiple input suppliers, while the supplier's surplus is equal to profits in this focal relationship.

Using the expressions for buyers' and suppliers' surpluses derived in Appendix A.3, the negotiated price can be written as:

$$p_{jk}(\varphi) = \gamma_j mc_{jk}(\varphi) + \frac{\Delta\tilde{\Pi}^B(p_{jk}(\varphi);\varphi)}{\bar{\kappa}_k(\varphi)} \left(1 - \zeta_{jk}(\varphi) + \frac{mc_{jk}(\varphi)}{p_{jk}(\varphi)}\zeta_{jk}(\varphi)\right), \tag{14}$$

where $\zeta_{jk}(\varphi)$ is the buyer's input-demand elasticity, $\bar{\kappa}_k(\varphi) \equiv \kappa_k(\varphi)/(1-\kappa_k(\varphi))$ is the buyer's relative bargaining ability, and $\Delta\tilde{\Pi}^B(p_{jk}(\varphi);\varphi)$ is the buyer's surplus per unit of input.

This expression implies that within-supplier price variation can arise from four sources: suppliers' marginal costs, buyers' demand elasticities, buyers' outside options embedded in their surplus from trade, and buyers' bargaining abilities. They nests the mechanisms discussed above. Across buyers with full bargaining weight ($\kappa_k(\varphi) = 1$), prices can vary according to the oligopsony predictions. In contrast, if sellers have full bargaining weight ($\kappa_k(\varphi) = 0$), prices can vary across buyers based on their demand elasticities for the seller's product or outside options. If both buyers and sellers have some bargaining abilities ($\kappa_k(\varphi) \in (0,1)$), predictions of both oligopoly and oligopsony can arise. In this case, the effect of buyer productivity on prices is ambiguous because oligopoly and oligopsony can predict the opposite effects.

A key prediction unique to bilateral bargaining is that buyers with greater bargaining abilities negotiate lower prices, conditional on their demand elasticities and outside options. Since lower negotiated prices increase equilibrium purchases, buyers with stronger bargaining positions also buy larger quantities.

Proposition 3 *If final-goods producers bargain with suppliers over input prices, then, all else equal, buyers with greater bargaining abilities pay lower input prices and purchase larger quantities.*

Proof. See Appendix A.3. ■

The distinction between these market structures is important because they imply different responses of input prices to trade shocks. I next study how increased export access affects firms' imported input prices.

2.6 The effect of exporting on firm's input prices

I allow for trade in final goods and study how exporting affects firm's input prices depending on the market structure in the input market. I assume that firms in downstream sector s can sell their output abroad after paying fixed exporting costs, f^x, and variable iceberg-type trade costs, τ_s. Foreign consumers have the same preferences as the domestic ones but potentially different per-capita income denoted with E^*.

In oligopolistic input markets, when firm φ can export its final goods, its derived demand for input j from supplier k becomes:

$$m_{jk}(\varphi) = \delta_{jk}(\varphi)^{\eta_j} \varphi^{\sigma_s - 1} \left[\frac{p_{jk}(\varphi)}{\mathbb{P}_j(\varphi)} \right]^{-\eta_j} \left[\frac{\mathbb{P}_j(\varphi)}{\mathbb{J}_s(\varphi)} \right]^{-\theta_s} \mathbb{J}_s(\varphi)^{(1-\alpha_s)(1-\sigma_s)-1} A_s^*(\varphi),$$

where $A_s^*(\varphi) \equiv A_s \left(1 + \mathbb{1}_x(\varphi)\tau_s^{-\sigma_s} \left(\mathbb{P}_s^*/\mathbb{P}_s\right)^{\sigma_s - 1} E^*/E\right)$ is a firm's input demand shifter in an open economy. When firm φ starts exporting, $\mathbb{1}_x(\varphi) = 1$, or experiences a reduction in variable trade costs, τ_s, $A_s^*(\varphi)$ increases from A_s to $A_s^* = A_s(1 + \tau_s^{-\sigma_s} \left(\mathbb{P}_s^*/\mathbb{P}_s\right)^{\sigma_s - 1} E^*/E)$. This does not change firm's preference for the supplier or its sectoral input requirements, and hence, does not affect its input demand elasticity in (9) directly. Yet, exporting affects firm's input demand elasticity indirectly through the number of its input suppliers.

When firm φ can export its output, it chooses to have multiple, rather than one, supplier of input j if the following condition is satisfied:

$$B_s^* \varphi^{\sigma_s - 1} \mathbb{J}_s'(\varphi)^{(1-\alpha_s)(1-\sigma_s)} \left\{ \left(\frac{\mathbb{J}_s''(\varphi)}{\mathbb{J}_s'(\varphi)} \right)^{(1-\alpha_s)(1-\sigma_s)} - 1 \right\} > f_j w, \tag{15}$$

where $B_s^*(\varphi) \equiv B_s \left(1 + \mathbb{1}_x(\varphi)\tau^{-\sigma_s} \left(\mathbb{P}_s^*/\mathbb{P}_s\right)^{\sigma_s - 1} E^*/E\right) > B_s$ captures differences in benefits from having multiple suppliers across exporting ($\mathbb{1}_x(\varphi) = 1$) and non-exporting ($\mathbb{1}_x(\varphi) = 0$)firms. Intuitively, by increasing firm's output scale, exporting encourages it to pay the fixed costs to increase the number of its input suppliers, $N_j(\varphi)$. This, in turn, increases its elasticity of demand for inputs from its existing suppliers and forces them to lower their prices. Therefore, exporting allows firms to get lower input prices in markets, where sellers price discriminate across buyers with different number of input suppliers.

In contrast, in oligopsonistic input markets, exporting is predicted to increase firm's input prices, conditional on its share in the supplier's output. When an oligopsonist in an input market starts exporting, its marginal revenue product of the input increases and

Table 1. Predicted patterns of within-seller price variation across market structures

Predicted price effect of	Market structure				
	Oligopoly		Oligopsony		Bargaining
	PD	EoS	Classic	AFKM	Classic
Buyer's preference for the seller	+	+	0	0	0
Productivity across buyers	−	−	+	−	?
Productivity within buyer	−	−	+	+	?
Buyer's bargaining abilities	0	0	0	0	−
Seller competition on large vs small buyers	−	0	0	0	−
Exporting	−	−	+	+	0

Notes: The table summarizes the qualitative predictions of the three market structures studied in the paper. PD denotes price discrimination, EoS denotes economies of scale, AFKM denotes the oligopsony model in Alviarez et al. (2021a). Bargaining refers to a bilateral bargaining framework which embeds oligopoly with price discrimination and classic oligopsony.

becomes:

$$MRP_j(\varphi) = (1-\alpha_s)\tilde{A}_s^*\tilde{\varphi}\tilde{M}_s(\tilde{\varphi})^{-\alpha_s}\left(\frac{m_j(\tilde{\varphi})}{\tilde{M}_s(\tilde{\varphi})}\right)^{-1/\theta_s}$$

where $\tilde{A}_s^* = \tilde{A}_s\left(1+\mathbb{1}_x(\varphi)\tau_s^{-\sigma_s}\left(\mathbb{P}_s^*/\mathbb{P}_s\right)^{\sigma_s-1}E^*/E\right)^{\frac{1}{\sigma_s(1-\alpha_s)+\alpha_s}} > \tilde{A}_s$ captures the effect of exporting and trade costs on firm φ's marginal revenue product of input j. Because in equilibrium the firm chooses input quantity that equalizes its marginal revenue product and the supplier's marginal costs, this increases the marginal costs and hence the price it pays in equation (12). If, at the same time, firm's quantity share in the supplier's output stays the same, exporting does not affect the mark-down. Hence, an increase in export sales of an oligopolistic input buyer results in a higher input price, conditional on its quantity share in the supplier's output.

These effects of exporting on firm's input prices arise in a bilateral bargaining framework when buyer's bargaining abilities are 0 or 1. Additionally, this framework implies that prices can vary across buyers of the same seller due to differences in their bargaining abilities. However, this mechanism implies that firm's exporting should not affect the price it pays in an input market because it does not affect its exogenous bargaining ability.

Proposition 4 *Conditional on input quality, exporting i) lowers firm's input prices if input sellers price discriminate based on buyers' productivity-dependent outside options, ii) does not affect firm's input prices if input sellers price discriminate based on buyers' exogenous bargaining abilities, and iii) increases firm's input prices if it has oligopsony power in the input market.*

Proof. See above and Appendix A.4 for details. ■

The mechanisms of price variation and the price effects of exporting across the three market structures are summarized in Table 1. Although several market structures can

Table 2. Firm types in Paraguay's firm-to-firm import transactions

	% firms	% transactions	% annual value	% annual weight
		A. Buyers		
Producers	14	10	22	30
Wholesalers	34	51	52	49
Retailers	11	18	13	10
MNE affiliates	8	22	31	31
		B. Sellers		
Intermediaries	4	9	4	5
MNE affiliates	17	20	21	18

Notes: Buyers types are identified from importers NACE industry classification, while seller types are based on the word indicators in their names and the information in Orbis. MNE affiliates are determined based on the similarly of buyer and seller names as well as the information provided in Orbis.

share one or two predictions, no two market structure share all six considered predictions. Therefore, a market structure can be identified by testing all six predictions in the data. One challenge is that some sources of firm heterogeneity such as buyer's preferences for the seller or buyer productivity are not directly observed. Another challenge is that the developed theoretical framework assumes away any product differentiation within seller that can also affect prices. In the next section, I discuss the dataset that allows me to control for within-seller product differentiation and construct the theory-consistent measures of buyer heterogeneity.

3 Data

To distinguish between buyers' and sellers' market power in within-seller price variation, I use a uniquely detailed customs dataset from Paraguay.[5] This dataset overcomes limitations of most existing customs datasets and is particularly well-suited for this study due to several unique features. Firstly, it provides identifiers of importers in Paraguay as well as names and countries of their foreign suppliers. This allows me to document large variation of prices across buyers of the same seller. Secondly, this data contains very detailed descriptions of traded products, including their brands, countries of origin, per-unit weight, and non-generic commercial descriptions, besides the standard 8-digit Harmonized systems' classification codes (HS8).[6] Using these, nearly barcode-level, product descriptions, I account for variation in product quality in within-seller price variation.

[5]The data collected by Paraguayan customs was purchased from Datamyne.

[6]Goldberg (1995), Head and Mayer (2019), Lashkaripour (2020), Alviarez et al. (2021b) show brands, origin countries and per-unit weight are a source of product differentiation.

Table 3. Joint heterogeneity of buyers and sellers

	$\bar{x}$	std	5p	10p	25p	50p	75p	90p	95p
					Panel A: Buyers				
'000 $USD	1214	8492	1.2	2.2	7.8	41.2	270.2	1524	4238
# Years	2.0	1.7	1	1	1	1	3	6	6
# HS8	17	44	1	1	1	3	14	43	81
# Countries	2.3	2.8	1	1	1	1	2	5	8
# Sellers*	2.7	4.1	1	1	1	1	3	6	9
# Countries/HS8	1.2	0.7	1	1	1	1	1	2	2
# Sellers*/HS8	1.4	1.1	1	1	1	1	1	2	3
N **Firms/Year**	8870	443	8175	8175	8767	8863	9009	9541	9541
					*Panel B: Sellers**				
'000 $USD	2574	11545	0.3	1.2	14.6	189	3605	4873	10789
# Years	3	2	1	1	1	2	5	6	6
# HS8	31	65	1	1	1	5	29	88	145
# Buyers	4.2	23.6	1	1	1	1	3	6	11
# Buyers/HS8	1.5	2.4	1	1	1	1	1	2	4
N **Firms/Year**	1546	82	1380	1380	1509	1544	1625	1630	1630

Notes: * denotes regular sellers to Paraguay, defined as a combination of a selling firm's name and country of purchase with more than 1000 appearances in the sample.

Thirdly, the Paraguayan customs dataset contains a wide range of imported products with potentially different market structures. This allows me to explore heterogeneity in market-power mechanisms of price variation across markets.

In this section, I describe these unique features of Paraguayan customs data in more detail and show that the findings are not specific to Paraguay in Section 5.2.

3.1 Heterogeneity of buyers and sellers

Between 2013 and 2018, Paraguayan customs recorded about 0.8 million import transactions annually, involving 8,870 importers and 1,550 regular exporters (with at least 1,000 transactions).[7] Table 2 describes the types of buyers (importers) and sellers (exporters) of imported goods in Paraguay. Importers include manufacturers, agricultural producers, wholesalers, and retailers; 45% are wholesalers and retailers and 14% are producers. Exporters are predominantly manufacturers, with only about 4% identified as intermediaries. Trade is largely arm's length: only 5% of Paraguay's import transactions are identified as (intra-firm) trade between affiliated parties, based on the similarity of buyer and seller names and information in Orbis. Because such transactions may reflect transfer pricing, I exclude them from most of the analysis.

[7] I focus on sellers with consistently reported names to reduce measurement error; results for the full sample are similar and available upon request.

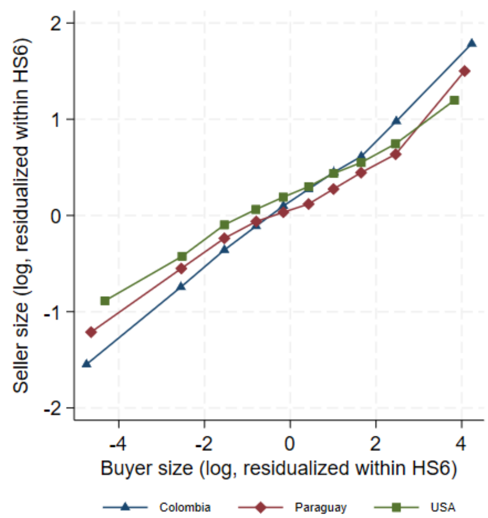


Figure 2. Positive assortative matching of buyers and sellers

Notes: The figure plots the relationship between seller size and buyer size within HS6 product categories for Paraguay, Colombia, and the United States. Both variables are measured in logs and residualized with respect to HS6 fixed effects. Buyer size is defined as quantities annually purchased from all other sellers within an HS6 category, and seller size as annually sold quantities to all buyers in an HS6 category. Each point represents binned averages of the residualized variables.

In line with the theoretical framework, both importers (buyers) and their foreign suppliers (sellers) in Paraguay exhibit a large degree of heterogeneity along several dimensions. Table 3 shows that an average importer annually spends \$1.2 million on products from 17 HS8 product categories from 2 different countries and 3 different sellers. In contrast, a median importer spends 30 times as little on only one HS8 product category from a single foreign supplier. An average regular exporter annually earns \$2.5 million on products from 31 HS8 categories exported to 4 buyers in Paraguay, while the median one earns 14 times as much by exporting only in one HS8 category to one buyer in Paraguay.

Both buyers and sellers differ substantially in the number of trading partners even within narrow product categories. Table 3 shows that although most firms have only one buyer or supplier in an HS8 category, a few largest buy or sell products in a given HS8 category from and to at least two firms. Sellers with multiple buyers in an HS8 category and their buyers are, respectively, 1.8 and 2.7 times larger than sellers and buyers in the entire sample (see Table B6). I use transactions of sellers with multiple buyers in an HS8 category to study the mechanisms behind within-seller price variation across buyers. Such transactions account for a third of all transactions and involve a quarter of all importers and a third of regular exporters to Paraguay.

Buyers and sellers with multiple trading partners in a product market exhibit a pos-

Table 4. Summary statistics on measures of product differentiation

	Within HS8 categories			Within Seller-HS8 categories		
	Mean	Median	Std. Dev.	Mean	Median	Std. Dev.
Number of seller countries	3.70	2.00	3.87			
Number of sellers	10.49	3.00	19.74			
Number of buyers	11.44	4.00	21.04	3.18	2.00	3.42
Number of brands	6.25	2.00	11.99	1.52	1.00	1.16
Number of descriptions	10.38	3.00	39.38	5.46	2.00	16.67
Number of origin countries	3.55	2.00	4.40	1.76	1.00	1.60
Number of units	1.40	1.00	0.90	1.22	1.00	0.52

Notes: First three columns report summary statistics for measures of product differentiation within HS8 product-year categories. Last three columns report analogous statistics within seller-HS8-year categories with more than one buyers. Blank cells indicate measures that are not naturally defined for a given level of aggregation. Different rows may use slightly different samples depending on availability of brand, origin, and description information.

itive assortative matching, which can give each side of the market the ability to affect prices. Figure 2 illustrates that among sellers with more than one buyer in an HS6 product market, larger sellers match with buyers that purchase more in this product market from other sellers. Importantly, this pattern of assortative matching is not specific to Paraguay. Using firm-to-firm relationships observed in Colombian customs data and U.S. Bills of Lading data from China, Figure 2 shows the same positive assortative matching holds in other countries.

3.2 Product differentiation

In the theoretical framework used to identify buyer and seller market power, products are differentiated across sellers, while within-seller differentiation is assumed away. Here, I document significant within-seller product differentiation along dimensions such as brand and commercial description, even within narrow HS8 categories. In the empirical analysis, I show that failing to account for this differentiation can bias the estimated effects and potentially alter the conclusions.

Table 4 documents substantial product differentiation even within narrowly defined HS8 product categories. In the average HS8 category, products imported into Paraguay are purchased by 11 distinct buyers from 10 different foreign sellers located in 4 countries. Beyond differentiation across sellers, the Paraguayan customs data also capture variation along several product dimensions, including brand, country of origin, and commercial description (see examples in Table B1). After cleaning and standardizing these textual data, I find that the average HS8 category contains 6 distinct brands, 10 commer-

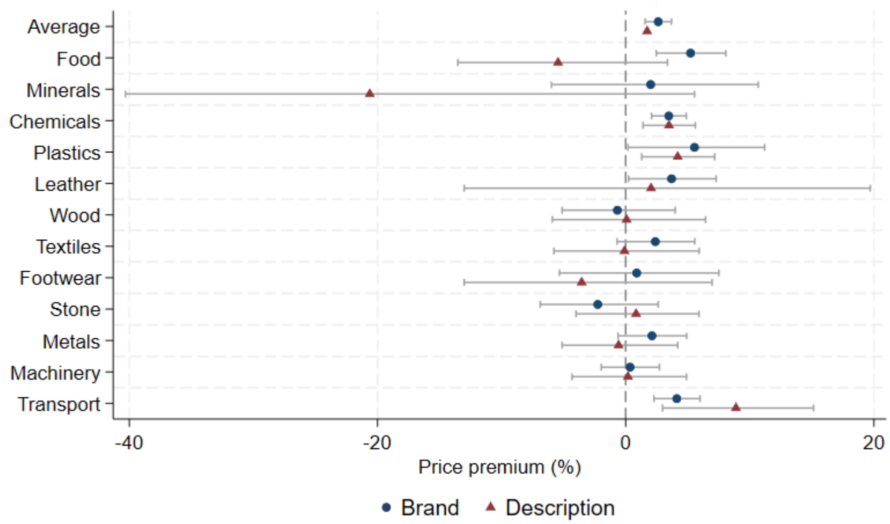


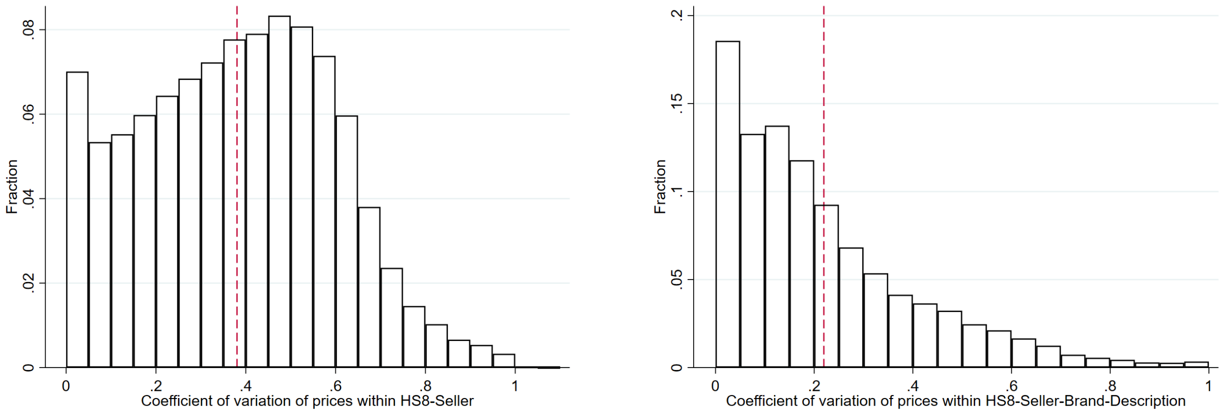
Figure 3. Brand and descriptions as demand shifters within HS8-Seller categories

Notes: The figure shows estimated price premia associated with brands and commercial descriptions across product groups. Brand and description effects are constructed in two steps. First, brand and description fixed effects are estimated from a regression of log prices controlling for unit weight and including HS8–seller–origin–year and HS8–buyer–year fixed effects. Second, these fixed effects are related to demand within HS8–seller categories, controlling for prices and buyer–year fixed effects. Coefficients are transformed into percentage price premia. Points show estimated effects and horizontal bars denote 95% confidence intervals.

cial descriptions,[8] and 4 countries of origin. Surprisingly, product differentiation remains even within HS8-Seller categories. The table reports that in HS8-Seller categories with at least two buyers, there are 1.5 distinct brands, 6 distinct commercial descriptions, and 2 countries of origin. Therefore, accounting for products' brands and descriptions, besides their HS8 codes and sellers may be important to fully capture product differentiation.

Controlling for brands and descriptions is important when assessing the role of market power in price variation, particularly if they capture vertical rather than horizontal differentiation. Since larger and more productive importers tend to use higher-quality inputs (Kugler and Verhoogen, 2011; Bastos et al., 2018), unobserved vertical differentiation could bias estimates of the effect of buyer size on prices. To assess the nature of differentiation embedded in brands and descriptions, I proceed in two steps. First, I estimate brand and description fixed effects from a regression of log prices, controlling for unit weight and including HS8–seller–origin–year and HS8–buyer–year fixed effects. Second, I examine how these fixed effects relate to demand within HS8–seller categories, conditional on prices and buyer–year fixed effects. I interpret positive effects as evidence

[8] To minimize measurement error, I include only brands and commercial descriptions with at least 1,000 and 10 observations, respectively. Details on the cleaning and standardization procedures are provided in Appendix B.



(a) Within Seller-HS8

(b) Within Seller-HS8-Brand-Description

Figure 4. Within-seller price variation across product definitions

Notes: Panel (a) shows coefficients of variation calculated as ratios of the standard deviation of unit values to their mean within HS8-Unit-Seller categories. Panel (b) reports coefficients of variation for HS8-Unit-Seller-Brand-Description-Year categories. Unit values more than three times larger or smaller than the median in each category are excluded, following Fontaine et al. (2020). Vertical lines indicate average coefficients of variation across all categories.

consistent with vertical differentiation, as they reflect systematic price premia within relationships, while effects close to zero are consistent with horizontal differentiation.

Figure 3 shows that, on average across all imported products, brands and descriptions act as demand shifters, consistent with vertical differentiation within HS8–seller categories. This is important for identification, as it implies that variation in these attributes captures systematic quality differences that could otherwise be confounded with buyer size. At the same time, there is substantial heterogeneity across product markets. Positive price premia for both brands and descriptions are concentrated in markets for transport equipment, plastics, and chemicals, while brands also appear to capture vertical differentiation in food products and leather. In contrast, in most other industries, higher brand or description fixed effects are not associated with higher demand once prices and importer–year fixed effects are controlled for. This suggests that, in these industries, brands and descriptions are more consistent with horizontal differentiation, and are less likely to bias estimates of the relationship between buyer size and input prices.[9]

[9]Figure B1 shows examples of product characteristics captured by commercial descriptions of passenger vehicles and how they affect their imported prices.

3.3 Price variation

Using uniquely detailed Paraguayan customs data, I document large within-seller price variation, which remains even after accounting for product differentiation. I proxy price with unit values calculated for each transaction as ratios of value in $USD (free-on-board, excluding freight and insurance) and quantity in known units (kilograms and units in 44% and 50% of transactions, respectively).[10] To measure the extent of within-seller price variation, I compute coefficients of variation of unit values within each seller-product category and plot their distribution in Figure 4.

Figure 4a shows substantial price variation within seller–HS8 product categories. Under the law of one price, product homogeneity within a category would imply zero dispersion in unit values. However, Paraguayan customs data reveal an average coefficient of variation of nearly 40% within seller–HS8 categories. This variation declines, but remains sizable, after accounting for product differentiation captured by brands and detailed product descriptions.[11] Figure 4b presents the distribution of coefficients of variation within seller–HS8–brand–description categories, where the average falls to about 20%. Thus, while brands and commercial descriptions capture meaningful dimensions of product differentiation and reduce price dispersion by roughly half, a substantial share of within–seller–HS8 price variation remains unexplained.

To quantify the role of observable characteristics more directly, Appendix Table B4 reports the explanatory power of product attributes and importer heterogeneity for within-seller price variation. Observable product characteristics—such as unit weight, brand, and country of origin—explain about 13% of the variation, while importer fixed effects alone account for 11%. When both are included, the adjusted R^2 rises to 0.18, indicating that product characteristics and importer heterogeneity each contribute substantially and independently to explaining price dispersion. This suggests that a large share of within-seller price variation cannot be attributed to observable product differentiation alone and is instead consistent with mechanisms such as buyer-specific pricing. Guided by theoretical framework in previous section, I explore these mechanisms in the next section.

[10] Other units of measurement of quantities include meters, square meters, liters, dozens, boxes rolls, etc.

[11] Sellers exports products in the same HS8 category with identical brand names and commercial descriptions to multiple buyers in Paraguay in 10% of case, accounting for 18% of transactions.

4 Empirical evidence

4.1 Identification strategy

To identify the role of buyer's and seller's market power in within-seller price variation, I test their implications summarized in Propositions 1 – 4. I generalize pricing rules under oligopoly, oligopsony, and bilateral bargaining in (8), (12) and (14), respectively, (in logs) as follows:

$$\begin{aligned}\log p_{jkt}(\varphi) = \rho_1 \log \textit{Seller's Share}_{jkt}(\varphi) + \rho_2 \log \textit{Buyer's Quantity}_{jkt}(\varphi) \\ + \mathbb{FE}_{s(\varphi)} + \nu_{jkt} + \xi_{jkt}(\varphi),\end{aligned} \tag{16}$$

where k, j, φ, t denote seller, buyer, product, and time, respectively. $\mathbb{FE}_{s(\varphi)}$ is buyer φ's industry s fixed effect capturing its input requirements; ν_{jkt} is seller-product-time fixed effect capturing seller's marginal costs constant across buyers, and $\xi_{jkt}(\varphi)$ is a buyer-specific error term.

Akin to the logic behind product quality measure in Khandelwal (2010), for a given purchased quantity, buyers with higher preferences for the seller in a product market spend a larger share of their import expenditures on the seller's product. Conditional on buyer's demanded quantities, the seller's share in buyer's expenditures is a theoretically consistent measure of the buyer's preference for the seller's product. Yet, given the same preference for a seller, more productive buyers have larger demand for the seller's product. Hence, conditional on the seller's share in buyer's expenditures, demanded quantities is a theoretically consistent measure of buyer's productivity.

Propositions 1 – 3 imply that the signs of coefficients ρ_1 and ρ_2 can disentangle classic oligopsony from other market structures. Under classic oligopsony, sellers are homogeneous ($\rho_1 = 0$) and more productive buyers pay higher prices ($\rho_2 > 0$), due to diseconomies of scale, if seller's average costs are buyer-specific. In contrast, if oligopolistic sellers price discriminate and/or have buyer-specific economies of scale, they charge higher prices to buyers with higher expenditure shares on their products ($\rho_1 < 0$) and lower prices to more productive buyers with better outside options ($\rho_2 < 0$). This patterns are also consistent with bilateral bargaining, which results in lower prices negotiated by buyers with better bargaining abilities who then buy larger quantities. Additionally, prices decrease in the buyer's quantity share in the seller's output ($\rho_2 < 0$) under the alternative oligopsony model in Alviarez et al. (2021a).

To distinguish the oligopsony mechanism of Alviarez et al. (2021a) from other market structures, I estimate equation (16) using over-time variation in prices within sellers' relationships with their only buyers in the market. I restrict the sample to sellers with only one buyer in an HS6 market at all times and include fixed effects for seller-product-buyer, seller-year, and HS6-year. In this specification, the classic oligopsony and oligopsony in Alviarez et al. (2021a) share the same prediction: when monopsonists expand (for example due to their productivity), their prices should increase ($\rho_2 > 0$). In contrast, oligopoly implies that single buyers get lower prices as they increase their size ($\rho_2 < 0$) due to either economies of scale or price discrimination based on the outside options.

To separate buyer-level economies of scale from price discrimination across buyers with different outside options, I examine the effect of seller competition in Lemma 1. For this, I estimate seller's pricing rule in equation (16) augmented with the interaction term between the number of sellers in a market and buyer's annual purchases:

$$\begin{aligned}\log p_{jkt}(\varphi) = \rho_1 \log \mathit{Seller's\ Share}_{jkt}(\varphi) + \rho_2 \log \mathit{Buyer's\ Quantity}_{jkt}(\varphi) \\ +\rho_3 \log \mathit{Buyer's\ Quantity}_{jkt}(\varphi) \times \Delta \log \bar{N}_{jt} + \mathbb{FE}_{s(\varphi)} + \nu_{jkt} + \xi_{jkt}(\varphi),\end{aligned} \tag{17}$$

where $\Delta \log \bar{N}_{jt}$ is demeaned (log) number of foreign sellers of product j at time t, and seller-product-year fixed effects ν_{jkt} absorb the effect of competition on seller's average prices.

The effect of competition on the extent of within-seller price variation of incumbents is captured by coefficient ρ_3. If price variation across buyers is fully explained by variation in the seller's marginal costs, then greater competition should not affect prices of large and small buyers differently ($\rho_3 = 0$). However, if larger buyers are charged lower markups because of their access to alternative suppliers, then an increase in the number of alternative suppliers should result in larger discounts offered to larger buyers ($\rho_3 < 0$).

Finally, I distinguish price discrimination based on buyers' outside options from the effect of buyer's bargaining abilities on price. If buyers differ in their bargaining abilities rather than outside options, then buyers with better bargaining abilities first negotiate lower prices and then purchase larger quantities ($\rho_2 < 0$). To test for this mechanism, I estimate the effect of exporting on the firm's imported input prices summarized in Proposition 4. I use the following version of the seller's pricing rule:

$$\log p_{jkt}(\varphi) = \rho_2^X \log \mathit{Buyer's\ Exports}_t(\varphi) + \mathbb{FE}_{s(\varphi)} + \nu_{jkt} + \xi_{jkt}(\varphi) \tag{18}$$

If sellers price discriminate based on buyer's productivity-dependent outside options, then buyers with larger export sales can afford more alternative suppliers and hence get lower prices from their existing ones ($\rho_2^X < 0$). In contrast, if price variation is explained by exogenous bargaining abilities of buyers, exporting should not have any effect on the

Table 5. Predicted effects of buyer heterogeneity on within-seller price variation

Market structure	Mechanism	ρ_1	ρ_2	ρ_2^X	ρ_3
Oligopoly	Price discrimination (preference for the seller, outside options)	+	−	−	−
	Buyer-level economies of scale	0	−	0	0
Oligopsony	Classic oligopsony	0	+	+	0
	Oligopsony in Alviarez et al. (2021a)	0	−	+	0
Bilateral bargaining	Buyer bargaining ability	+	−	0	0
Data		+	−	−	−

Notes: The table summarizes qualitative predictions of the market structures discussed in the paper. Bilateral bargaining can generate pricing patterns consistent with both oligopoly and oligopsony mechanisms. The predictions reported here isolate the component of price variation driven solely by differences in buyers' bargaining abilities. ρ_1 denotes the elasticity of prices with respect to the seller's share in buyer expenditures; ρ_2 denotes the elasticity with respect to buyers' annual quantities purchased from the seller; ρ_2^X denotes the effect of exporting on buyers' input prices; and ρ_3 denotes the interaction between seller competition and buyer-specific quantities.

firm's input price ($\rho_2^X = 0$). If, instead, prices are set by oligopsonistic buyers, then buyers that export more have higher input demand and pay higher input prices due to diseconomies of scale ($\rho_2^X > 0$).

I summarize how coefficients ρ_1, ρ_2, ρ_2^X and ρ_3 in equations (16) - (17), can be used to separate various market structures in Table 5.

Addressing endogeneity concerns. Since the signs of these coefficients can identify a market structure, it is important to address several common endogeneity concerns. Firstly, I use detailed commercial product descriptions, brand names, countries of origin, and per-unit weight to absorb the unobserved product quality variation as a source of *simultaneity* bias. Secondly, I include product quantities per transaction, to control for transaction-level economies of scale as a source of *omitted variable* bias. Thirdly, I experiment with various demand-side instruments for purchased quantity and export sales to rule out *measurement error* bias and other sources of reverse causality. Finally, I address a potential *endogeneity of entry* when estimating its effect on within-seller price variation.

4.2 Market-power mechanisms of price variation

Table 6 presents estimates of equation (16). I use transaction-level unit values to proxy for prices, define markets at the 6-digit HS level, control for buyers' input requirements using 4-digit NACE industry fixed effects, and absorb seller-specific marginal costs with seller–HS8–unit–year fixed effects.

Column (1) shows that, conditional on the quantities annually purchased from a seller, buyers allocating a larger share of their expenditures to that seller pay higher prices ($\rho_1 > 0$). Quantitatively, doubling the buyer's expenditure share increases prices by about

Table 6. Patterns of within-seller price variation across buyers

Dependent Variable:	log *Transaction Price*					
	(1)	(2)	(3)	(4)	(5)	(6)
	OLS	OLS	OLS	OLS	OLS	IV
Log Seller's Share	0.075***	0.076***	0.130***	0.089***	0.100***	0.119**
	(0.015)	(0.014)	(0.014)	(0.023)	(0.038)	(0.058)
Log Buyer's Quantity	-0.117***	-0.118***	-0.151***	-0.069***	-0.081***	-0.107*
	(0.015)	(0.015)	(0.018)	(0.018)	(0.027)	(0.056)
Affiliated Buyer		-0.242***				
		(0.079)				
Log Relationship Length			0.061***	0.018	-0.048*	-0.046*
			(0.016)	(0.020)	(0.027)	(0.026)
Log Shipment Quantity				-0.264***	-0.246***	-0.245***
				(0.036)	(0.032)	(0.032)
Log Net Weight/Unit					0.254***	0.253***
					(0.040)	(0.040)
ProductxUnitxSellerxYear FE	✓	✓	✓	✓	✓	✓
xBrandxDescriptionxOrigin FE					✓	✓
Buyer's Industry FE	✓	✓				
Importer FE			✓	✓	✓	✓
Transactions	All	All		Arm's length		
N obs	994,016	994,016	1,163,967	233,223	164,286	164,286
Adj. R^2	0.938	0.938	0.950	0.972	0.976	0.184
Kleibergen-Paap rk Wald F						23.0

Robust standard errors clustered at importer- and exporter-levels in parentheses.
* p<0.10, ** p<0.05, *** p<0.01

Notes: The table presents the results of estimating equation (16). Column (6) uses lagged buyer quantity as an instrument for current buyer quantity. Constant not shown.

7.5%. This pattern is consistent with sellers charging higher markups to buyers with stronger preferences for their products. At the same time, conditional on buyers' expenditure shares, buyers purchasing larger quantities from the seller pay lower prices ($\rho_2 < 0$): doubling annual purchases reduces prices by roughly 12%. This negative relationship is consistent with several market-power and cost-based mechanisms summarized in Table 5, which I distinguish in the analysis below.

I begin by showing that these patterns of within-seller price variation cannot be explained by intra-firm pricing, measurement error in unit values, or transaction-level economies of scale. Column (2) of Table 6 adds a dummy for buyer affiliation with the seller and shows that affiliated buyers pay, on average, 24% lower prices, consistent with intra-firm pricing. However, accounting for affiliated-party transactions does not eliminate the positive relationship between prices and buyers' expenditure shares or the negative relationship between prices and buyers' annual purchases from the seller.

Focusing only on arm's-length transactions, column (3) shows that these patterns become even stronger once relationship length and importer fixed effects are included to

Table 7. Buyer district size and imported input prices of non-exporting firms

Dependent Variable:	log *Transaction Price*			log *Buyer's Quantity*
	OLS	IV	Reduced form	First stage
	(1)	(2)	(3)	(4)
log *Seller's Share*	0.054***	0.051***	0.039***	0.239***
	(0.008)	(0.008)	(0.007)	(0.070)
log *Buyer's Quantity*	-0.086***	-0.065**		
	(0.012)	(0.032)		
log *Buyer's District Area*			0.015**	-0.220***
			(0.007)	(0.048)
log *Buyer's District Population*			-0.050**	0.500***
			(0.020)	(0.099)
log *Unit Weight*	0.339***	0.341***	0.357***	-0.096***
	(0.048)	(0.048)	(0.042)	(0.022)
HS8xUnitxSellerxBrandX FE	✓	✓	✓	✓
Buyer's IndustryxYear FE	✓	✓	✓	✓
N obs	217,859	217,859	269,318	269,318
Adj. R^2	0.975	0.094	0.972	0.926
Kleibergen-Paap rk Wald F		19.3		

Robust standard errors clustered at importer- and exporter-levels in parentheses.
* p<0.10, ** p<0.05, *** p<0.01

Notes: The table presents the results of estimating equation (16) using a subsample of non-exporting importers in Paraguay. Column (2) instruments buyer quantity with the log area and log population of the buyer's district. Column (3) reports the reduced form, and column (4) reports the first stage. Constant not shown.

capture persistent differences in transaction costs across buyers. Column (4) further controls for shipment quantities to account for transaction-level economies of scale and potential measurement error in unit values. Although larger shipments are getting substantial quantity discounts, consistent with Ganapati and Hottman (2026), prices continue to fall with buyers' annual purchases and rise with sellers' shares in buyers' expenditures.

I further show that failing to account for within-seller product differentiation biases both price elasticities toward zero. Column (5) of Table 6 absorbs product differentiation using granular seller–HS8–unit–brand–description–origin–year fixed effects, while also controlling for products' per-unit net weight.[12] Accounting for these detailed product characteristics increases both elasticities in absolute value. This pattern is consistent with larger and more productive firms purchasing products of higher quality, which is being captured by brands and commercial descriptions in Paraguayan customs data.

I also address potential reverse causality in the estimated price elasticity with respect

[12] Examples of products distinguished by brands and commercial descriptions are reported in Table B3 in the Appendix, including "Shampoo Question Professional Keratin Lift 960cc," "Shampoo Questions Professional Retention 960cc," "Tractor Valtra model A990 4x4 yellow 2017," and "Tractor Valtra model BM110 4x4 yellow 2017."

to buyers' annual purchases from a seller. Column (6) instruments current annual purchases using lagged purchases and yields similar estimates. As an alternative strategy, Table 7 exploits variation in local demand across Paraguayan districts. Focusing on non-exporting importers, I use district population and area as instruments for buyers' demand. The first-stage and reduced-form estimates show that importers located in larger and more densely populated districts purchase more and pay lower prices for the same product from the same seller. Using these district characteristics to instrument for buyers' annual purchases, column (2) continues to reveal substantial quantity discounts offered to larger buyers.

Having established that sellers vary prices across buyers with different expenditure shares and purchase quantities, I next examine which market structures are most consistent with these patterns. Table 5 shows that the estimated elasticities ($\rho_1 > 0$ and $\rho_2 < 0$) are inconsistent with a standard oligopsony framework but can arise under oligopoly pricing, bilateral bargaining, or the non-classical oligopsony model of Alviarez et al. (2021a). The key features of the framework in Alviarez et al. (2021a) is that sellers' average costs depend on total output rather than buyer-specific quantities, while equilibrium prices are determined by the demand rather than the average-cost curve. As a result, larger buyers receive lower prices because they account for a larger share of sellers' output, with the monopsonist obtaining the lowest price. Consistent with this mechanism, the estimated price elasticities in column (3) of Table 6 closely match those obtained using the specification of Alviarez et al. (2021a). To distinguish among these alternative market structures, I next test their additional empirical predictions.

In Table 8, I test a key implication of the oligopsony framework in Alviarez et al. (2021a) using over-time variation in prices charged by sellers serving only a single buyer in a market.[13] In this setting, the buyer is a monopsonist with a unit share in the seller's output and is therefore predicted to pay the lowest feasible price, equal to the seller's average costs. If this buyer expands its purchases over time, the seller's average costs increase, implying higher prices charged to the monopsonist. Columns (1)–(2) of Table 8, however, show the opposite pattern. Within sellers' relationships with their only buyers in the market, increases in buyers' annual purchases reduce prices over time. Column (2) shows that this result remains after controlling for shipment-level economies of scale and detailed product differentiation.[14] These findings are difficult to reconcile with the monopsony mechanism in Alviarez et al. (2021a) and instead point toward other market

[13] Alviarez et al. (2021a) focus on sellers with multiple buyers within a market and therefore do not study this variation.

[14] The large estimated shipment-quantity discounts are also difficult to reconcile with the assumption that sellers' average costs depend primarily on total rather than buyer-specific quantities.

Table 8. Over-time variation in prices of sellers with one buyer in a market

Dependent Variable:		log *Transaction Price*		
	(1)	(2)	(3)	(4)
	OLS	OLS	OLS	IV
log *Seller's Share*	0.270***	0.214***	0.215***	0.212***
	(0.016)	(0.016)	(0.016)	(0.017)
log *Buyer's Quantity*	-0.252***	-0.121***	-0.131***	-0.124***
	(0.013)	(0.016)	(0.018)	(0.015)
log *Buyer's Quantity* × *#Sellers*			-0.017**	-0.017*
			(0.008)	(0.010)
log *Unit Weight*		0.273***	0.273***	0.290***
		(0.047)	(0.046)	(0.057)
log *Shipment Quantity*		-0.192***	-0.192***	-0.202***
		(0.032)	(0.032)	(0.027)
ProductxUnitxSellerxImporter FE	✓			
xBrandxDescriptionxOriginxImporter FE		✓	✓	✓
SellerxYear FE	✓	✓	✓	✓
HS6xYear FE	✓	✓	✓	✓
Transactions		Arm's length		
N obs	826,423	374,477	374,477	239,404
Adj. R^2	0.922	0.975	0.975	0.147
Kleibergen-Paap rk Wald F				6933.4

Robust standard errors clustered at importer- and exporter-levels in parentheses.
* p<0.10, ** p<0.05, *** p<0.01

Notes: The table presents the results of estimating equations (16) and (17) using over-time variation of single-buyer exporter to Paraguay. Column (4) instruments (demeaned) number of sellers in a market with its lagged value. Constant not shown.

structures in which larger buyers systematically obtain lower prices.

Price variation both across buyers and within buyer–seller relationships over time is consistent with oligopolistic competition of sellers with buyer-level economies of scale. To test this mechanism, I estimate the effect of seller competition on within-seller price variation using equation (17) and report the results in Table 9. Under buyer-level economies of scale, greater seller competition should lower prices for all buyers proportionally, without affecting within-seller price dispersion across buyers. In contrast, the OLS estimates in column (1) show that larger buyers receive even larger discounts in more competitive markets($\rho_3 < 0$).[15] Column (2) reports similar results when using interactions between lagged market competition and lagged buyer purchases as instruments. This effect becomes even stronger in columns (3) and (4), which control for brands, commercial descriptions, and countries of origin.

Seller competition has a similar effect on within-relationship price variation over time. The last two columns of Table 8 show that, within seller–buyer relationships involving a

[15] This follows from the negative and statistically significant interaction between the number of sellers in the market and buyers' annual purchases from the seller.

Table 9. The effect of competition on within-seller price dispersion

Dependent Variable:	log *Transaction Price*			
	(1)	(2)	(3)	(4)
	OLS	IV	OLS	IV
log *Seller's Share*	0.099***	0.107***	0.094***	0.129**
	(0.015)	(0.027)	(0.031)	(0.058)
log *Buyer's Quantity*	-0.076***	-0.078***	-0.098***	-0.140**
	(0.013)	(0.029)	(0.027)	(0.057)
log *Buyer's Quantity* × log *#Sellers*	-0.030***	-0.032***	-0.039***	-0.041***
	(0.005)	(0.009)	(0.009)	(0.016)
log *Shipment Quantity*	-0.242***	-0.253***	-0.234***	-0.248***
	(0.021)	(0.024)	(0.032)	(0.031)
log *Relationship Length*	0.037***	0.047*	0.008	-0.049*
	(0.014)	(0.027)	(0.021)	(0.026)
log *Net Weight/Unit*	0.360***	0.349***	0.248***	0.250***
	(0.022)	(0.024)	(0.037)	(0.039)
ProductxUnitxSellerxYear FE	✓	✓	✓	✓
xBrandxDescriptionxOrigin FE			✓	✓
Buyer FE	✓	✓	✓	✓
Transactions	Arm's length			
N obs	971,802	693,325	203,615	150,658
Adj. R^2	0.953	0.243	0.980	0.184
Kleibergen-Paap rk Wald F		32.7		11.9

Robust standard errors clustered at importer- and exporter-levels in parentheses.
* p<0.10, ** p<0.05, *** p<0.01

Notes: The table presents the results of estimating equation (17). Columns (2) and (4) instrument buyer quantity and its interaction with the (demeaned) number of sellers on a market using lagged buyer quantity and the lagged interaction term. Constant not shown.

single buyer, prices decline more strongly with buyer size in more competitive markets. This pattern is difficult to reconcile with buyer-specific economies of scale alone, which would predict that competition lowers prices uniformly across buyers rather than disproportionately benefiting larger buyers. Instead, the results are consistent with sellers price discriminating across buyers with different outside options. Greater seller competition increases the availability of alternative suppliers, particularly for initially larger and more productive firms, allowing them to obtain even larger discounts.

To provide further evidence for price discrimination based on buyers' outside options, I test another implication of the model: the effect of exporting on firms' imported input prices. Table 10 reports estimates of equation (18). As a benchmark, column (1) uses product-country fixed effects and shows a strong positive relationship between firm's export sales and imported input prices. This pattern is consistent with the well-known productivity–quality complementarity in international trade, whereby more productive exporters purchase higher-quality inputs (Kugler and Verhoogen, 2012; Bustos, 2011; Bastos et al., 2018).

However, the relationship becomes economically and statistically insignificant once product-seller fixed effects are introduced in column (2). Further controlling for within-seller product differentiation using brands and countries of origin in column (3) makes the coefficient negative, though still imprecisely estimated. Finally, column (4) use the world-import-demand instrument of Hummels et al. (2014) for firm's export sales.[16] The IV estimates reveal a statistically significant negative effect of exporting on firm's imported input prices from the same supplier.

This result ($\rho_3^X < 0$) is consistent with price discrimination based on buyers' outside options. Export growth increases firm scale and raises the returns to investing in alternative sourcing relationships. This strengthens the buyer's outside options and lowering the prices charged by incumbent suppliers. At the same time, this effect is more difficult to reconcile with explanations of price variation based solely on persistent differences in bargaining ability across buyers. In this case, input prices need not respond to plausibly exogenous changes in firm's export demand (see Proposition 4).

More broadly, the comparison across columns of Table 10 highlights the importance of accounting for product differentiation. The positive association in column (1) suggests that more productive exporters choose systematically higher-quality suppliers, even within the same country. Controlling for supplier fixed effects and within-supplier differentiation substantially changes the estimated relationship between exporting and input prices, indicating that unobserved product heterogeneity biases estimates of buyer-size discounts toward zero.

Robustness. The evidence of price discrimination based on buyers' outside options is robust to several alternative explanations, including tax-motivated misreporting, the availability of domestic substitutes, and finer product differentiation. Table B7 shows similar patterns of within-seller price variation among the largest taxpayers in Paraguay, for whom incentives to under-report import values are likely lower. Table B8 demonstrates that the results also hold in product categories without observed domestic substitutes based on Paraguay's export data. Finally, Figure B1 shows that the same pricing patterns arise in the highly differentiated market for imported vehicles, even after controlling for detailed product characteristics such as model, trim, year of manufacture, and engine type, in addition to brand, weight, and country of origin.

One mechanism that may facilitate price discrimination is the geographic dispersion of importers, which limits opportunities for arbitrage. To explore this channel, I estimate

[16] Following Hummels et al. (2014), the instrument is constructed as a weighted average of world demand for the firm's exported products across all destination markets other than Paraguay, using firms' 2012 export shares as weights.

Table 10. The effect of exporting on firm's imported input prices

Dependent Variable:	log *Transaction Price*					
	(1) OLS	(2) OLS	(3) OLS	(4) IV	(5) Reduced form	(6) First stage
log *Buyer's Export Sales*	0.048***	-0.000	-0.010	-0.054***		
	(0.017)	(0.013)	(0.017)	(0.017)		
log *World Import Demand*					-0.014**	0.254***
					(0.006)	(0.052)
log *Shipment Quantity*	-0.272***	-0.308***	-0.298***	-0.307***	-0.308***	0.007
	(0.025)	(0.047)	(0.055)	(0.047)	(0.047)	(0.007)
log *Unit Weight*	0.391***	0.423***	0.383***	0.425***	0.423***	0.028
	(0.020)	(0.043)	(0.055)	(0.043)	(0.043)	(0.017)
log *Relationship Length*	0.181***	0.019	-0.024	0.034	0.025	0.182
	(0.066)	(0.046)	(0.036)	(0.049)	(0.046)	(0.259)
ProductxUnitxYearxCountry FE	✓					
ProductxUnitxYearxSeller FE		✓	✓	✓	✓	✓
xOriginxBrand FE			✓			
Buyer's Industry FE	✓	✓	✓	✓	✓	✓
N obs	536,487	41,990	55,306	41,990	41,990	41,990
Adj. R^2	0.906	0.918	0.920	0.248	0.918	0.973
Kleibergen-Paap rk Wald F				23.8		

Robust standard errors clustered at the provider level in parentheses.
* p<0.10, ** p<0.05, *** p<0.01

Notes: The table presents the results of estimating equation (18). Following Hummels et al. (2014), *World Import Demand* for firm's product is constructed as imports of the firm's products by countries it exports to from all other countries weighted by their share in the firm's exports in pre-sample year 2012. Constant not shown.

price elasticities with respect to seller's share in buyer expenditures and buyer quantities separately for sellers whose buyers are located within the same district and across different districts. Figure 5 shows that both elasticities are larger in absolute value when buyers are located in different districts, where arbitrage is likely more costly. This is consistent with inland transportation costs limiting resale opportunities, particularly for smaller buyers (Ignatenko, 2020), thereby increasing sellers' ability to price discriminate.

5 Quantitative importance of market power

5.1 Additional cost advantage of more productive firms

By ruling out alternative explanations, I documented price discrimination based on buyer's productivity-dependent outside options as a new mechanism of within-seller price variation. Now, I assess its relevance across markets and quantify its contribution to input price variation across firms in an industry.

Figure 5. Arbitrage opportunities reduce the extent of price discrimination

Notes: The figure plots price elasticities of interest estimated across two subsamples based on buyers' location in Paraguay.

Firstly, I show that price discrimination can explain within-seller price variation in most imported goods' markets in Paraguay. I estimate seller's price elasticities in equation (16) separately for 12 broad markets and plot them in Figure 6. In line with price discrimination based on buyer's preference for the seller, seller's price elasticity with respect to her share in buyer's expenditures is positive in markets for minerals, textiles, stone, machinery, transport, metals, plastics and wood. In these 8 markets, the negative price elasticity with respect to the buyer's annual purchases from the seller is also consistent with price discrimination based on buyer's outside options. Yet, in markets for minerals, machinery, stone, and wood, it becomes insignificant after accounting for transacted quantity. Hence, in these markets, price discrimination can coexist with transaction-level economies of scale. In contrast, in markets for food and leather, seller's price elasticity with respect to buyer's annual purchases is positive, in line with oligopsonistic markdown variation.

Secondly, I show that price discrimination based on buyer's outside options in inputs markets gives a substantial additional cost advantage of more productive firms in an industry. I compute differences in imported inputs' prices across firms within an industry implied by the differences in their annually purchased quantities, due to price discrimination. I apply the estimated elasticity of -0.028 to the ratio of annually pur-

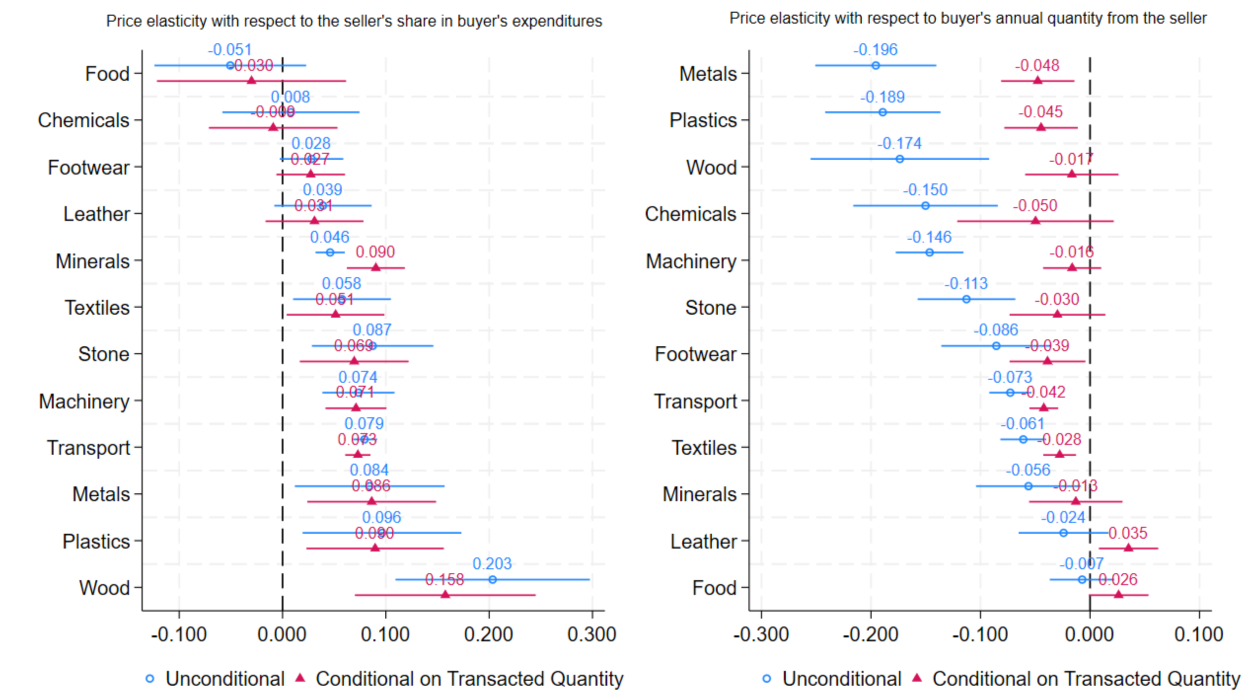


Figure 6. Seller's price elasticities across 12 broad markets

Notes: The figure plots the results of estimating equation (16) across 12 broad markets, accounting and not accounting for transacted (shipment) quantities.

chased quantities in each HS6 market by firms with one supplier in the market at the 75th ($q75$) and 25th ($q25$) percentiles of their distribution within an industry. I plot the distribution of the implied input price differences between thus defined large and small input buyers within an industry across input markets in Figure 7. It shows that in an average input market, firms at the 75th percentile of the distribution of their annually purchased quantities pay 7% lower prices.

5.2 External validity

The presented empirical evidence suggests that in most imported goods' markets in Paraguay price variation is most consistent with seller's ability to price discriminate across buyers differing in their outside options. In other countries, different market structures could be better at explaining the observed within-seller price variation for two reasons. Firstly, other countries could have different composition of imported products that differ in their market structures. Secondly, even in the same product markets, market structures could vary across countries. Here, I address these two main threats to external validity of my

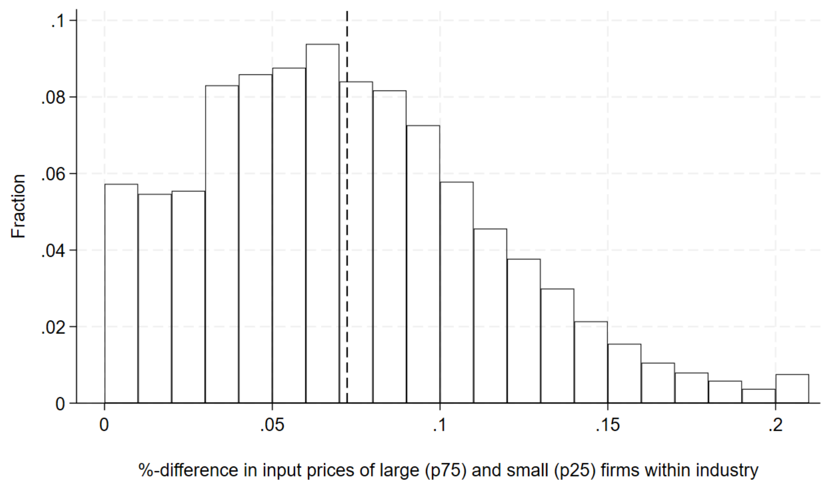


Figure 7. Input price differences across firms with large and small annual purchases from their suppliers

findings and show that they are not specific to Paraguay but instead apply to a broad set of countries and markets.

Figure 8 shows that Paraguay's import composition is broadly similar to that of other countries. It compares the distribution of imports across 12 broad product categories in Paraguay in 2017 to the average across all countries, as well as to Colombia and the United States. These two countries also provide detailed firm-to-firm customs data commonly used in the literature. Paraguay and Colombia both exhibit relatively lower shares of food, animal, and vegetable products and higher shares of machinery compared to the global average. The United States has an even lower share of food-related products, a similarly high share of machinery, and a much larger share of transport equipment.

To assess whether these differences in import composition affect the results, I reweigh Paraguay's data to match the import structure of other countries in Table B9. Specifically, each observation is weighted by the ratio of its product's import share in the comparison country to its share in Paraguay. This leaves within-product relationships unchanged but alters the relative importance of different product categories in the estimation. The results are remarkably similar across weighting schemes, indicating that the main patterns of price variation are not driven by Paraguay's specific import composition. Instead, they reflect more general mechanisms of price variation, most consistent with sellers' price discrimination based on buyers' outside options.

Next, I examine whether market structures in imported goods markets in other countries resemble those in Paraguay. For this, I use Colombia's customs data, which also identifies both buyers and sellers in each import and export transaction, product's HS10

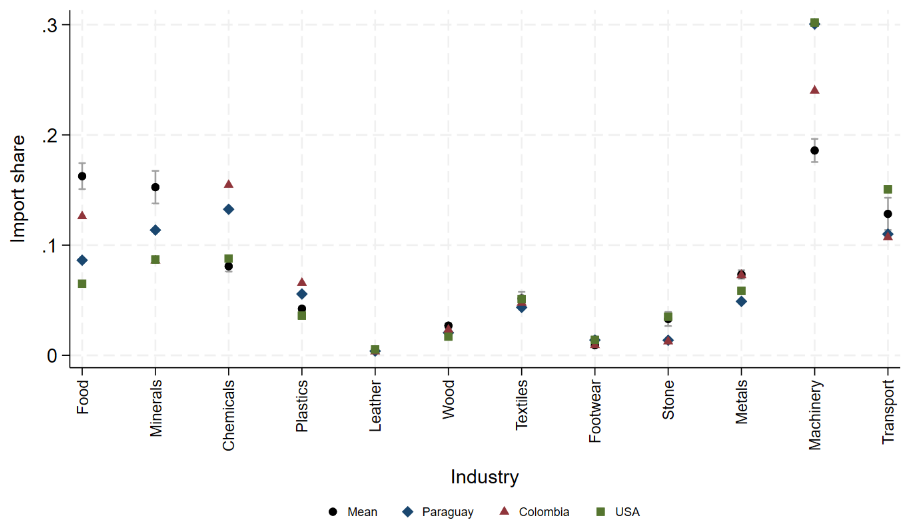


Figure 8. Import composition in Paraguay and other countries, 2017

category, unit of measurement of quantities, country of origin, and net weight. Although it does not report any other product characteristics, it allows me to compare aggregate patterns of within-seller price variation to those established for Paraguay.[17]

In Table 11, I compare patterns of within-seller price variation across importers in Paraguay and Colombia in HS6 product categories imported to both countries. Column (1) shows that, in Colombia, the price elasticity with respect to the seller's share in buyer expenditures is positive, as in Paraguay, but smaller in magnitude. In contrast, the elasticity with respect to buyer quantities is negative and statistically indistinguishable from that in Paraguay. Column (2) focuses on within-relationship variation over time for sellers with only one buyer in HS6 category. The estimated elasticities retain the same signs in both countries, though they are generally smaller in absolute value in Colombia.

Columns (3)–(4) report specifications using standardized regressors to facilitate comparisons across countries and variables. Because the dispersion of firm size and transaction characteristics differs across datasets, coefficients in levels are not directly comparable. Standardizing the regressors places them on a common scale, so coefficients can be interpreted as the effect of a one standard deviation change. The results show that the relative importance of seller's share, buyer size, and shipment characteristics is similar across countries. Overall, these findings suggest that price variation in both Paraguay and Colombia is consistent with seller market power to price discriminate across across buyers with different outside options.

[17]Not accounting for product's brands and commercial descriptions is shown to bias price elasticities of interests towards zero (see Tables 6 and 8).

Table 11. Comparison of price variation patterns in Paraguay's and Colombia's imports

Dependent Variable:	log *Transaction Price*			
	(1)	(2)	(3)	(4)
	Levels	Levels	Standardized	Standardized
log *Seller's Share*	0.118***	0.257***	0.156***	0.339***
	(0.010)	(0.012)	(0.013)	(0.016)
log *Seller's Share* × *Colombia*	-0.040***	-0.128***	-0.046***	-0.159***
	(0.010)	(0.014)	(0.014)	(0.018)
log *Buyer's Quantity*	-0.055***	-0.116***	-0.213***	-0.439***
	(0.010)	(0.012)	(0.038)	(0.045)
log *Buyer's Quantity* × *Colombia*	0.007	0.046***	0.031	0.181***
	(0.011)	(0.014)	(0.043)	(0.053)
log *Shipment Quantity*	-0.206***	-0.210***	-0.685***	-0.695***
	(0.010)	(0.015)	(0.033)	(0.050)
log *Shipment Quantity* × *Colombia*	0.087***	0.084***	0.285***	0.275***
	(0.014)	(0.020)	(0.046)	(0.066)
log *Net Weight/Unit*	0.393***	0.364***	1.116***	1.034***
	(0.015)	(0.018)	(0.044)	(0.050)
log *Net Weight/Unit* × *Colombia*	0.275***	0.294***	0.438***	0.498***
	(0.019)	(0.021)	(0.050)	(0.057)
SellerxProductxUnitxOriginxYear FE	✓		✓	
Buyer FE	✓		✓	
BuyerxSellerxProductxUnitxOrigin FE		✓		✓
SellerxYear FE		✓		✓
HS6xUnitxYear FE		✓		✓
N obs	2,821,490	1,742,248	2,821,490	1,742,248
Adj. R^2	0.957	0.949	0.957	0.949

Robust standard errors clustered at importer- and seller-levels in parentheses.
* p<0.10, ** p<0.05, *** p<0.01

Notes: The table presents the results of estimating equation (16) using a pooled sample of Paraguay's and Colombia's firm-to-firm import transactions. Columns (3)–(4) use standardized regressors. Constant not shown.

In Figure 9, I further show that this mechanism extends to U.S. importers, at least in some markets. I analyze Colombian exporters' transactions with importers in the U.S, which account for roughly 20% of all Colombia's export transactions. I estimate price elasticities of interest for U.S. importers from Colombia, using either variation across buyers of the same exporter or over-time variation within single-buyer exporters. Both identification strategies yield the same result: in U.S. imports from Colombia, prices increase with the seller's share in buyer expenditures and decrease with the buyer's purchased quantities. The magnitudes of these elasticities are similar to those estimated for other destinations of Colombian exports and to those obtained using Paraguayan import data. They remain robust to reweighting the sample to match the U.S. import structure.

Price elasticities estimated from within-seller variation across U.S. buyers without additional controls in Figure 9a are consistent with the estimates of buyer power in the

(a) Exporters with multiple buyers in a market (b) Exporters with one buyer in a market

Figure 9. Pattern of within-seller price variation in Colombia's export transactions

Notes: The figure plots price elasticities estimated using equation (16) in Colombia's firm-to-firm export transactions with the U.S. and other countries.

bargaining framework of Alviarez et al. (2021a)[18]. At the same time, price elasticities estimated using over-time variation within single-buyer exporters in Figure 9b point to a different mechanism. Because this specification holds fixed the identity of the buyer, it abstracts from differences in bargaining weights across buyers, and instead captures within-relationship price changes with buyer expansion. These elasticities therefore provide direct evidence of price discrimination based on buyers' outside options.

6 Conclusions

This paper studies what transaction-level price variation within narrowly defined product categories reveals about market structure in international trade. Using highly detailed customs data, I show that once product differentiation is carefully accounted for, residual price dispersion contains systematic information about the sources of market power in buyer–seller relationships. I develop a theoretical framework and an empirical strategy that allow market structures to be inferred across a broad range of industries without requiring detailed institutional knowledge of individual markets.

Applying this framework to imported-goods markets in Paraguay, I find that observed pricing patterns are difficult to reconcile with pure oligopsony or buyer-specific bargaining ability alone. Instead, the evidence points to price discrimination by oligopolistic sellers across buyers with different outside options. Larger buyers obtain lower prices not simply because they bargain more effectively, but because their scale improves their

[18] Price elasticities estimated without controls for shipment size in Figure 9a are close to but smaller than those in Alviarez et al. (2021a), who use all U.S. import transactions.

ability to substitute across suppliers. Consistent with this mechanism, larger discounts arise in more competitive markets and strengthen when buyers' outside options improve through export growth.

Finally, the findings imply that the gains from trade and international competition as well as the incidence of trade policy may differ systematically across firms with different access to alternative suppliers. Incorporating these heterogeneous market structures into quantitative models of trade and welfare is a promising direction for future research.

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A Online Theory Appendix (not for publication)

A.1 Proof of Proposition 1

Under oligopoly, seller k of input j maximizes the following profits:

$$\pi_{jk} = \int_{\varphi \in \Omega_{jk}} \left(p_{jk}(\varphi) - \frac{m_{jk}(\varphi)^{1/\gamma_j} w}{a_k^{1/\gamma_j}} \right) m_{jk}(\varphi) d\varphi \tag{19}$$

where Ω_{jk} denotes a set of buyers purchasing product j from upstream firm k. Since in this environment buyers are price takers, they determine their demand for input j from a cost-minimization problem taking its price as given. Solving the first-order conditions separately for each buyer yields a buyer-specific price as a product of seller's costs and mark-up in (8). The mark-up, in turn, is a function of the elasticity of input demand, which is derived from the buyer's cost minimization problem:

$$\min_{m_{j,k} \forall j,k} \sum_{k=1}^{N_m} p_{jk} m_{jk} \quad \text{subject to} \quad \left(\sum_{k=1} \delta_{jk}(\varphi) m_{jk}^{\frac{\eta_j - 1}{\eta_j}} \right)^{\frac{\eta_j}{\eta_j - 1}} \geq m_s(\varphi),$$

where $m_s(\varphi)$ is aggregate demand for inputs in sector s. Solving this problem yields:

$$m_{jk}(\varphi) = \delta_{jk}(\varphi)^{n_j} \left(\frac{p_{jk}(\varphi)}{\mathbb{P}_j(\varphi)} \right)^{-\eta_j} m_s(\varphi),$$

where $\mathbb{P}_j(\varphi) \equiv \left(\sum_{n=1}^{N_m} \delta_{jk}(\varphi)^{\eta_j} p_{jk}^{1-n_j}(\varphi) \right)^{\frac{1}{1-n_j}}$ is input j's price index faced by downstream buyer φ. The aggregate demand for inputs from sector s is, in turn, a solution to the following cost-minimization problem:

$$\min_{m_s(\varphi) \forall s} \sum_{j \in N_s} \mathbb{P}_j(\varphi) m_s(\varphi) \quad \text{subject to} \quad \left(\sum_{j \in N_s} m_j(\varphi)^{\frac{\theta_s - 1}{\theta_s}} \right)^{\frac{\theta_s}{\theta_s - 1}} \geq M_s(\varphi), \tag{20}$$

where $M_s(\varphi)$ is aggregate quantity of material inputs purchased by buyer φ. Solving this problem yields

$$m_s(\varphi) = \left(\frac{\mathbb{P}_j(\varphi)}{\mathbb{J}_s(\varphi)} \right)^{-\theta_s} M_s(\varphi), \tag{21}$$

where $\mathbb{J}_s(\varphi) \equiv \left(\sum_{j\in N_s} \mathbb{P}_j(\varphi)^{1-\theta_s}\right)^{\frac{1}{1-\theta_j}}$ is the material inputs' price index faced by buyer φ. It depends on the aggregate demand for material inputs, $M_s(\varphi)$, which is a solution to the firm's problem of choosing between material inputs and labor to minimize its costs:

$$\min_{L,M_s(\varphi)} \quad wL + \mathbb{J}_s(\varphi)M_s(\varphi) \quad \text{subject to} \quad \varphi L_s^{\alpha_s} M_s^{1-\alpha_s}(\varphi) \geq q_s(\varphi),$$

where $q_s(\varphi)$ is the demand for firm's φ product in its output industry s in (3). Plugging the solution to this problem into (21), and then (21) yields the derived demand for input j from firm φ:

$$m_{jk}(\varphi) = \delta_{jk}(\varphi)^{\eta_j}\varphi^{\sigma_s-1}p_{jk}(\varphi)^{-\eta_j}\mathbb{P}_j(\varphi)^{\eta_j-\theta_s}\mathbb{J}_s(\varphi)^{(1-\alpha_s)(1-\sigma_s)+\theta_s-1}A_s,$$

$$\mathbb{P}_j(\varphi) \equiv \left(\sum_{n=1}^{N_m} \delta_{jk}(\varphi)^{\eta_j} p_{jk}^{1-n_j}(\varphi)\right)^{\frac{1}{1-n_j}}, \quad \mathbb{J}_s(\varphi) \equiv \left(\sum_{j\in N_s} \mathbb{P}_j(\varphi)^{1-\theta_s}\right)^{\frac{1}{1-\theta_j}}$$

$$A_s \equiv \beta_s E\mathbb{P}_s^{\sigma_s-1}\left(\frac{\sigma_s}{\sigma_s-1}\right)^{-\sigma_s}\left(\frac{w}{\alpha_s}\right)^{\alpha_s(1-\sigma_s)}(1-\alpha_s)^{1-(1-\alpha_s)(1-\sigma_s)}$$

As in Atkeson and Burstein (2008), oligopolists internalize the effect of their pricing decisions on their downstream buyers' costs when assessing their input demand elasticity. Log-linearizing this derived demand and then taking the derivative with respect to log $p_{jk}(\varphi)$ then yields input demand elasticities in (9). They are functions of seller's share in buyer's input j expenditures and in buyer's total expenditures on material inputs, $s_{jk}^J(\varphi) \equiv \frac{p_{jk}(\varphi)m_{jk}(\varphi)}{\sum_{n=1}^{N_m} p_{jk}(\varphi)m_{jk}(\varphi)}$ and $s_J^M(\varphi) \equiv \frac{\mathbb{P}_j(\varphi)m_j(\varphi)}{\sum_{j\in N_s}\mathbb{P}_j(\varphi)m_j(\varphi)}$, respectively.

Buyers will find it profitable to have multiple suppliers in an input market, when their profits from having them (denoted with "′′") exceed their profits when having only one (denoted with "′"):

$$\pi_s^{'}(\varphi) = \beta_s \mathbb{E}\mathbb{P}_s^{\sigma_s-1}\left(\frac{\sigma_s}{\sigma_s-1}\right)^{1-\sigma_s}\varphi^{\sigma_s-1}\left(\frac{w}{1-\alpha_s}\right)^{\alpha_s(1-\sigma_s)}\left(\frac{\mathbb{J}_s^{'}(\varphi)}{\alpha_s}\right)^{(1-\alpha_s)(1-\sigma_s)}$$

$$\pi_s^{''}(\varphi) = \beta_s \mathbb{E}\mathbb{P}_s^{\sigma_s-1}\left(\frac{\sigma_s}{\sigma_s-1}\right)^{1-\sigma_s}\varphi^{\sigma_s-1}\left(\frac{w}{1-\alpha_s}\right)^{\alpha_s(1-\sigma_s)}\left(\frac{\mathbb{J}_s^{''}(\varphi)}{\alpha_s}\right)^{(1-\alpha_s)(1-\sigma_s)} - f_j w$$

Re-arranging the condition that $\pi_s^{''}(\varphi) > \pi_s^{'}(\varphi)$ results in condition in (11), where $B_s \equiv \frac{\beta_s}{\sigma_s} E\mathbb{P}_s^{\sigma_s-1}\left(\frac{\sigma_s}{\sigma_s-1}\right)^{1-\sigma_s}\left(\frac{w}{1-\alpha_s}\right)^{\alpha_s(1-\sigma_s)}\alpha_s^{(\sigma_s-1)(1-\alpha_s)}$.

To interpret this condition, I use insights from Feenstra (1994) and re-write the change in buyer's marginal costs after adding suppliers of input j as[19]

$$\frac{\mathbb{J}_s''(\varphi)}{\mathbb{J}_s'(\varphi)} = \left(\frac{p_{jk}''(\varphi)}{p_{jk}'(\varphi)}\right)^{\omega_j''(\varphi)} \left(s_{jk}^{J''}(\varphi)\right)^{\frac{\omega_j''(\varphi)}{\eta_j - 1}}, \tag{22}$$

$s_{jk}^{J''}(\varphi)$ is a share of seller k in buyer's expenditures on input j defined in (9); and $\omega_j''(\varphi)$ is a Sato-Vartia (log-change) weight defined as:

$$\omega_j''(\varphi) \equiv \frac{\left(s_j^{M''}(\varphi) - s_j^{M'}(\varphi)\right) / \left(\log s_j^{M''}(\varphi) - \log s_j^{M'}(\varphi)\right)}{\sum_{i \in N_s} \left(s_i^{M''}(\varphi) - s_i^{M'}(\varphi)\right) / \left(\log s_i^{M''}(\varphi) - \log s_i^{M'}(\varphi)\right)}$$

The first component on the right-hand side of (22) reflects the reduction in seller k's price of input j after the buyer adds other suppliers of that input, while the second component takes into account a positive effect of the growth of input varieties on buyer's productivity. When a buyer starts purchasing an input from multiple suppliers, then seller k's share in buyer's expenditures on that input falls from one to $s_{jk}^{J''}(\varphi) < 1$, and the larger this reduction, the larger the variety gains of productivity for the buyer. Unsurprisingly, these variety gains disappear when seller differentiation within industry goes down or, in other words, when their products become perfectly substitutable ($\eta_j \to +\infty$).

A.2 Proof of Proposition 2

Under oligopsony, input buyer φ chooses material inputs and labor, to solve the following profit-maximization problem:

$$\pi_s(\varphi) = p_s(\varphi) q_s(\varphi) - w L_s(\varphi) - \sum_{j \in N_s} p_j(m_j(\varphi)) m_j(\varphi), \tag{23}$$

subject to the final consumers' demand in (3), downstream technology in (4) - (6), and internalizing the effect of an increase in input quantity on sellers' average costs $p_j(m_j(\varphi)) = \frac{w m_j(\varphi)^{1/\gamma_j - 1}}{a^{1/\gamma_j}}$. Firm's profits can be re-written as a function of input quantities and their prices as:

$$\pi_s(\varphi) = \beta_s E \mathbb{P}_s^{\frac{1}{\sigma_s}} \varphi^{\frac{\sigma_s - 1}{\sigma_s}} L_s^{\alpha_s \frac{\sigma_s - 1}{\sigma_s}} M_s(\varphi)^{(1-\alpha_s)\frac{\sigma_s - 1}{\sigma_s}} - w L_s - \sum_{j \in N_s} p_j(m_j(\varphi)) m_j(\varphi)$$

[19] Here I follow Amiti et al. (2020) in assuming that a buyer's taste for a given seller in an input market does not depend on the number of sellers the buyer sources this input from.

As in Berger et al. (2019), I first solve firm's problem maximization problem with respect to labor:

$$L_s(\varphi) = \Lambda_s \tilde{\varphi} \tilde{M}_s^{1-\alpha_s},$$

where $\Lambda_s \equiv \left(\frac{1}{(\beta_s \mathbb{E}\mathbb{P}_s^{\sigma_s - 1})^{\frac{1}{\sigma_s}}} \frac{\sigma_s}{w\alpha_s(\sigma_s - 1)} \right)^{\frac{1}{\alpha_s(\frac{\sigma_s-1}{\sigma_s}-1)}}$, $\tilde{\varphi} \equiv \varphi^{\frac{1-1/\sigma_s}{1-\alpha_s(1-1/\sigma_s)}}$, and $\tilde{M}_s(\tilde{\varphi}) \equiv M_s(\varphi)^{\frac{1-1/\sigma_s}{1-\alpha_s \frac{\sigma_s-1}{\sigma_s}}}$. Plugging this expression in oligopsonist's profit function (23, yields the profit function net of labor expenses.

Having chosen labor, buyer φ chooses input quantity that equalizes its marginal revenue product[20] with its marginal costs. The equilibrium input price $p_{jk}(\varphi)$ is then determined from an upward-sloping seller's average cost curve at the equilibrium quantity:

$$(1-\alpha_s)\tilde{A}_s \tilde{\varphi} \tilde{M}_s(\tilde{\varphi})^{-\alpha_s} \left(\frac{m_{jk}(\tilde{\varphi})}{\tilde{M}_s(\tilde{\varphi})} \right)^{-1/\theta_s} = \frac{\partial p_{jk}(\tilde{\varphi})}{\partial m_{jk}(\tilde{\varphi})} m_{jk}(\tilde{\varphi}) + p_{jk}(\tilde{\varphi}) \tag{24}$$

where $\tilde{\varphi} \equiv \varphi^{\frac{1-1/\sigma_s}{1-\alpha_s(1-1/\sigma_s)}}$, $\tilde{M}_s(\tilde{\varphi}) \equiv M_s(\varphi)^{\frac{1-1/\sigma_s}{1-\alpha_s(1-1/\sigma_s)}}$, and $\tilde{A}_s$ is a sector-specific demand shifter:

$$\tilde{A}_s \equiv (1-\alpha_s) \left((\beta_s \mathbb{E}\mathbb{P}_s^{\sigma_s - 1})^{1/\sigma_s} \frac{\sigma_s - 1}{\sigma_s} (w/\alpha_s)^{-\alpha_s(1-1/\sigma_s)} \right)^{\frac{1}{1-\alpha_s(1-1/\sigma_s)}}$$

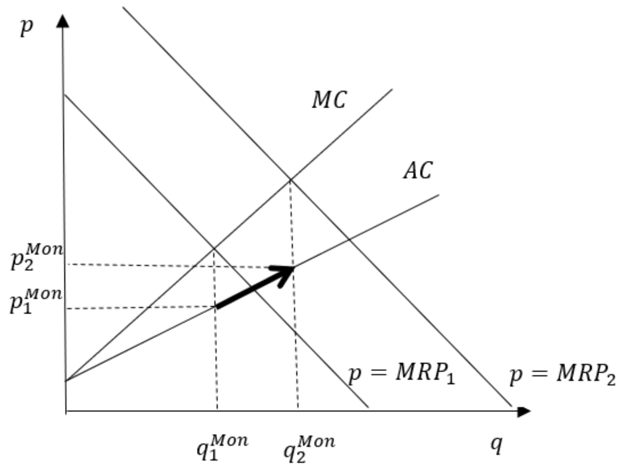
. As a result, the equilibrium input price can be written as in equation (12):

$$p_{jk}(\varphi) = \underbrace{\tilde{A}_s \tilde{\varphi} \tilde{M}_s(\tilde{\varphi})^{-\alpha_s} \left(\frac{m_{jk}(\tilde{\varphi})}{\tilde{M}_s(\tilde{\varphi})} \right)^{-1/\theta_s}}_{MRP_{jk}(\varphi)} \underbrace{\left(1 + \frac{\partial p_{jk}(\tilde{\varphi})}{\partial m_{jk}(\tilde{\varphi})} \frac{m_{jk}(\tilde{\varphi})}{p_{jk}(\tilde{\varphi})} \right)^{-1}}_{markdown_{jk}(\varphi)}. \tag{25}$$

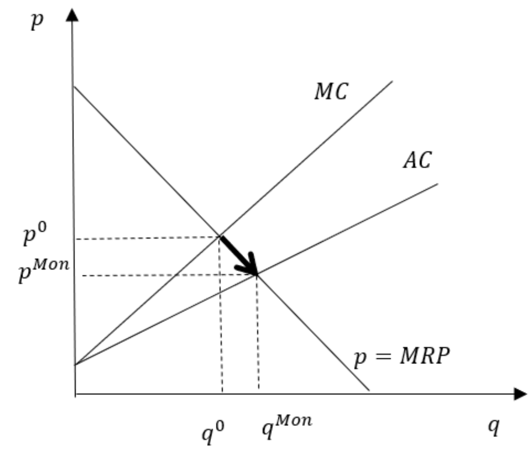
From here, it is easy to see that buyer's productivity, φ shifts out the marginal revenue product. It also affects the markdown: more productive buyers are paying higher markdowns relative to the perfectly competitive prices. However, because in equilibrium, under classic oligopsony, prices are on the seller's upward sloping average cost curve, they increase with the buyer's productivity.

Alternative oligopsony model Figure A1 compares the determination of the equilibrium prices under the classic oligopsony discussed above and the oligopsony mechanism in Alviarez et al. (2021a). Under classic oligopsony, equilibrium quantities are found at the intersection of the buyer's marginal revenue product and the seller's marginal costs. Then equilibrium prices are set equal to the seller's average costs at this equilibrium quantity. Figure A2a shows that when a classic monopsonist becomes more productive,

[20] To be precise, this is marginal revenue net of labor expenses, as in Berger et al. (2019).



(a) Classic oligopsony



(b) Oligopsony in Alviarez et al. (2021a)

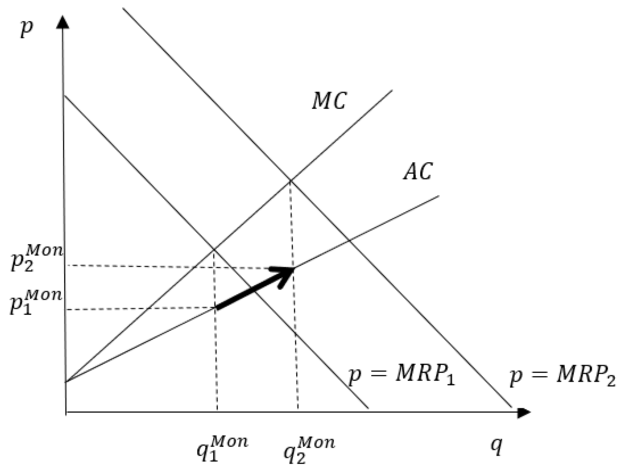
Figure A1. Price variation under oligopsony

Notes: The figure illustrate equilibrium price variation under various forms of oligopsony. The downward sloping lines represent oligopsonists' marginal revenue products that act as demand curves. The upward sloping lines are the seller's marginal and average cost curves. The arrows represent the direction of equilibrium price changes when buyer's productivity in (a) or buyer's quantity share in the seller's output in (b) increase.

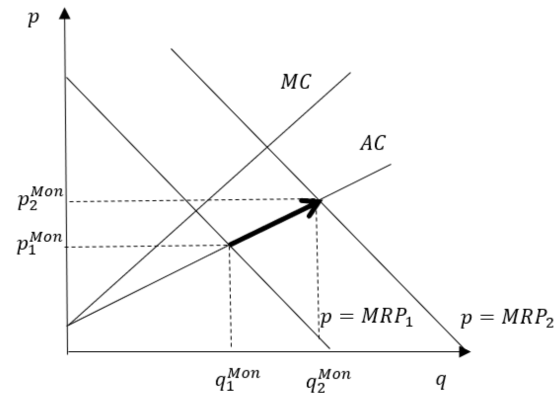
her marginal revenue product shifts out and equilibrium price increases, moving up the average cost curve.

In contrast, under oligopsony in Alviarez et al. (2021a), equilibrium prices are found at the intersection of the buyer's demand (marginal revenue product) and the seller's average costs. When the buyer's quantity share in the seller's output is close to zero, the price is equal to the seller's marginal costs. When the buyer is a monopsonist with quantity share close to unity, the price is the lowest and equal to the seller's average costs. Therefore, as illustrated in Figure A1b, an increase in the quantity share of the buyer in the seller's output lowers the price, moving down the demand curve (marginal revenue product).

However, both models of oligopsony predict the same pattern of price changes in response to an increase in the monopsonist's demand, for example, after an increase in its productivity. Figure shows that this shifts out the monopsonist's marginal revenue product and increases the supplier's average costs curve. Since for the monopsonist, prices in both oligopsony models are equal to the seller's average costs, they increase in the new equilibrium.



(a) Classic oligopsony



(b) Oligopsony in Alviarez et al. (2021a)

Figure A2. Price change in response to the monopsonist's productivity under oligopsony

Notes: The figure illustrates a change in equilibrium prices in response to a monopsonist's productivity. The downward sloping lines represent the monopsonist's marginal revenue product that acts as demand curves. The upward-sloping lines are the seller's marginal and average cost curves. The arrows represent the direction of equilibrium price changes when buyer's productivity increases.

A.3 Proof of Proposition 3

Environment and Equilibrium Concept. I model price determination using a Nash-in-Nash bargaining framework with multiple buyers and suppliers simultaneously negotiating bilateral prices. Each buyer may source from multiple suppliers and each supplier may sell to multiple buyers. Bilateral negotiations are conducted simultaneously and each buyer–supplier pair takes all other trading relationships and negotiated prices as given.

The equilibrium concept follows the standard Nash-in-Nash bargaining framework. For a given buyer–supplier pair, the negotiated price maximizes the Nash product of the buyer's and supplier's incremental gains from trade relative to the disagreement outcome in which the focal relationship is severed while all other trading relationships remain active. Consequently, if negotiations between buyer φ and supplier k fail, buyer φ continues sourcing from its remaining suppliers and supplier k continues to sell to its remaining buyers.

Buyer and Seller Surpluses. Let $\Pi^B(N_j;\varphi)$ denote buyer φ's profits when sourcing from the set of suppliers N_j, and let $\Pi^S(\Omega_k;a_k)$ denote supplier k's profits when selling to the set of buyers Ω_k. The buyer's incremental surplus from reaching an agreement with supplier k is:

$$\Delta\Pi^B(p_{jk};\varphi) = \Pi^B(N_j;\varphi) - \Pi^B(N_j\backslash k;\varphi), \tag{26}$$

where $N_j\backslash k$ denotes the set of suppliers excluding supplier k.

Analogously, the supplier's incremental surplus from trading with buyer φ is:

$$\Delta\Pi^S(p_{jk};a_k) = \Pi^S(\Omega_k;a_k) - \Pi^S(\Omega_k\backslash\varphi;a_k), \tag{27}$$

where $\Omega_k\backslash\varphi$ denotes the set of buyers excluding buyer φ.

Using the production structure described in Section 2.5.3, these surpluses can be written as:

$$\Delta\Pi^B(p_{jk}) = B_s\varphi^{\sigma_s-1}\left\{\mathbb{J}_s(p_{jk})^{(1-\alpha_s)(1-\sigma_s)} - \mathbb{J}_s(p_{jk'})^{(1-\alpha_s)(1-\sigma_s)}\right\}$$
$$\Delta\Pi^S(p_{jk}) = \left(p_{jk} - \frac{wm_{jk}(p_{jk})^{1/\gamma_j-1}}{\gamma_j a_k^{1/\gamma_j}}\right)m_{jk}(p_{jk}),$$

where $\mathbb{J}_s(p_{jk'})$ are unit input costs when buyer φ and seller k fail to reach agreement over input j's price.

Derivation of the Bargained Price. The negotiated price solves:

$$\max_{p_{jk}}\left[\Delta\Pi^B(N_j;\varphi)\right]^{\kappa_k(\varphi)}\left[\Delta\Pi^S(\Omega_k;a_k)\right]^{1-\kappa_k(\varphi)} \tag{28}$$

where firms' extra profits from successful negotiations can be written as: First-order conditions for this problem expressed in logs are as follows:

$$\kappa_k(\varphi)\frac{\frac{\partial\pi^B(p_{jk})}{\partial p_{jk}}}{\Delta\Pi^B(N_j;\varphi)} + (1-\kappa_k(\varphi))\frac{\frac{\partial\pi^S(p_{jk})}{\partial p_{jk}}}{\Delta\Pi^S(\Omega_k;a_k)} = 0$$

Re-arranging the terms, one can get:

$$\frac{\partial\pi^B(p_{jk})/\partial p_{jk}}{\partial\pi^S(p_{jk})/\partial p_{jk}} = \frac{1-\kappa_k(\varphi)}{\kappa_k(\varphi)}\frac{\Delta\Pi^B(N_j;\varphi)}{\Delta\Pi^S(\Omega_k;a_k)}$$

Plugging in expression for $\Delta\Pi^B(N_j;\varphi)$ and $\Delta\Pi^S(\Omega_k;a_k)$ and solving for price yields the expression in the main text:

$$p_{jk}(\varphi) = \gamma_j mc_{jk}(\varphi) + \frac{\Delta\tilde{\Pi}^B(p_{jk}(\varphi);\varphi)}{\bar{\kappa}_k(\varphi)}\left(1 - \zeta_{jk}(\varphi) + \frac{mc_{jk}(\varphi)}{p_{jk}(\varphi)}\zeta_{jk}(\varphi)\right) \tag{29}$$

This pricing equation suggests four sources of within-supplier price variation: (i) supplier's marginal costs $mc_{jk}(\varphi)$, (ii) final goods' producer's input demand elasticity $\zeta_{jk}(\varphi)$, (iii) final goods' producer's (relative) bargaining ability $\bar{\kappa}_k(\varphi) \equiv \kappa_k(\varphi)/(1-\kappa_k(\varphi))$; and (iv) final goods' producer's surplus per unit of input $\Delta\tilde{\Pi}^B(p_{jk}(\varphi);\varphi) \equiv \Delta\Pi^B(p_{jk}(\varphi);\varphi)/m_{jk}(\varphi)$.

A.4 Proof of Proposition 4

In oligopolistic markets, a reduction in the foreign country's tariffs or domestic firm's entry into a foreign market lead to an increase in the domestic firm's derived demand for inputs.

$$m_{jk}(\varphi) = \delta_{jk}(\varphi)^{\eta_j}\varphi^{\sigma_s-1}p_{jk}(\varphi)^{-\eta_j}\mathbb{P}_j(\varphi)^{\eta_j-\theta_s}\mathbb{J}_s(\varphi)^{(1-\alpha_s)(1-\sigma_s)+\theta_s-1}A_s^*(\varphi)$$

Here, $A_s^*(\varphi) \equiv A_s\left(1+\mathbb{1}_x(\varphi)\tau_s^{-\sigma_s}\left(\mathbb{P}_s^*/\mathbb{P}_s\right)^{\sigma_s-1}E^*/E\right) > A_s$ captures an increase in firm's input demand following its decision to export ($\mathbb{1}_x(\varphi)=1$) or a reduction of the foreign country's tariff τ_s.

If, in oligopolistic markets, buyers are price takers, their input demand elasticities for a seller's product in (9 and hence mark-ups are determined by the seller's share in the buyer's expenditures. As shown in (**??**), these shares do not vary with the total demand of the buyer for the seller's product. Therefore, in this case, a reduction in foreign country's tariffs or a domestic firm's entry into a foreign market does not affect its input prices.

In contrast, if, in oligopolistic markets, exogenously larger (more productive) buyers can affect prices through outside options, an input demand shifter $A^* > A$ encourages buyers to make costly investments in getting better outside options. Condition in (11) that needs to be satisfied for a buyer to get more suppliers in a market when exporting by domestic firms is possible becomes:

$$B_s^*(\varphi)\varphi^{\sigma_s-1}\mathbb{J}_s'(\varphi)^{(1-\alpha_s)(1-\sigma_s)}\left\{\left(\frac{\mathbb{J}_s''(\varphi)}{\mathbb{J}_s'(\varphi)}\right)^{(1-\alpha_s)(1-\sigma_s)}-1\right\} > f_j w,$$

where $B_s^*(\varphi) \equiv B_s\left(1+\mathbb{1}_x(\varphi)\tau_{fs}^{-\sigma_s}\epsilon_f^{\sigma_s}\left(\mathbb{P}_{fs}/\mathbb{P}_s\right)^{\sigma_s-1}E_f/E\right) > B_s$ if $A_s^*(\varphi) > A_s$. As a result, for initially large enough domestic firms, better exporting opportunities allows them to get lower prices from their existing suppliers. Under oligopsony, a reduction in the foreign country's tariffs or domestic firm's entry into a foreign market lead to an increase in the oligopsonist's marginal revenue product of each input. It increases the value of the expression on the right-hand side of (12), which can be re-written as:

$$(1-\alpha_s)\tilde{A}_s^*\tilde{\varphi}\tilde{M}_s(\tilde{\varphi})^{-\alpha_s}\left(\frac{m_j(\tilde{\varphi})}{\tilde{M}_s(\tilde{\varphi})}\right)^{-1/\theta_s} = \frac{\partial p_j(\tilde{\varphi})}{\partial m_j(\tilde{\varphi})}m_j(\tilde{\varphi}) + p_j(\tilde{\varphi}) \tag{30}$$

Here, $\tilde{A}_s^* = \tilde{A}_s\Big(1 + \mathbb{1}_x(\varphi)\tau_s^{-\sigma_s}(\mathbb{P}_s^*/\mathbb{P}_s)^{\sigma_s-1}E^*/E\Big)^{\frac{1}{\sigma_s(1-\alpha_s)+\alpha_s}} > \tilde{A}_s$ captures an increase in the marginal revenue product of an oligopsonist that decides to export or experiences a reduction of the foreign country's tariff.

For the oligopsonistic market to reach a new equilibrium, marginal costs on the left-hand side of (30) should increase to balance an increased marginal product revenue of an oligopsonist. Because, under oligopsony, marginal and average costs are assumed to increase in quantities, it means that in the new equilibrium, an oligopsonist purchases more units of each input. Because sellers are perfectly competitive and set prices equal to their average costs it results in higher prices charged to the oligopsonist.

B Online Data Appendix (not for publication)

B.1 Cleaning

Textual analysis of firm and brand names

Before cleaning company names reported in Paraguayan customs data, I used them to identify trade intermediaries on both buyer and seller sides. For that, I used Stata's regular expressions (*regex*) to look for words common for trade intermediaries in their names: export, import, trading, exportadora, importadora, exp, imp, etc. To identify wholesalers and retailers among Paraguayan importers, I merged their names with names of Paraguayan companies in the Orbis data, which reports companies' main NACE industries. Wholesalers and retailers are firms operating mainly in 2-digit NACE industries "46" and "47", respectively.

To standardize foreign seller names, I first clean the reported names from commonly used legal abbreviations (Ltd., Limited, Incorportated, LLC, GMBH, Group, Company, Holding, etc), names of their countries (reported separately in the data) and names of largest world cities. I also removed word indicators of trade intermediaries (exp, imp, trading, etc.) discussed above.

Then, to correct spelling mistakes in seller names, I calculated a similarity score between every two cleaned company names, using Stata's *matchit* function. This similarity score ranges from 0 to 1, where a score of 1 implies a perfect similarity between two strings, according to the chosen string matching technique. I started with the strictest *token* technique, for which I used the threshold similarity score value of 0.9 to identify the two names as the same. This resulted in clusters of firms with very similar names, to which I assign a common name. Then to these common names I sequentially applied other techniques in the order of their strictness: *circular fourgram-*, *threegram-*, *fivegram-*, and *bigram-*. Each time I assigned a common name to firms with a similarity score above 0.75 and proceeded by matching the resulting names with another method. This procedure allowed me to substantially reduce the number of unique seller names from 255 278 to 89 365.

I apply the same procedure to clean and standardize reported brand names too.

Definitions of regular sellers and brands

I identify a foreign seller with its unique name (cleaned and standardized) and a reported country from which a good is exported to Paraguay. This way, each location of a multinational firm is treated as a separate firm. Then I define a regular (or frequent) seller to Paraguay as a foreign seller with at least 1000 recorded transactions throughout the sample period. For these regular sellers, I manually checked that the variations of each regular seller's name in the original data were indeed due to spelling mistakes and that my textual analysis correctly identified them as the same seller.

I define a regular (or frequent) brand name as a cleaned brand name which appears in at least 300 transactions in my sample. For these regular brands, I also manually checked that a common brand name assigned to initially differently spelled brands only corrected misspelling in the original brand names.

Units of measurement

I assigned kilograms to products whose HS6 code is suggested to be reported in kilograms in the Mercosur Nomenclature. Moreover, I assign kilograms as the units of measurement to transactions, whose reported unit of measurement is not kilograms but whose commercial quantity was equal to the reported (gross or net) weight. All other products were assigned the reported unit of measurement cleaned from typos.

Intra-firm transactions and multinational affiliates

In absence of an indicator for intra-firm transactions in my data, I infer them from the available names of transacting firms and brands of transacted products. First, for each transaction, I check whether a cleaned and standardized seller name appears as a part of an importer's name. This way I detect transactions between, for example, "Unilever de Paraguay" and "Unilever de Brazil", "Unilever de Uruguay", "Unilever de Argentina; "Yazaki do Brasil" and "Yazaki de Paraguay"; "Tetra Pak" and "Tetra Pak Paraguay". Secondly, I check whether a cleaned and standardized brand name appears as a part of an importer's name. The idea behind this step is that a foreign seller will not be producing a product under its buyer's name unless they are in the long-term relationships that potentially involve common ownership. This helps me identify transactions between related parties whose names do not have anything in common. And finally, I identify as intra-firm trade transactions between firms with common ownership, according to the information available in the Orbis ownership data. As a result of this procedure, around 6% of all import transactions in Paraguayan customs data are classified as intra-firm transactions.

Furthermore, I define an importer as a multinational affiliate if it has intra-firm transactions with at least one foreign seller to Paraguay. Analogously, I define a foreign seller as a multinational affiliate if has at least one intra-firm transaction.

Definitions of industries

Importers' industries are defined as their main NACE industry classification codes.

Textual analysis of commercial descriptions

Importers are obliged to provide non-generic product descriptions in a free format. To achieve some standardization of them, I first clean them of all information that is provided separately: seller names, countries of purchase, countries of origin, brand names, quantities (in numbers and in words), units of measurement, and weight. I also removed all Spanish, Portuguese, and English articles and propositions, and verbs such as "includes", "contains", etc. Table B1 provides examples of cleaned brand names, and product descriptions.

Table B1. Examples of cleaned and standardized brands and commercial descriptions of imported products in the Paraguay's customs data (translated from Spanish)

HS code	Description	Brand
32149000	Mortar type ACI 20 kg bag	Votorantim
32149000	Mortar type ACI 20 kg bag	Quartzolit
33021000	Acid solution colorants	Coca-Cola
33021000	Aspartame	Coca-Cola
33051000	Shampoo Keratin Lift x 960cc	Question Professional
33051000	Shampoo Nutrition 960cc	Question Professional
33051000	Shampoo Retention 960cc	Question Professional
84833029	Vehicle bearings	Ford
84833029	Vehicle bearings	Toyota
87019490	Tractor model A990 4x4 yellow 2017	Valtra
87019490	Tractor model A750 4x4 yellow 2017	Valtra
87019490	Tractor model BM110 4x4 yellow 2017	Valtra

This conservative cleaning procedure ensures that after its application most potentially relevant product information is not removed. However, it does not take into account the fact that different importers can use different words or use them in a different order to describe the same product characteristics. I address this problem in a subsample of passenger vehicles (HS4 code "8703"), for which relevant product characteristics are known.

For passenger vehicles, I use Stata's regular expressions to find word indicators for used cars ("used", "usado", etc.), manual and automatic cars ("mec", "mt", "mecanica", "automatica", etc.), diesel and gasoline cars ("diesel", "naftero", "gasolina", etc.), flexible fuel cars ("flex", "flex fuel", etc.), sedan and hatchback car models ("sedan", "sdn", "hatch", etc.). I extract information on vehicles' years of fabrication and calculate car ages as a difference between transaction's year and the identified year of fabrication. Additionally, some brands have indicators for a turbo engine (TDI, TFSI, etc.) and luxury trims (GLS, GL, LTZ, etc.) that I use as another quality measure.

B.2 Additional summary statistics

Table B2 shows that most goods imported to Paraguay are differentiated intermediate goods.

Table B2. Types of imported goods in Paraguay, 2013 - 2018

	% transactions	% annual value	% annual weight
	A. By differentiation		
Homogeneous	12	22	48
Differentiated	88	59	22
	B. By final use		
Capital	14	22	4
Intermediate	45	34	54
Consumer	29	23	13

Table B4 demonstrates explanatory power of product's per-unit weight, brand, and country of origin in within-seller price variation. It reports adjusted R^2 of regressions in which (log) price deviations from the annual seller-specific average in an HS8 category are explained by these characteristics and importer fixed effects. In column (4), product's per-unit weight, brand and country of origin together, on average, explain 13% of within-seller price variation in HS8 category. In contrast, importer fixed effects alone in column (5) explain 11% of this variation, on average. When both importer fixed effects and product characteristics are included in the regression, adjusted R^2 increases to 0.18. This means that, independently from each other, the detailed product characteristics and

Table B3. Product differentiation of goods imported to Paraguay, 2013 - 2018

	$\bar{x}$	std	5%	10%	25%	50%	75%	90%	95%
				Product categories (HS8)					
# HS8 categories	6736	147	6630	6630	6641	6660	6826	6996	6996
# Sellers*	10	19	1	1	1	3	11	27	44
# Buyers	23	49	1	1	2	7	22	62	101
# Countries	6.3	6.6	1	1	2	4	8	15	20
# Units	2.3	1.6	1	1	1	2	3	4	5
# Brands/Seller*	3	4	1	1	1	1	3	8	11
# Origins/Seller*	1.2	0.8	1	1	1	1	1	2	2

Notes: * denotes regular (frequent) sellers or brands defined above.

Table B4. Importer and product characteristics in within-seller price variation

Dependent variable:	log Demeaned Price, HS8×Seller×Year					
	(1)	(2)	(3)	(4)	(5)	(6)
Adj. R^2	0.04	0.03	0.01	0.13	0.11	0.18
HS8, Per Unit Weight	✓			✓		✓
HS8×Brand		✓		✓		✓
HS8×Origin			✓	✓		✓
HS8×Importer					✓	✓

Notes: The reported Adj. R^2 are from regressions with log price deviations from the HS8-Seller-Year average as a dependent variable and the marked fixed effects as explanatory variables.

importer characteristics explain 39% (= (0.18 − 0.11)/0.18) and 28% (= (0.18 − 0.13)/0.18) of the total explained within-seller price variation, respectively.

Table B5 shows that importer heterogeneity remains to be an important independent determinants of within-seller price variation even when detailed characteristics of passenger vehicles are taken into account. Independently from each other, these characteristics and importer fixed effects explain, on average, 20% and 65% of the total explained variation of prices within Seller-HS8-Year, respectively.

Table B6 shows summary statistics for a subsample of interest: transactions of sellers selling products from the same HS8 category to multiple buyers in Paraguay.

B.3 Robustness

Table B7 shows that buyer-size discounts in Table **??** are not a result of misreporting for tax evasion reasons. It reports the results of estimating equation (16) using import transactions of Paraguay's largest taxpayers.[21] In this subsample, buyer-size discounts do not disappear, but become even larger. This cannot be explained by tax evasion, as the

[21] The lists of top 500 tax payers in Paraguay is reported here www.set.gov.py

Table B5. The role of product differentiation and importer heterogeneity in price variation for passenger vehicles within HS8-Seller-Year (HS4 code "8703")

Dependent variable:	log Demeaned Price, HS8-Seller-Year				
	(1)	(2)	(3)	(4)	(5)
Adj. R^2	0.09	0.28	0.36	0.15	0.42
HS8×Brand×Origin	✓				✓
HS8×Brand×Origin×Model		✓	✓		✓
Weight + Other vehicle's characteristics			✓		✓
HS8×Importer				✓	✓

Notes: The reported Adj. R^2 are from regressions with log price deviations from the HS8-Seller-Year average as a dependent variable and the marked fixed effects as explanatory variables. Other vehicle's characteristics include: car age, dummy variables for used (as opposed to new) cars, gasoline engine (as opposed to diesel), manual (as opposed to automatic) box, turbo engine, sedan (as opposed to hatchback), and luxury model's trim.

Table B6. Firm characteristics in the subsample of interest

	$\bar{x}$	std	50%
Panel A: Buyers			
'000 $USD	3256	15009	194
# HS8	38.5	71	10
# Countries	3.6	4	2
# Sellers*	3.4	5.0	2
*Panel B: Sellers**			
'000 $USD	4731	16502	1020
# HS8	46.6	80	19
# Buyers	8.3	14.6	4

Notes: * denotes regular sellers to Paraguay as defined above.

largest tax payers are not likely to engage in misreporting. But it is consistent with them being the largest importers with much better outside options. They are 363 importers that account for 56% of Paraguay's annual import value.

Table B8 shows that the documented patterns of price variation across buyers of the same seller are not driven by buyer's choice between unobserved domestic and observed foreign sellers in a market. It shows the results of estimating equation (16) in a subsample of products, which are not likely to be produced domestically in Paraguay. These products account for about 22% of the country's import transactions and are from HS8 categories, in which Paraguay never exported any products during the sample period. Price variation across buyers of these products is qualitatively similar to that in the full sample, but buyer-size discounts are smaller. This is consistent with the documented ef-

Table B7. Price variation across buyers of the same seller, large taxpayers

Dependent Variable:	log *Transaction Price*			
	(1)	(2)	(3)	(4)
	OLS	OLS	IV	I stage
log *Seller's Share*	0.167***	0.152***	0.183***	0.284***
	(0.036)	(0.038)	(0.047)	(0.027)
log *Buyer's Quantity*$_t$	-0.091***		-0.108***	
	(0.021)		(0.038)	
log *Buyer's Quantity*$_{t-1}$		-0.049***		0.458***
		(0.018)		(0.037)
log *Transaction Quantity*	-0.283***	-0.294***	-0.289***	0.045***
	(0.024)	(0.027)	(0.026)	(0.014)
log *Unit Weight*	0.313***	0.302***	0.302***	-0.006**
	(0.031)	(0.032)	(0.032)	(0.003)
HS8×Unit×Seller×Year	✓	✓	✓	✓
Industry	✓	✓	✓	✓
N obs	345250	282315	282315	282315
N clusters	317	260	260	260
Adj. R^2	0.917	0.909	0.231	0.983
Kleibergen-Paap rk Wald F statistic			153.611	

* p<0.10, ** p<0.05, *** p<0.01
Robust standard errors clustered at importer- and exporter- levels in parentheses.

Notes: Constant is not shown.

fect of competition on the extent of price discrimination: in markets without competition from domestic suppliers, buyer-size discounts are smaller.

Figure B1 shows that product differentiation does not fully explain the observed patterns of price variation across buyers of the same sellers even in a subsample of most differentiated products. It plots coefficients and their 95% confidence intervals from estimating seller's pricing equation (16) in a subsample of passenger vehicles. In their commercial descriptions, I observe the most detailed product characteristics such as vehicle's model, brand, trim, engine type, size, year of fabrication, and whether it is used or new. Figure B1 shows that these characteristics have expected effects on the vehicle's price: ie. older and manual cars are sold with a discount. However, accounting for these characteristics and shipment size, I still find that when buying from the same seller, importers that import cars in larger annual quantities are charged less for the same vehicle. This result cannot be an outcome of measurement errors in quantities, because each vehicle in Paraguayan customs data is reported as a separate transaction.

Table B8. Price variation across buyers of the same seller, products without exported domestic substitutes

Dependent Variable:	log *Transaction Price*			
	(1)	(2)	(3)	(4)
	OLS	OLS	IV	I stage
log *Seller's Share*	0.062***	0.060***	0.067***	0.233***
	(0.013)	(0.013)	(0.015)	(0.032)
log *Buyer's Quantity*$_t$	-0.025***		-0.030*	
	(0.009)		(0.016)	
log *Buyer's Quantity*$_{t-1}$		-0.013*		0.429***
		(0.007)		(0.049)
log *Transaction Quantity*	-0.164***	-0.169***	-0.167***	0.079***
	(0.016)	(0.019)	(0.019)	(0.011)
log *Unit Weight*	0.358***	0.373***	0.372***	-0.039***
	(0.036)	(0.043)	(0.042)	(0.013)
HS8×Unit×Seller×Year	✓	✓	✓	✓
Industry	✓	✓	✓	✓
N obs	168419	105974	105974	105974
N clusters	444	354	354	354
Adj. R^2	0.983	0.984	0.233	0.985
Kleibergen-Paap rk Wald F statistic:			75.986	

* p<0.10, ** p<0.05, *** p<0.01

Robust standard errors clustered at importer- and exporter- levels in parentheses.

Notes: Constant is not shown.

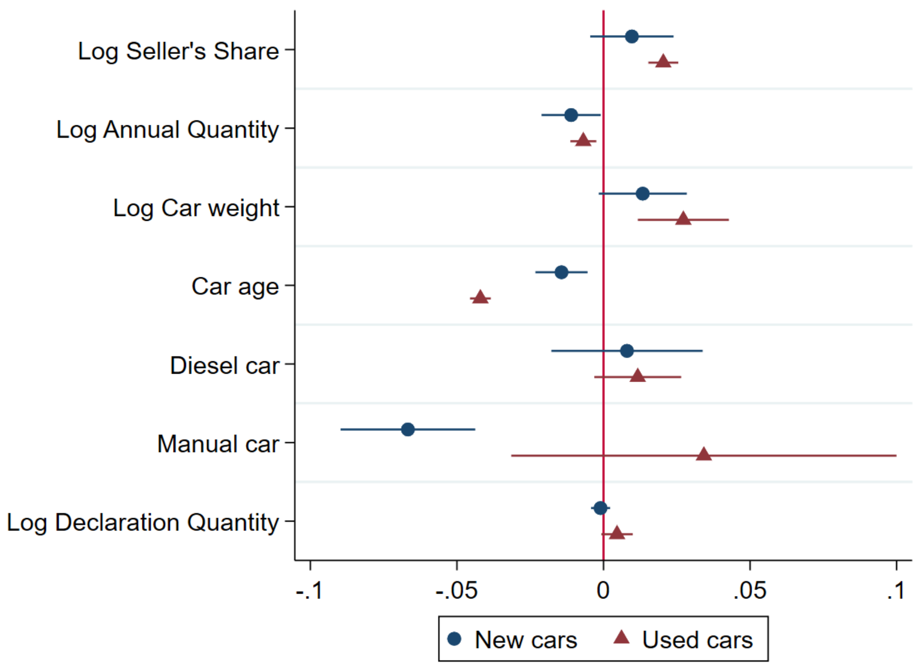


Figure B1. Within-seller price variation in a market for imported passenger vehicles, conditional on vehicle's detailed characteristics

Notes: Estimated coefficients in equation (16) and their 95%-confidence intervals are plotted for a subsample of imported passenger vehicles (HS4 code "8703"). The estimates are obtained separately for new and used vehicles using specification with Seller-HS8-Brand-Model fixed effects and accounting for detailed vehicle characteristics.

Table B9. Reweighting by product composition

Dependent Variable:	log *Transaction Price*					
	Average weights		US weights		Colombia weights	
	(1)	(2)	(3)	(4)	(5)	(6)
log *Seller's Share*	0.123***	0.082***	0.125***	0.075***	0.129***	0.086***
	(0.013)	(0.028)	(0.013)	(0.025)	(0.015)	(0.032)
log *Buyer's Quantity*	-0.139***	-0.063***	-0.140***	-0.056***	-0.149***	-0.064***
	(0.018)	(0.022)	(0.017)	(0.019)	(0.018)	(0.023)
log *Shipment Quantity*		-0.220***		-0.222***		-0.225***
		(0.039)		(0.037)		(0.036)
log *Net Weight/Unit*		0.233***		0.241***		0.251***
		(0.033)		(0.038)		(0.035)
log *Relationship Length*	0.046***	0.006	0.045***	0.008	0.062***	0.015
	(0.015)	(0.018)	(0.015)	(0.018)	(0.016)	(0.021)
SellerxHS8xUnitxYear FE	✓	✓	✓	✓		✓
xBrandxDescriptionxOrigin FE		✓		✓		✓
Importer FE	✓	✓		✓	✓	✓
N obs	1,163,967	222,069	1,163,967	222,069	1,163,967	222,069
Adj. R^2	0.959	0.983	0.954	0.980	0.951	0.979

Robust standard errors clustered at importer- and seller-levels in parentheses.
* p<0.10, ** p<0.05, *** p<0.01

Notes: Columns (1)–(2), (3)-(4), (5)-(6) use baseline weights, columns (3)–(4) reweight Paraguay's import transactions to match global average, U.S., and Colombia's import composition, respectively.