Buyer Market Power and Exchange Rate Pass Through *

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Job Market Paper

Very preliminary and incomplete.
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Abstract

This paper studies the role of buyer market power in determining the response of international prices to shocks, specifically to changes in the exchange rate ("exchange rate pass-through"). A comprehensive dataset linking Colombian exporters (sellers) to their foreign importers (buyers) indicates that (i) most Colombian exports are concentrated in a few foreign buyers in each market, (ii) the same seller charges different prices to different buyers in the same product and destination, and (iii) markets with higher concentration of sales among buyers display lower exchange rate pass-through. Motivated by these stylized facts, I propose an open economy model of oligopsony that accounts for buyer market power in international markets and its consequences for price determination in international transactions. The model shows that larger foreign buyers pay a marked-down price; that is, a price below marginal product. At the firm level, large foreign buyers face a lower exchange rate pass-through to prices in the seller's currency. The mechanism is flexible markdowns: larger buyers have higher markdowns so they have more scope for adjusting them while keeping prices more stable. At the market level, more buyer-concentrated markets have greater markdowns and a lower exchange rate pass-through. I use the estimates from the empirical analysis to calibrate the model and propose counterfactual where buyer market power is eliminated. Under this scenario, seller revenues increase; however, the price in seller currency is more responsive to exchange rate shocks.

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1 Introduction

2 Literature Review

This paper contributes to three strands of the literature. First, my paper contributes to the standard literature on market power (De Loecker, Eeckhout and Unger, 2020; Atkeson and Burstein, 2008; De Loecker et al., 2016). In particular, there is a growing literature on buyer market power in labor markets, using olipsonony and monopsony models to explain workers wages are marked down from their marginal products (Berger, Herkenhoff and Mongey, 2022; Azar, Marinescu and Steinbaum, 2019; De Loecker, Eeckhout and Unger, 2020; Lamadon, Mogstad and Setzler, 2022; Felix, 2022). My theoretical approach most closely resembles Berger, Herkenhoff and Mongey (2022) in labor markets in USA and Zavala (2022) for agricultural value chains in Ecuador. However, I focus on the market of inputs in international trade. To the best of my knowledge, my paper is the first to study the effects of buyer market power on the transmission of international shocks, and exchange rate shocks in particular.

Second, my paper relates to the literature on incomplete exchange rate pass-through (Amiti, Itskhoki and Konings, 2014; Auer and Schoenle, 2016; Burstein and Gopinath, 2014; Gopinath et al., 2020). Most of these papers focus on one sided decisions, usually of exporters. In contrast, the detailed buyer-seller data I use in this paper allows me to investigate the role of buyer-seller relationships in determining the pass-through of exchange rate shocks.

Third, I contribute to a nascent literature on buyer-seller links and their implications.While existing literature has studied the formation or destruction of links or the shock propagation through these links (Huneeus, 2018; Lim, 2018), my paper is the first to extend this analysis to the international markets. In particular, none of this papers has analyzed the macroeconomic implications of this links in the presence of exchange rate shocks.

The rest of the paper proceeds as follows. Section 3 presents my data and setting. Section 4 explains some stylized facts on buyer-seller relationships in Colombia and their consequences for the exchange rate pass through. Section 5 presents my model that links buyer market concentration to input prices, from which I derive the expression for estimating the effect of an exchange rate shock on buyer market power and prices as a whole. Section 6 presents my empirical strategy, and its link to my theoretical model. Section 7 shows implications of my theoretical model and a more general analysis. Section 8 proposes a case study for big importers in the US. Section 9 concludes.

3 Data

This paper combines buyer-seller transaction data for Colombia in international markets with data on bilateral exchange rate shocks. In this section, I will describe the data and present summary statistics that are relevant for the analysis.

3.1 Buyer-Seller Data

One of the challenges of studying buyer market power in international markets is the lack of detailed information on bilateral transactions between buyers and sellers. I use novel data on the universe of cross-border trade transactions between Colombian exporters and importers, and foreign firms during 2007-2020. The data comes from the National Directorate of Taxes and Customs of Colombian (DIAN).[1] For each transaction, the DIAN reports the value and quantity shipped (in U.S. dollars and in Colombian pesos), the shipment date, the 10-digit Harmonized System (HS10) code of the product traded, the country of destination, the weight, the port through which this transaction occurred and the transportation mode. The key element of the dataset is that I am able to uniquely identify the foreign firm interacting with the Colombian firms and, in this way, I can carry on a buyer-seller analysis.

I combine this administrative microdata with data on bilateral exchange rate shocks from International Financial Statistics from the International Monetary Fund (IMF). In particular, I use the monthly nominal bilateral exchange rate expressed as local currency per U.S. dollar.

3.2 Descriptive Statistics for Colombia

As Colombia is a developing country that hosts thousands of small firms exporting to the rest of the world it is the ideal setting to study how the characteristics of their buyers affect their prices and how these prices react to shocks. The US is Colombia's largest trading partner, representing about 41% of Colombia's exports. In addition, as the Colombian peso has depreciated against the USD and other leading currencies several times over the last decades, my data also poses a perfect setting to study the exchange rate pass through to international prices.

I have information on the universe of Colombian firms exporting to the rest of the world. My data consists of all exports from 50,869 Colombian firms producing 6,941 different HS10-level goods[2] exporting to 54 different countries from 2007-2020. Table **??** summarizes the main descriptive statistics relevant for my analysis.

Variable	Mean	SD
# Destinations	54	0
# Products	4524	91
# Sellers per year	13382	5479
# Buyers per year	39028	2914
Buyer market share	13%	23%
# Buyers by destination \$\times\$ HS10	4.55	22.7
# Products by buyer	3.68	8.84

Table 1: Summary Statistics

[1] DIAN stands for Dirección de Impuestos y Aduanas Nacionales de Colombia. This dataset was accessed through Datamyne.

[2] Each product is identified with a 10-digit code, which corresponds to the Harmonized Commodity Description and Coding System at the highest level of disaggregation. An example for this could be women or girls cotton panties vs knitted or crochet ones.

4 Stylized Facts

Small sellers in Colombia sell their products to large firms abroad. In this section, I document two stylized facts on the role of these large buyers in Colombian export markets. Together they suggest the existence of substantial buyer market power. Most importantly, they support the idea that buyer market power is not only relevant for price setting in international markets but also for prices adjustments to exchange rate shocks (exchange rate pass-through).

I find that (i) most Colombian exports are sold to the largest foreign buyers in each market and, that (ii) sellers price discriminate across buyers in international markets and (iii) there is a negative correlation between the exchange rate pass-through coefficient and the concentration of buyers in a market.These facts motivate the oligopsony model in section 5 where buyer market power determines the degree of exchange rate pass-through into international prices.

Fact I: Most Colombian exports are sold to the largest foreign buyers in each market

Guided by the well-known existence of large firms dominating the markets, I explore this in my data. I define a market as a destination $\times$ product $\times$, where a product is at the HS10 level.

First, I identify the top buyers (top 3, top 5, top 10) of exports in each market and calculate how much the contribute to the total value bought in each market. Figure 1, Panel A shows that the value of the exports bought by the top three buyers alone accounts for 78% percent of exports from Colombia, suggesting the high degree of buyer concentration of Colombia's export market. For example, for the market of coffee in the US for a certain year, this would mean Starbucks, Peets Coffee and Dunkin Donuts account for most of the value Colombia sells of coffee to the US

Second, I calculate the degree of concentration of sales by using a standard measure of concentration, the Herfindhal-Hirsh Concentration Index (HHI). Before defining this index, I define S_{bjkt} as buyer b's share of the nominal value of all exports of product j to country k in period t:

$$S_{bjkt} = \frac{p_{bjkt} q_{bjkt}}{\sum_b p_{bjkt} q_{bjkt}}$$

I then define the Herfindahl Hirsh Index:

$$HHI_{jkt} = \sum_{b \in \Theta_{jkt}} S_{bjkt}^2$$

Figure 1, Panel B plots the distribution of the HHI. Note that in a market with only one buyer the HHI would be 1, while in a market with two buyers where each of them accounts for half of the market share, the HHI is 0.5. The figure shows there is a considerable amont of markets with a high HHI, implying a high degree of concentration of sales among buyers.

I benchmark the observed level of concentration against the HHI index for sellers comparing the concentration of buyers in Colombian markets with the concentration of sellers. The figure indicates the concentration of export flows among buyers is as important as the concentration among sellers, and therefore, it should have important economic implications.

Panel A Panel B

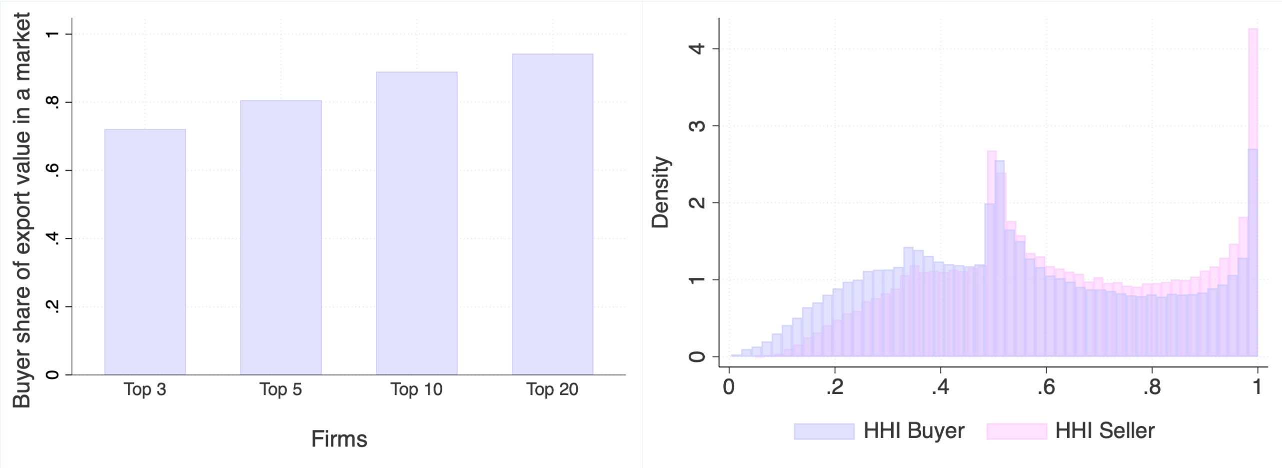


Figure 1: Buyer market concentration

Fact II: Sellers price discriminate across buyers in international markets.

I document the existence of multi-buyer firms in a market and that these firms price-discriminate among their buyers.

Figure 2, Panel A, shows that there is a significant amount of multi-buyer firms in Colombian export markets. In my sample, these firms account for roughly 80% of the exports value of the country. To date, there exists no empirical evidence on price discrimination for buyers in international markets. I document this new stylized fact for sellers (exporters) in Colombia. As documented in Figure 2, Panel B the same firm, exporting the same product, to the same destination, in the same year, charges different prices of different buyers. This is true even controlling for sector-by-destination-by-year fixed effects in order to compare similar destination markets (i.e., controlling for size of the market, as well as growth of a particular sector). The standard deviation from the mean of prices of the same firm for the same product to the same destination across similar buyers is around 0.58%. This suggests that there are characteristics specific to a buyer that affect considerably the price a firm sets.

Panel A Panel B

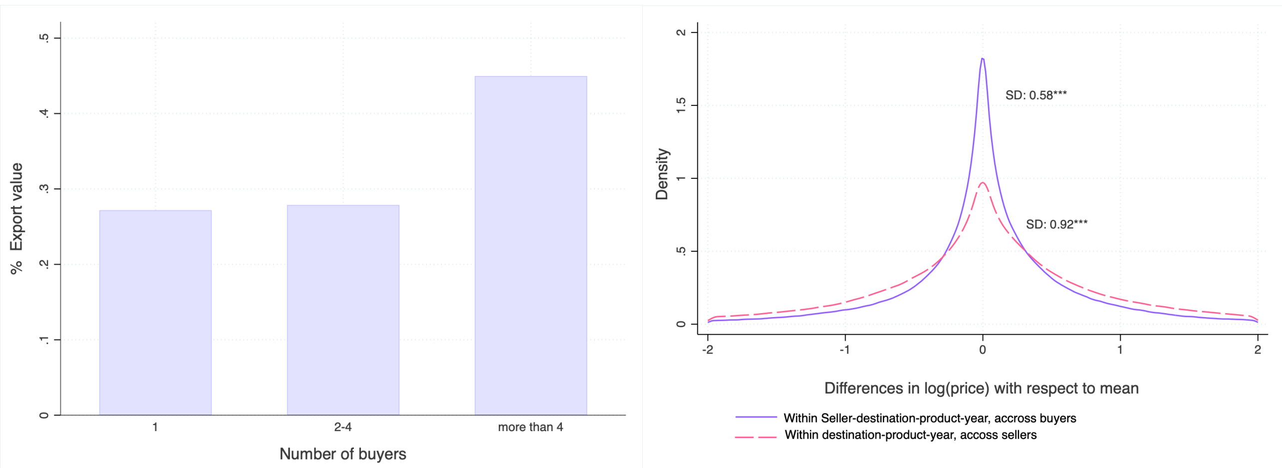


Figure 2: Export value explained by multi-buyer sellers and top buyer

Fact III: Markets with high concentration of sales among buyers display low exchange rate pass-through

I now explore how the concentration of buyers relates to the exchange rate pass through. I define exchange rate pass through as how export prices, that is the prices of the sellers in Colombia, react when there is change in the exchange rate. For every market, destination-product, I run the following regression:

$$\Delta \ln p_t = \underbrace{\Psi_{jk}}_{\substack{Exchange\ rate \\ pass-through}} \Delta \ln e_{kt} + \epsilon_t$$

where p_t corresponds to the average price in seller currency (Colombian pesos) and e_k is the nominal bilateral exchange rate (local currency per unit of foreign currency).

Figure 3 presents the coefficients of my regression on a bin-scatter. It shows there is a negative correlation between the exchange rate pass through and the concentration of buyers. This means that in the event of an exchange rate shock markets where buyers are more concentrated have less changes in prices, in the sellers' currency. This last fact motivates my model in the following section, exploring buyer market power in international markets as the main channels for this effect: given that buyers are large and have buyer market power, this affects the way prices are adjusted.[3]

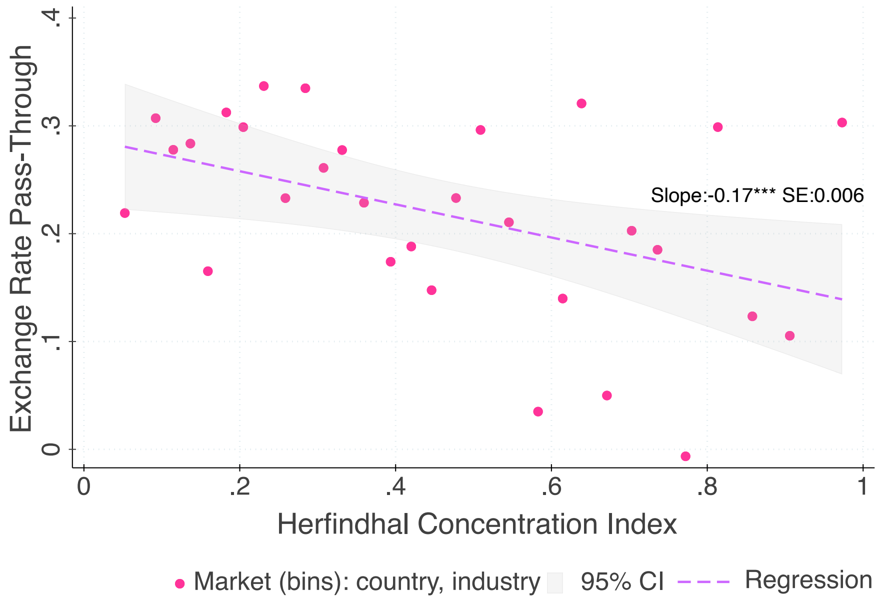


Figure 3

5 The Model

I develop an oligopsony model in international markets where there are an infinite number of sellers located in the home country and a few large buyers in each market in the foreign countries. This concentration of demand gives the buyers market power and allows them to choose the prices

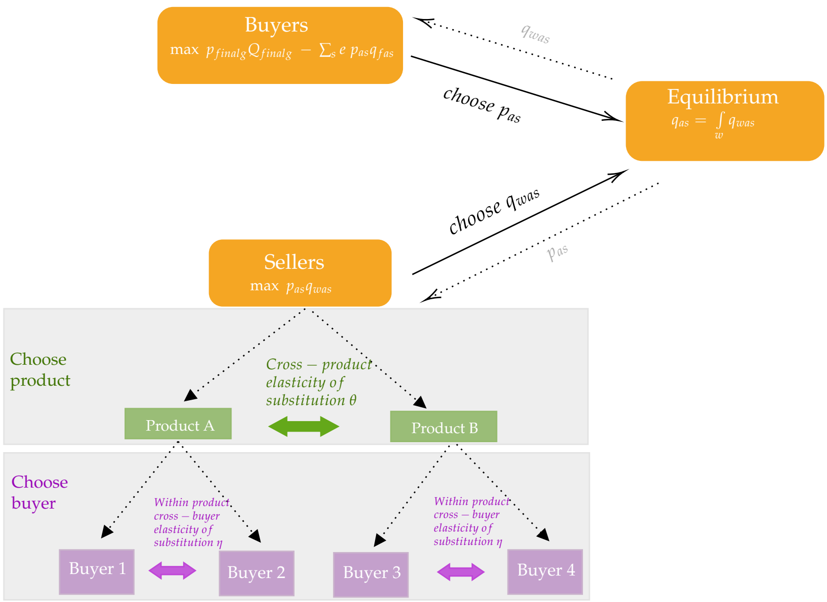
[3] I have just shown that this relationship holds in the cross section for the different industries. In section 9.2.8 of the Appendix, I also show this relationship holds in the time series for Colombia.

they pay.[4] The concentration of buyers, and hence, their market power differs across and within products. Given these prices, sellers choose which products they produce, and to which buyer they sell. I model the seller's choice of sector and buyer as a discrete choice problem, which yields a nested CES supply curve.

The equilibrium price is a function of the relative buyer market share.[5] The shape of this function is determined by two key elasticities, the cross-product supply elasticity and within-product cross-buyer supply elasticity, which govern the heterogeneity of costs in the seller's choice problem. Intuitively, the more heterogeneous the sellers' costs, the greater the consequences of buyers' market power.

5.1 Timeline and Model Structure

The timeline of the model is as follows: (i) productivity shocks are realized, (ii) buyers choose the price they want to pay for their inputs, and (iii) sellers choose the quantity they are going to supply of each input. I solve this by backward induction, starting with the seller's problem then moving to the buyer's problem. The following figure summarizes the structure of the model, with notation explained in the text ahead.



5.2 Seller Supply Function

There is an infinite mass of potential sellers in a home country indexed by $s \in [0, 1]$ who sell their products indexed by $j \in [1, ..., M]$ to buyers b in destination countries k. Each seller decides two things, (i) which product to produce, and (ii) which buyer to supply to. This decision will depend on the sellers' initial endowment, some productivity shocks and the price offered by the buyers.

To begin with, each seller s has an endowment $q_s \sim \Psi$, that he can decide to allocate to the

[4] In my baseline model buyers compete a la Bertrand. However, in the appendix, I additionally solve for Cournot competition.

[5] In this sense, the model also connects to the work of Alviarez et al. (2022).

production of any product-buyer combination. The more the seller uses of a product for a buyer the less he has left of this endowment to use for another product and buyer, that is, $\sum_{bj} q_{sbj} = q_s$. Also, the more of the endowment q_s the seller has, the more he could produce.

Second, apart from their initial endowment, each seller s for product j for buyer b in destination k receives an idiosyncratic productivity drawn iid from a nested Frechet distribution: he receives an idiosyncratic shock ρ_{sjk} for producing each product j (product-specific shock) and an idiosyncratic shock ρ_{sbjk} for supplying each buyer b within product j (within-product buyer-specific shock). Therefore, the idiosyncratic shocks determines the supply. The higher the shock for buyer b and product j, the more the seller can supply if he chooses that buyer and product. An intuitive way of thinking about these shocks is: ρ_{sjk} corresponds to the availability of inputs and technology for the seller to produce product j, and ρ_{sbjk} corresponds to search costs and frictions for the seller to connect with buyer b of product j.

Third, the sellers observe the prices offered by the different buyers for the different products in each destination and take these prices into account when maximizing their profits.

The seller chooses the buyer and product that yields the highest profits for each destination k, given the productivity shocks and the prices set by the buyers:[6]

$$\max_{q_{sbjk}} \sum_{bj} p_{sbjk} q_{sbjk} \rho_{sbjk}^{\frac{1}{\eta}} \rho_{sjk}^{\frac{1}{\theta}} \ \ s.t. \ \sum_{bj} q_{sbjk} = q_s$$

where p_{sbk} is the price at the destination if it is consumed by buyer b in sector s. Note that this price varies by buyer b since they have market power [7].

For intuition, consider the problem of a seller who has an initial endowment of q_s square feet of land to be cultivated. He could use it for either growing coffee or cocoa beans depending on his technology, ρ_{sjk}, he has (e.g., he has a machine more suitable for either of those beans). If he to produce coffee, he could either sell it to Starbucks or Peet's Coffee depending on the search costs, ρ_{sbjk}, (e.g., he already sold before to Starbucks' so has some relationship with them, or, he matches better with Starbucks preference on packaging). Finally, the seller will take into account the price offered by those buyers before deciding to sell to any of them. There could be a trade-off between producing lower quantities and higher prices offered by the buyers.

The probability that seller s chooses product j and buyer b, $Pr(sbjk)$, is independent of his endowment, q_s. Due to the Frechet distribution of productivity shocks, for a given seller, that is fixing q_s, the probability of choosing buyer b and product j is the same as the probability that $(Pr(revenue_{b',j',k} < revenue_{b,j,k}) \forall b', j' \neq b, j)$. Following Eaton and Kortum (2002), this probability is then equal to how much of the total production of all sellers goes to each buyer and product. Formally, we define λ_{bjk} as the share (of the total of sellers production) that is sold to buyer b of product j in destination k [8]:

$$\lambda_{bjk} = \underbrace{\frac{P_{jk}^{1+\theta}}{\sum_{j'k} P_{j'k}^{1+\theta}}}_{Pr(chooses\ product\ j)} \underbrace{\frac{P_{bjk}^{1+\eta}}{P_{jk}^{1+\eta}}}_{Pr(chooses\ buyer\ b|j)} \tag{5.1}$$

[6]Note that there are no costs in this maximization given all the sellers have an endowment. One way some types of costs are included are through the different shocks ρ_{sbjk}, ρ_{sjk} but not inputs costs.

[7]As there are no diminishing returns to selling to a given buyer-product in equilibrium each seller will just pick one buyer-product and sell everything to him, if there are no ties

[8]All destinations here will differ on the exchange rate, and they might also have different elasticities. More details on this in Section 5.2.1.

where $P_{jk} = B_{jk}\left(\sum_{b'\in j} B_{b'jk} p_{b'jk}^{\eta}\right)^{\frac{1}{\eta}}$ and $P_k = \left(\sum_{j'} P_{j'k}^{1+\theta}\right)^{\frac{1}{1+\theta}}$. I derive this Appendix 9.1.2.
Aggregating across sellers yields a nested CES upward slopping supply curve for buyer b in product j, country k: [9]

$$q_{bjk} = \left(\frac{p_{bjk}^{\eta}}{P_{jk}^{\eta}}\right)\left(\frac{P_{jk}^{\theta}}{P_k^{\theta}}\right) Y \tag{5.2}$$

where $Y = \sum_{b'j'k'} p_{b'j'k'} q_{b'j'k'}$

5.2.1 Interpreting Elasticities

There are intuitive interpretations of the parameters θ and η.[10] First, θ governs the correlation of product-specific shocks. This means that the higher θ, the more correlated are the seller's productivity draws across sectors. This means that, if the idiosyncratic productivity for the different product is more likely to be similar, the prices in the product will be more relevant to determine the quantity choice. Intuitively, θ will be high if the availability of inputs needed for many different sectors and technology is similar so that there is little heterogeneity in productivity. Finally, θ is the elasticity of substitution across products in the CES supply function. If θ is relatively high, then it is easy to substitute products from the point of view of the seller. Higher substitutability would correspond to higher rates of seller switching between products, in a dynamic setting.

Analogously, η governs the correlation of buyer-specific shocks. The higher η, the more correlated are the seller's draws across buyers within a product. Then, since search costs to connect with one buyer or another are similar, the price each buyer offers will be more important. If η is high then sellers are able to actually connect with many buyers, and there will be low heterogeneity in the cost of finding a buyer.

Following the literature on the topic, we expect $\eta > \theta$, which has different interpretations: (i) idiosyncratic costs shocks are more strongly correlated across buyers than across products, (ii) there is more heterogeneity in the productivity of producing in different products than in costs of connecting with two different buyers[11], and (iii) sellers are more substitutable within products than across products from the point of view of the buyers.

5.3 Buyer's Profit Maximization

There are a finite number of buyers in a foreign country k. Each buyer purchases his inputs to produce a final good to sell in his home country. A buyer can buy different inputs from different countries [12]. Her production function is a CES:

$$Q_{finalg} = \left(\int_{jk} z_b q_{bjk}^{\frac{1-\sigma}{\sigma}} djk\right)^{\frac{\sigma}{\sigma-1}} \tag{5.3}$$

where $z_{sbk} \sim O$ is an idiosyncratic productivity term, which is the only source of ex-ante heterogeneity across buyers within a given sector.

[9] See Appendix 9.1.3 for derivations and intuitions on how prices relative to the price index relate to quantity.
[10] The interpretation of elasticities is inspired by (Berger, Herkenhoff and Mongey, 2022; **?**).
[11] Note that in the empirical analysis this condition holds for the same destination and in the same period.
[12] Note that he can also buy the *same* input j from different countries

Buyers of product j exert market power over sellers, which I model as Bertrand competition. When deciding the price to pay, buyers form expectations about how sellers will respond. This means, they internalize the upward sloping supply curve: each additional unit they purchase increases the price of every other unit. Note that, as I assume that the market structure is oligopsonistic, then a buyer can affect the price index P_j, however, there is an infinite mass of products such that the buyer cannot affect the aggregate price index P.
Therefore, the problem of a buyer b that buys product j in country k consists of choosing the prices they will offer to sellers p_{bjk}. Buyers maximize the following profit function subject to a production function, equation 5.3, and the quantity supplied by the seller, equation 5.2:

$$max_{p_{bjk}}\ p_{finalg}Q_{finalg} - \sum_{origin,j} \frac{1}{e_k^{origin}} p_{bjk}q_{bjk} \quad \text{s.t.} \quad Q_{finalg} = \left(\int_{jk} z_{bjk} q_{bjk}^{\frac{1-\sigma}{\sigma}} dj\right)^{\frac{\sigma}{\sigma-1}} \quad and \quad q_{bjk} = \frac{p_{bjk}{}^{\eta}}{P_{jk}{}^{\eta}} \frac{P_{jk}{}^{\theta}}{P^{\theta}} Y \tag{5.4}$$

The first term of the profit function corresponds to the revenue the buyer obtains after selling quantity Q_{finalg} of the final good he produces at price p_{finalg}. The domestic price of output is modeled as exogenous[13]. The second term corresponds to the costs paid for the inputs (they buy different products and different countries), that is, all the quantities, q_{bjk}, bought at prices, p_{bjk}.

The profit function is expressed in local currency. Buyers sell their final products in the home country so the revenue term is expressed in local currency. As buyers buy these inputs in international markets (costs term), which means they pay for them in the currency of the producer, I introduce the term e_k^{origin} that corresponds to the nominal exchange rate in order to convert the costs to local currency. The subindex k indicates the country of the buyer, while the super index *origin* corresponds to the country of the seller.[14] This term is defined as foreign currency per unit of home currency.

The first order condition can be written:

$$p_{bjk} = \underbrace{\frac{1}{\mu_{bjk}}}_{mark\ down:\mu_{bjk}>1} \times \underbrace{MRP_{bjk}}_{marginal\ \ revenue\ \ product} \times e_k \tag{5.5}$$

where markdown $\mu_{bjk} = 1 + \epsilon_{bjk}^{-1}$ with $\epsilon_{bjk} = \frac{\partial ln q_{bjk}}{\partial ln p_{bjk}}$ is the supply elasticity faced by buyer b of product j to destination k.

Equation 5.5 shows that the price of the input in the producer's currency (seller's currency) depends on the markdown, the exchange rate and the marginal value of the input, that is the value the input adds to the final product. In other words, the buyers, who are the ones that have market power, will pay for an input an amount equal to how much this input adds to their revenues "reduced" in how much market power they have[15][16].

There are some relevant intuitions derived from equation 5.5. First, the MRP_{bjk} is expressed in buyer's currency and the markdown has no unit so in order for the price to be in the currency of the seller I need to multiply by the exchange rate e_k. If all transactions happened in the domestic

[13] I relax this assumption in Appendix ?? and assume these buyers charge markups

[14] Note that we think about our home country as the *only* origin country for the seller as we move forward, so the superindex "origin" is omitted in the rest of the paper but e_k refers to the bilateral exchange rate between our home country where the seller is and country k where the buyer is.

[15] Note that this is equivalent to Berger, Herkenhoff and Mongey (2022) on labor market power where the wage is equal to the markdown times the marginal productivity of labor

[16] The intuition is the these buyers avoid purchasing the last few units of a good whose value to them is greater than their marginal cost, in order to hold down the price paid for prior units.

market (that is there is no difference in currency, so $e_k = 1$), then price is equal to the markdown times the MRP. Second, under perfect competition, $\frac{1}{\epsilon_{bjk}} = 0$ and the price is equal to the marginal value of the input. When the buyer has market power, he internalizes the upward sloping supply of inputs, $\frac{1}{\epsilon_{bjk}} > 0$, and the input price is "marked down" from the perfectly competitive level. The steeper the supply curve faced by the buyer (higher $\frac{1}{\epsilon_{bjk}}$), the more market power he has, the higher the markdown, and the lower the price, ceteris paribus. Alternatively, the more value the input adds to the final good (higher MRP), the higher the price.[17]

5.4 Buyer Market Power and Supply Elasticity

The elasticity of supply allows us to better understand how prices are determined. Given Bertrand competition [18], the elasticity of supply has the following closed form:

$$\epsilon_{bjk} = \eta(1 - S_{bjk}) + \theta S_{bjk} \tag{5.6}$$

where

$$S_{bjk} = \frac{p_{bjk} q_{bjk}}{\sum_b p_{bjk} q_{bjk}} = \frac{p_{bjk}^{\eta+1}}{\sum_{b' \in B} p_{b'jk}^{\eta+1}} \tag{5.7}$$

is the relative size of buyer b and product j in destination k. This variable is key throughout the whole analysis given that together with the elasticities it determines the market power of the buyers.

Focusing on equation 5.6, the supply elasticity ϵ_{bjk} is the weighted average of the elasticity of substitution across products j and across buyers b, where the relative size of the buyers governs these weights. Note that the smaller the buyer share, which could relate to a higher level of competition (more buyers per market), the more weight on the substitutability across buyers within a product, η, receives more weight. If there are many buyers, then they do not exert so much influence, and sellers can always switch to other buyers of the same product or input. However, as the number of buyer decreases, the relevance relies on the potential substitution between products, θ.

Finally, I arrive to my first theoretical result. Rearranging equation 5.6, and assuming $\eta > \theta$, I find the elasticity of supply is decreasing in buyer market share, and so the markdown is increasing in buyer market share. Therefore, larger buyers have larger markdowns. Formally,

Proposition 1 *1. The markdown of buyer b for product j in destination k is increasing in a buyer's market share in the market*

$$\mu_{bjk} = \frac{\eta\left(1 - \frac{p_{bjk}^{\eta+1}}{\sum_{b' \in B} p_{b'jk}^{\eta+1}}\right) + \theta\left(\frac{p_{b'jk}^{\eta+1}}{\sum_{a' \in s} p_{b'jk}^{\eta+1}}\right)}{1 + \eta\left(1 - \frac{p_{b'jk}^{\eta+1}}{\sum_{b' \in B} p_{b'jk}^{\eta+1}}\right) + \theta\left(\frac{p_{bjk}^{\eta+1}}{\sum_{b' \in B} p_{b'jk}^{\eta+1}}\right)}; \quad \Gamma_{bjk} = \frac{\partial \mu_{bjk}}{\partial S_{bjk}} < 0$$

2. The marginal revenue of product, MRP_{bjk}, of a buyer b in product j is increasing in a buyer's market

[17] I am not assuming constant returns to scale in the marginal revenue of the product. Doing so would be expecting that each additional unit of different inputs would increase the marginal revenue in the same amount. If there were constant returns to scale in the production function then $\frac{\partial MRP_{bjk}}{\partial q_{bjk}}$ would be 0. This would mean the MRP_{bjk} is not affected with a change in quantities and so also not affected with a change in prices (or exchange rate).

[18] I focus on Cournot competition and present results under Bertrand competition in the appendix

share in the market

$$MRP_{bjk} = \frac{\partial revenue}{\partial q_{bjk}} = p_{bjk} q_{bjk}^{-\frac{1}{\sigma}}; \quad \Theta_{bjk} = \frac{\partial MRP_{bjk}}{\partial S_{bjk}} > 0$$

Proof *See appendix.*

5.5 Concentration

In this section, I aggregate my previous results at the market level. Aggregating the right-hand side of Equation 5.7 across all firms in a local market, weighting each firm by it's buyer market share, gives the key relationship between the degree of buyer market power in the inputs market and its concentration level:

Proposition 2 *Suppose inputs supply follows a nested CES, and buyers compete for sellers à la Bertrand, the average price markdown in market s is given by:*

$$\mu_{jk} = \frac{\overline{MRP}_{jk}}{\overline{p}_{jk} e_k} = 1 + \epsilon^{-1} = 1 + \eta HHI_{sk} + \theta(1 - HHI_{sk}) \tag{5.8}$$

where $\overline{MRP}_{jk}$ and $\bar{p}_{jk}$ are market j's (revenue-weighted) average marginal revenue product of the input and average price, respectively, ϵ_j^{-1} is the (revenue weighted) average market supply elasticity, and $HHI_{jk} = \sum_{b \in \Theta_{jk}} S_{bjk}^2$ is the market's Herfindhal.

Proof *See appendix.*

Having the equilibrium price and after showing how it depends on the markdown, I can now finally investigate the relationship of the markdowns to price adjustment to exchange rate shocks.

5.6 Exchange rate pass-through

In this section, I investigate the role of buyer market power in determining the export price response to exchange rate shocks (exchange rate pass-through elasticity). I consider a generic exchange rate shock at the pair country level Δe_k, that is, our home country and destination country k.

By definition, a bilateral exchange rate shock affects the prices and quantities for all exports in the home country. This means that, after an exchange rate shock, when buyer b chooses the new price, full efficiency would require considering how the shock affects the prices chosen by all the other buyers of seller s.[19] Consistent with my assumption in the buyer profit maximization problem, I assume that when buyer b chooses the new bilateral price, he takes as given both prices and quantities

[19] Intuitively, by affecting the price and quantities in for other pairs buyer-seller, a given shock may affect the price p_{bjk} through changes in buyer's market share. Section 9.1.9 considers how the pass-through formula would change once these indirect effects are considered; the more general pass-through formula can be derived by solving a complex system of equations for each seller s.

of all other pairs. In other words, this means focusing on the direct effect of the shock on the price p_{bjk}.[20]

Log-differentiating equation 5.5, and using the result in Proposition 1, I rewrite the log change in price, $dlnp_{bjk}$, as:[21]

$$dlnp_{bjk} = \text{dln}\mu_{bjk} + dlnMRP_{bjk} + dlne_k \tag{5.9}$$

Solving for each term, I derive:

$$\begin{aligned} \text{dln}\mu_{sbjk} &= \frac{\text{dln}\mu_{bjk}}{\text{dln}S_{bjk}} \frac{\text{dln}S_{bjk}}{\text{dln}p_{bjk}} \, \text{dln}p_{bjk} && (5.10)\\ &= \Upsilon_{sbjk}(\eta+1)(1-S_{bjk}) \, \text{dln}p_{bjk} && (5.11)\\ &= \Gamma_{bjk} \, \text{dln}p_{bjk} && (5.12) \end{aligned}$$

where I have defined $\Upsilon_{bjk} = -\frac{\partial ln\mu_{sbjk}}{\partial S_{bjk}} > 0$ as the partial elasticity of bilateral markdowns with respect to the buyer share S_{bjk} and $\Gamma_{bjk} = \frac{dln\mu_{bjk}}{dlnp_{bjk}} < 0$.

$$\begin{aligned} dlnMRP_{sbjk} =& \frac{dlnMRP_{sbjk}}{\text{dln}p_{bjk}} \, \text{dln}p_{bjk} && (5.13)\\ =& \frac{-1}{\sigma}(1-x_{bjk})\epsilon_{bjk} \, \text{dln}p_{bjk} && (5.14)\\ =& \Phi_{bjk} \, \text{dln}p_{bjk} && (5.15) \end{aligned}$$

where σ is the elasticity of substitution of the CES production function, x_{bjk} is the expenditure share of buyer b from destination k on product j and ϵ_{bjk} is the elasticity of substitution as in equation 5.6.

Substituting equations 5.10 - 5.13 into 9.10, it is possible to write the log change in the price, p_{sbjk}, for each buyer b, in product j and destination k as a function of the buyer's market share, S_{sbjk}, and fundamentals. The following proposition characterizes the direct component of the pass-through of a exchange rate shock into the price p_{bjk}

Proposition 3 *The pass-through of a bilateral exchange rate shock to the price p_{bjk} when $dlnp_{bjk} = 0, \forall i \neq k$. is given by:*

[20] I validate this assumption in the next section, where I show that the effect of the country pair level shock into the bilateral price is unchanged regardless of whether or not the quantities or prices of other buyers in the same product j and destination k are controlled for in the estimation.

[21] Note that I am dropping the subindex s, I will assume sellers are homogeneous in the prices they receive from the buyers so I can isolate the buyer effects. In my empirical part I control for differences in two different sellers connected with the same buyer

$$\frac{dp_{bjk}}{de_k} = \frac{1}{1+\underbrace{\Gamma_{bjk}(\eta,\theta,S_{bjk})}_{Mark\ down\ channel(+)} + \underbrace{\Phi_{bj}(\varphi_j,S_{bjk})}_{Marginal\ Revenue\ Channel(-)}} \tag{5.16}$$

where $\Gamma_{bjk} = \Upsilon_{sbjk}(\eta+1)(1-S_{bjk})$ *and* $\Phi_{bjk} = \varphi_j\epsilon_{bjk}$, *with* $\varphi_j = \frac{-1}{\sigma}(1-x_j)$

Proof *See appendix.*

Equation 5.16 indicates that the pass through elasticity into prices in a model with buyer market power can be written as a function of the buyer share in the market and the parameter vector $\nu = \{\eta,\theta,\varphi\}$.

5.6.1 Aggregate level

Next, I calculate the average exchange rate pass through by sector and destination, in terms of the Herfindhal Concentration Index.

Proposition 4 *The average exchange rate pass through is given by:*

$$\Psi_{sbjk} = \frac{dp_{jk}}{de_k} == \frac{1}{1+\underbrace{\tilde{\Gamma}_{jk}(\eta,\theta,HHI_{jk})}_{Mark\ down\ channel(+)} + \underbrace{\tilde{\Phi}_{jk}(\varphi_j,HHI_{jk})}_{Marginal\ Revenue\ Channel(-)}} \tag{5.17}$$

where $\widetilde{\Gamma}_{jk} = \frac{d\mu_{jk}}{de_k}$ *and* $\tilde{\Phi}_{bjk} = \frac{dlnMVP}{dlne_k}$

Proof *See appendix.*

5.7 Channels

In this section, I decompose the overall exchange-rate pass through effect into a markdown and a marginal revenue channel. From my theoretical model, I derive an expression that will allow me to quantify each of these channels in the empirical part in Section 6.4.

5.7.1 Markdown Channel

The markdown channel is driven by an endogenous response of the buyer's market power to the shock. Following a positive exchange rate shock ($\uparrow e_k$, a devaluation of the home country), the buyer reduces its markdown and increases the price in the buyer currency (compensating for the shock and keeping the price more stable in seller currency) such that the seller does not substitute away from that buyer. In other words, he internalize the upward sloping supply curve in equation 5.2: each additional unit he purchase increases the price of every other unit.

The key theoretical result of my model is that, at the firm level, the markdown channel Γ_{bjk} is an increasing function of the buyer market share. [22] Therefore, the markdown channel operates differently for buyers with different buyer market share: buyers with higher market share have more variable markdowns. Intuitively, buyers with higher market share, have higher markdowns: they pay a price way below the marginal revenue product. Given this, they have more *scope* to adjust their markdowns as desired.

In order to identify the magnitude of this effect, and formally analyze each component present in this channel, I focus on a direct implication of Proposition 2:

Corollary 1

$$\textit{markdown channel} = \frac{\partial \ln \mu_{bjk}}{\partial \ln p_{bjk}} = \frac{-(\eta+1)(1-S_{bjk})S_{bjk}}{\left(\frac{\eta}{\theta-\eta}\right)\left(\eta+(\theta-\eta)S_{bjk}+1\right)}$$

If the cross-product elasticity of substitution is lower than the within-product cross-buyer elasticity, $\eta > \theta > 1$, then firms with higher S_{bjk}, have more variable markdowns.

$$\frac{d\textit{markdown channel}}{dS_{bjk}} > 0$$

Proof *Differentiate equation 5.8 with respect to S_{bjk}. See appendix* **??** *for details.*

To understand the intuition behind the Corollary 1, suppose that the exogenous shock is a positive bilateral exchange rate shock, whose variation I introduce in the empirical section. Two things need to hold in order for a positive exchange rate shock to increase the markdown of buyer b in product j, country k, and thereby reduce price paid via buyer market power.

First, a positive exchange rate shock (a depreciation) must increase buyer market share. The reason for this is that buyer market share is the only endogenous component of that buyer's markdown. The other two components, η and θ, are supply parameters, which by assumption do not change. The source of market power in the international markets environment is sellers production heterogeneity for products and buyers. Buyers can "exploit" this heterogeneity to pay marked down prices. The bigger a buyer is relative to its competitors, the more it can mark prices down without sellers easily leaving because there are fewer buyer options nearby, and sellers tend to prefer switching in the same product across buyers before switching markets completely. Therefore, the degree of market power in each market, product-destination *jk*, can only meaningfully change if the relative size of the buyer meaningfully change. Second, there must be a difference between sellers' key inverse elasticities of substitution (i.e., $\theta - \eta$). If there is no difference in elasticities, sellers substitute equally between buyers and product. In this scenario, the effect of the exchange rate on buyer market share would be irrelevant for changes in the buyer market power. Such is the case under two of the model's limiting cases: monopsonistic competition (i.e., no gap to induce effects on market power, but because $\theta - \eta < 0$, there is still some level of market power), and perfect competition (i.e., no gap to induce effects, and because $\theta = \eta = 0$ no level of market power either)[23].

[22] Equation 5.10 shows Γ_{bjk} depends on S_{bjk} and Appendix 9.1.13 shows the relationship is increasing

[23] For this section, I borrow some of the intuitions for the labor market in Berger, Herkenhoff and Mongey (2022); Felix (2022)

5.7.2 Marginal revenue channel

The marginal revenue channel captures the price response due to changes in the buyer's average revenue. When the bilateral price increases due to a positive exchange rate shock, a standard supply effect leads the seller to supply more of that variety. Higher supply decreases the average revenue, decreasing the price.

Rearranging Equation 5.13, I get the following expression for the marginal revenue channel:

$$\frac{dlnMRP_{sbjk}}{\mathrm{dln}p_{bjk}} = \frac{-1}{\sigma}(1 - x_{bjk})\epsilon_{bjk}$$

It can be seen that the marginal revenue channel depends on (i)the σ the parameter for elasticity of substitution in the CES production function of the buyer (ii) x_{bjk} the share of input j in the production costs of the buyer and (iii) the elasticity of supply [24]. I will interpret how each parameter contributes to this channel.

First, the higher the σ, the more substitutability between products in the production function and the less relevant the marginal revenue channel. In the extreme, if $\sigma \rightarrow \infty$, then every input has a close substitute either from another seller in that same country or in another country and there is no differential marginal revenue effect for larger buyers, because there is no marginal revenue effect at all.[25]

Second, the higher the x_{bjk}, the more relevant the product for buyers' production. If $x_{bjk} = 1$, input j is the only input and the marginal revenue will have constant returns to scale, where increasing one unit of the input will increase on the same amount the marginal revenue. If that were the case, then the buyer market share would be irrelevant for this channel, because again, this channel would be shut down.

Third, the higher the elasticity of supply, the bigger the marginal revenue channel. Note that this is the only term in the marginal revenue channel that depends on the buyer market share. This effect differs by buyer market share. As the elasticity of supply is smaller for bigger buyers, the bigger the buyer, the less substantial the revenue (and price) decrease.

6 Model meets data

In this section, I map the expressions from the theoretical model to the data on Colombian exporters to the effect of an exchange rate shocks on international prices. The results confirm the mechanisms proposed by the theory and show the markdown channel dominates. Then, I use indirect inference to estimate the parameters that account for the markdown channel and quantify the effect. Robustness checks for this section are in the Appendix 9.2.4.

[24] As shown in equation 5.13, the marginal revenue channel depends on the production function of the buyers, since it is related to how the product bought is used for production. In my baseline model, I propose a CES production function, but I solve for alternative specification in appendix **??**.

[25] If the production function were a Cobb Douglas then $\sigma = 1$. This case is explored in the Appendix.

6.1 Exchange Rate Pass through

Consider a sudden change in the bilateral exchange rate between the home country and destination k. Below, I analyze the degree to which the exchange rate shock is passed on to international prices depending on buyer market power.

The theoretical pass-through regression Equation 5.16 cannot be directly estimated since pass-through Ψ_{sbjk} is not a variable that can be observed in the data. Therefore, I step back to the decomposition of the log price change in Equation 9.10, which I linearize in buyer market share.

6.1.1 Linearization

In order to estimate the effect of an exchange rate shock on prices for buyers with different market shares, I linearize the expression for equation 5.16 on the buyer market share, S_{bjk}. I then calculate a first order approximation, replace the differential d with a time operation Δ and rearrange deriving the following proposition:

Proposition 5 1. *The first-order approximation to the exchange rate pass-through elasticity into prices in seller currency for buyer b, in product j and destination k is given by*

$$\psi *_{bjk} \approx \mathbb{E}\left[\frac{\Delta p_{bjk}}{\Delta e_k}\right] = \alpha_{jk} + \beta_{jk} S_{bjk} \tag{6.1}$$

2. *The first-order approximation to the exchange rate pass-through elasticity into producer currency export prices for product j and destination k is given by*

$$\psi *_{jk} \approx \mathbb{E}\left[\frac{\Delta p_{jk}}{\Delta e_k}\right] = \alpha_{jk} + \beta_{jk} HHI_{jk} \tag{6.2}$$

where HHI_{jk} corresponds to the concentration of that sector in that destination.

Proof *See appendix.*

The pass-through elasticity $\psi *_{bjk}$ measures the equilibrium log change of a buyer-product-destination price relative to the log change in the bilateral exchange rate, averaged across all possible states of the world and economy shocks. Proposition 5 relates firm-level pass-through to buyer market share, which forms a sufficient statistic for cross-sectional variation in pass-through within product-destination, independently of the specifics of the general equilibrium environment, and of shocks that hit the economy and shape the dynamics of the exchange rate. The values of the coefficients in this relationship (α_{jk} and β_{jk}) can be estimated in the data. Furthermore, Proposition 5 provides closed form expressions for coefficients α_{jk} and β_{jk}.

Starting by Proposition 5, I arrive at my main empirical specification, where I regress the annual change in the log export price on the change in the log exchange rate, interacted with the buyer market share. Formally, the exchange rate pass-through into seller currency prices to buyer b, in product j and destination k:

$$\Delta p_{s,b,j,k,t} = \underbrace{[\alpha + \beta S_{b,j,k,t-1}]}_{Exchange\ rate\ pass\ through} \Delta e_{kt} + \underbrace{\varphi_{s,j,k} + \varphi_{s,t}}_{Fixed\ Effects} + \epsilon_{s,b,j,k,t} \tag{6.3}$$

where $\Delta p_{s,b,j,k,t}$ is the log change in price of good j from seller s to buyer b in country k at time t, $\Delta e_{k,t}$ is the log bilateral exchange rate change (Colombian peso seller currency per 1 unit buyer currency - destination k). That is, an increase in e_k corresponds to the bilateral depreciation of seller currency, Colombian peso, relative to the destination-k buyer currency. $\varphi_{s,j,k}, \varphi_{s,t}$ are destination-product-seller fixed effect, year-seller fixed effect. [26]

I estimate parameters α and β with values averaged across seller-product -destination-period. The regression equation 6.3 is a structural relationship that emerges from the theoretical model, and $S_{b,j,k,t-1}$ corresponds to my measure of buyer market share defined in Equation 9.1.2.[27] Note that $\alpha + \beta S_{b,j,k,t-1}$ corresponds to the exchange rate pass through coefficient. That is, if this term is zero, a shock in the exchange rate produces no change in the seller currency prices (Colombian pesos), and a proportional change (to the change in the exchange rate) into the buyer currency (rest of the world currency)[28].

The main empirical contribution of this paper corresponds to the coefficient β, which determines how the market share of the buyer affects the exchange rate pass through. If this coefficient is negative, larger buyers experience a lower change in price in the seller currency in response to exchange rate changes. For example, if Colombia depreciates its currency by 1%, this translates into a $\alpha + \beta$% change for the cases where a buyer is the only buyer in that destination, for that product in a given year. However, when there is more than one buyer, the effect of the ER shock is $\alpha + \beta S_{bjk}$%. I summarize the distribution of this variable in my data in the appendix.

I propose different specifications including the fixed effects indicated by parameters in the theoretical model. First, I include a year-HS-country fixed effect. This fixed effect is meant to isolate the differences between markets and compare across buyers with different market shares. Note that the inclusion of this fixed effect, controlling for market level outcomes, is also consistent with the assumption made in Section 5, in which I state that both the quantities that exporters sell to other buyers b, and the prices that other sellers charge to firm b, do not change.[29] Second, I include several fixed effects accounting for the seller dimension, such as a year-seller fixed effect to control for shocks to the marginal cost, quality and for characteristics of the buyer-seller relationship such as tenure, different products, etc. More robustness checks on this can be found in the Appendix 9.2.4.

6.2 Firm level main empirical findings

In Table 2, I present the results for my benchmark empirical specification, equation 6.3. To explore the underlying mechanisms behind the equilibrium relationship between pass-through and buyer market share I begin with a more simple specification and build up my benchmark empirical

[26] In the data, I test directly for the nonlinearity in this relationship and find no statistically significant evidence.

[27] In the appendix, I discuss the assumption that $\Delta e_{k,t}$ is uncorrelated with $S_{b,j,k,t-1}$ and so the OLS estimates of α and β from this regression are the theoretical coefficients in the pass through relationship.

[28] This would correspond to a complete exchange rate pass through as defined throughout the literature (Amiti, Itskhoki and Konings, 2014; Gopinath et al., 2020)

[29] In particular, for less saturated versions of the same regression, I also construct specific market level controls in the data and include them in the regression (e.g., market price index, inflation, GDP).

specification, equation 6.3. As the equation includes different set of fixed effects, we go from the least saturated regression to the more demanding fixed effects.

Table 2 reports the results. First, in column 1, I find that at the annual horizon the unweighted average exchange rate pass-through elasticity into seller prices in the sample is 0.16, or, equivalently, 0.84 ($= 1 - 0.16$) into destination prices. I include product-destination specific effects (where industry is defined at the HS 8-digit level) to be consistent with the theory, and year effects to control for common marginal cost variation. In column 2, I include an interaction between exchange rates and buyer market share. I show that the simple average coefficient reported in column 1 masks a considerable amount of heterogeneity, as buyers (for the same seller) with different market share have very different pass-through rates. Buyers with a high market share exhibit a lower exchange rate pass-through into seller-currency export prices. The median buyer in the sample has 13% market share and a pass through of 14% in the currency of the seller. As the market share increases, the pass through declines. For example, the pass through of a buyer with almost no market power (around zero market share) is 17.8% and a buyer with 50% of market share has only a 5% pass through.

Table 2: Effect of Buyers Market Share on Exchange Rate Pass-through

	(1)	(2)	(3)	(4)
	△ Log(Price)	△ Log(Price)	△ Log(Price)	△ Log(Price)
log(△ ER) = α	0.129*	0.110	0.178**	
	(0.0673)	(0.132)	(0.0805)	
S_{t-1}		-0.0884***	-0.106***	-0.0862***
		(0.00981)	(0.0110)	(0.0119)
log(△ER)xS_{t-1} = β		-0.332*	-0.246*	-0.266**
		(0.170)	(0.128)	(0.122)
Period FE	x			
Country-HS FE		x		
Period-Seller FE	x		x	x
Country-HS-Seller FE	x		x	
Country-HS-Period FE				x
N	515834	515834	515834	515834

Standard errors are clustered at the country-time level and are shown in parentheses * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

In order to better understand the results from my regression, Table 3 shows the number of firms with different levels of exchange rate pass through and buyer share. The largest buyers have on average between 0% and 5% pass-through while the smallest buyers have an exchange rate pass-through bigger than 20%.

Table 3

EPRT	Number of firms	Mean BS
$0 < \alpha + \beta BS_t < 0.05$	68548	0.91
$0.05 < \alpha + \beta BS_t < 0.10$	57011	0.66
$0.10 < \alpha + \beta BS_t < 0.15$	82935	0.44
$0.15 < \alpha + \beta BS_t < 0.20$	169764	0.21
$0.20 < \alpha + \beta BS_t$	1144500	0.02

These results reflect that the main mechanism dominating is the markdown channel as I find larger firms have lower exchange rate pass-through. That is, given larger buyers have market power, they internalize the upward sloping supply curve for inputs, which implies that each additional unit they buy rises the price of every other unit.[30] As a result, they increase prices by less than if the supply curve they face were flat. For a given buyer, the higher the market power, the steeper the supply curve faced, and so the lower the pass-through of an exchange rate shock to the seller's price. The intuition behind this is that larger buyers have more market power, which allows them to adjust the markdowns after the exchange rate shock without affecting the price.

6.3 Aggregation at the market level

In this section, I explore the market level exchange rate pass through. I start from the theoretical equation 6.2, and obtain the following regression at the market level:

$$\Delta p_{s,k,t} = [\alpha + \beta HHI_{s,k,t}]\Delta e_{kt} + FEs + \epsilon_{s,k,t}$$

where $\Delta p_{s,k,t}$ is the log change of the average price in a market, destination, year; $HHI_{s,k,t}$ is the Herfindhal Hirsh Index [31].

While calculating the exchange rate pass through at the market level, I can no longer include seller fixed effects to control for specific seller characteristics, such as, the seller market share. Thus, the coefficient of this regression could be reflecting either buyer or seller market power. To solve for this potential issue, I aggregate the information I have at the seller level, and calculate the concentration index also for the sellers. This allows me to disentangle the effects. On this ground, I can account accurately for the effect of buyer market concentration. Results for this regression are shown in Table 4: when exports are more concentrated among a few buyers, the exchange rate pass-through for the average market price is lower.

[30] This is analogous to a monopoly case where the only seller internalizes the downward slopping demand curve.

[31] We summarize the distribution of the Herfindhal Hirsh Index and the exchange rate pass through at the market level in the appendix of the appendix.

Table 4: Effect of Market Concentration on Average Exchange Rate Pass-through

	(1)	(2)	(3)	(4)
	△ Log(Price)	△ Log(Price)	△ Log(Price)	△ Log(Price)
L(△ ER) = α	0.0624**	-0.0313	0.120***	-0.0261
	(0.0274)	(0.0306)	(0.0316)	(0.0335)
HHIbuyer	0.00534	-0.00368	-0.00928**	-0.00692
	(0.00390)	(0.00554)	(0.00448)	(0.00712)
L(△ER) × HHIbuyer = β	-0.0674**	-0.329***	-0.338***	-0.284***
	(0.0342)	(0.0507)	(0.0360)	(0.0602)
HHIseller		0.0131**	0.0167***	0.0148**
		(0.00596)	(0.00470)	(0.00738)
L(△ER) × HHIseller		0.380***	0.212***	0.356***
		(0.0548)	(0.0418)	(0.0637)
HS FE	x	x		
Country FE	x	x		
Period FE	x	x	x	
HS - Country FE			x	x
HS - Period FE				x
N	153807	153807	153807	153807

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Column (1) shows that, even without controlling for seller HHI, buyer concentration has a significant relationship with exchange rate pass-through. Columns (2), (3) and (4) include information of the distribution of sellers' market share while controlling for period, HS-country and HS-period fixed effects. My preferred specification is Column (4), because it contains the most restrictive fixed effects. It shows that the concentration of the buyers has a strong influence in explaining the exchange rate pass through.

6.4 Estimation of the Markdown Channel

In the model, two key elasticities govern market power and so, the magnitude of the markdown channel: the elasticity of substitution across products, θ, and the elasticity of substitution within product, across buyers, η. In this section, I describe an approach which integrates (i) new empirical estimates using bilateral exchange rate shocks (done in section 6.2) and (ii) new moments from the cross-section, into (iii) a simulated method of moments routine in which all unknown parameters are estimated jointly.

6.4.1 Challenges for estimation

Equation 5.16, shows that the pass-through term, $\frac{dp_{sbjk}}{de_k}$ is a function of four parameters, η, θ, φ and S_{bjk}. Once we linearize on buyer market shares, S_{bjk}, I have two coefficients (Equation 6.1) which I obtain from running the regression in the data. The size of the coefficients, β and α are informative on the magnitudes of the elasticities θ and η. However, I cannot disentangle them from the effect of the marginal revenue, φ. This is a well-known issue in the markup literature (De Loecker and Warzynski, 2012), which is usually addressed by estimating the production function and backing out market power.[32] Instead, I combine the elasticities from the empirical part with moments from the cross section and use the structure of the model to estimate η and θ directly, along with other parameters.

6.4.2 Indirect Inference

I recover the parameters of the model through indirect inference implemented as simulated method of moments (SMM). I estimate all parameters jointly, but outline the estimation procedure separately for each group of parameters. Appendix **??** provides further details.[33]

Estimates for η and θ

In order to estimate η and θ, I proceed in the following steps: (1) estimate Equation 6.1 in the actual data, (2) simulate Equation 6.1 in the model, (3) pick η and θ so that the coefficients α and β from the model match their counterparts in the data.

I estimate Equation 6.1 in the actual data already is section 6.2 and obtain $\hat{\alpha}$ and $\hat{\beta}$. To simulate Equation 6.1 I use the following procedure. First, I draw the productivity of each buyer from an exogenous distribution.[34] For each guess of η and θ, I solve the model. Next, I shock the prices by drawing from the distribution of bilateral exchange rate shocks. I solve the model again to create a simulated panel, treating the outcomes across these two model economies as panel data. The resulting exchange rate pass-through coefficients, denoted $\beta(\eta,\theta)$ and $\alpha(\eta,\theta)$, are functions of η and θ.

I pick η and θ so that the pass-through coefficients estimated from the simulated data match the coefficients that I estimated from the actual data (coefficients from Table **??**) such that:

$$(\hat{\eta},\hat{\theta}) = arg \min_{\eta,\theta} \left\{ \|\hat{\alpha} - \alpha(\eta,\theta)\| + \|\hat{\beta} - \beta(\eta,\theta)\| \right\}$$

Estimate for φ_j

I take advantage of the data available for Colombia and use cross-section moments to estimate parameters that govern the marginal revenue product. Holding η and θ fixed, I normalize on one of the buyers in each market and calculate the relative prices. I use these values to estimate a term that contains x_j and σ together:

$$\frac{p_{sbjk}}{p_{sb'jk}} = \frac{p_{finalgood}}{p_{finalgood}} \left(\frac{x_{b'jk}}{x_{bjk}}\right)^{\sigma} \frac{e_k}{e_k}$$

External parameters: ϵ_k, z_b and others

I assume that (log) buyers productivity, $log\, z_b$ and log changes in exchange rate shocks, Δe_k, follow normal distributions:

[32] Another typical problem for the estimation of the elasticity of supply (and so the markdown) is that when firms behave strategically the structural elasticity cannot be measure using how prices respond to a well identifies shock. The structural elasticity is a partial equilibrium concept answering the counterfactual: how much firms change supply, holding its competitors q_{sbjk} constant. The reduced-form elasticity includes all other firms' responses.

[33] I follow a top-down approach related to Berger, Herkenhoff and Mongey (2022); **?** work

[34] This is needed in order to have non-symmetric buyer market shares.

$$log z \sim N(\mu_z, \sigma_z^2) \;\; and \;\; log \Delta e_k \sim N(\mu_e, \sigma_e^2)$$

For buyer productivity, I choose (μ_z, σ_z^2) such that it matches the distribution of buyers market shares. For bilateral exchange rate shocks, I choose (μ_e, σ_e^2) to match the distribution of log changes in bilateral exchange rate in the data. For buyer productivity, I choose (μ_z, σ_z^2) equal to (0,1). Finally, the number of products, and the number of buyers are also chosen to match the data from Colombia.

6.4.3 Parameter estimates

Parameter	Description	Value	Moment	Model	Data
A. Assigned					
N	Number of products	6,983			
M_j	Number of buyers per product	17			
μ_{e_k}	Mean of log ER changes	0.03			
$\sigma_{e_k}^2$	SD of log ER changes	0.1			
B. Estimates					
θ	Across product sustitutability	4.23	Baseline pass-through $\hat{\alpha}$	0.181	0.175
η	Across buyer sustitutability	1.11	Interaction buyer share $\hat{\beta}$	-0.243	-0.241
σ	Input sustitutability	0.3	Relative price level	0.012	0.013
z	Productivity shifter	0.05	Average firm size	0.21	0.23

Table 5: Summary of parameters

6.4.4 Quantifying the Markdown Channel

After obtaining the estimates for η and θ, and using the corresponding S_{bjk} in my data, I calculate the implied markdowns faced by Colombian exporters. I find the average markdown to be 26%. Then, using the structural equation from the model, I quantify the markdown channel. Figure 4 shows the markdown channel is bigger for buyer with larger market shares, once I plug in the estimates for the elasticities.

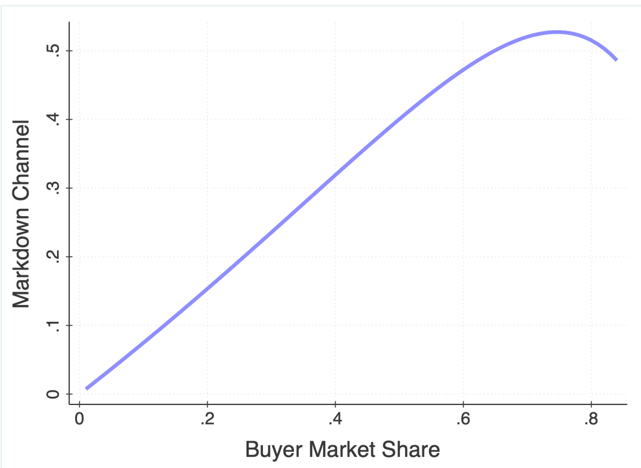


Figure 4: Markdown Channel and ERPT varies with size

7 Counterfactual Analysis and Implications

In this section I explore the macroeconomic effects of i) allowing for less concentrated markets, ii) eliminating market power.

7.1 Decreasing market concentration

The existence of large firms, especially, large buyers has been a growing concern for policy makers, given their macroeconomics effects (De Loecker, Eeckhout and Unger, 2020; Eggertsson, Robbins and Wold, 2021). These consequences become even more relevant in international markets, given there are not only a small number of high-performance players (Bernard et al., 2007; Morlacco, 2020) but also high entry costs that create barriers to competition (Antras, Fort and Tintelnot, 2017).

In this section, I study the quantitative implications of a reduction of the concentration of buyers. I use my estimated coefficients to calculate the average exchange rate pass through in a market. I start from the firm level expression for the pass through:

$$\frac{\mathrm{d}lnp_{sbjk}}{\mathrm{d}lne_k} = \alpha + \beta BS_{jbk}$$

Plugging in for the estimated coefficients, $\hat{\alpha}$, $\hat{\beta}$ and each firm's buyer size, I obtain a firm level exchange rate pass through which I then aggregate to the market level, using weights ω

$$\sum_{b'} w_{b'} \frac{\mathrm{d}lnp_{sbjk}}{\mathrm{d}lne_k} = \hat{\alpha} + \hat{\beta} \sum_{b'} w_{b'} BS_{jk}$$

Note that when I use the weight equal to the buyer shares, this leads to the following expression with the Herfindalh index:

$$\sum_{b'} BS_{jb'k} \frac{\mathrm{d}lnp_{sbjk}}{\mathrm{d}lne_k} = \hat{\alpha} + \hat{\beta} HHI_{jk}$$

Table 6, column (2) shows the results for benchmark calculation of the average exchange rate pass through. The first line corresponds to the case where the weights are the share of the buyer. The second line corresponds to having weights equal to the trade flow share the buyer has in the year, and the exchange rate pass through at the country-year level.

Table 6: Average Exchange Rate Pass Through

ω	Merger	Benchmark	Symmetric shares Different # buyers	Symmetric shares Equal # buyers
Buyer share	51.70%	**41.50%**	32.10%	1.30%
Trade flow	81%	**30.40%**	25.30%	16.20%

Comparing to these benchmark values, I propose three other counterfactual scenarios: a) A merge between the two biggest firm (in terms of buyer share) in every market - so this means an increase in concentration, b) leaving fixed the number of buyers in each market and assigning a symmetric share of sales to each buyer, and c) assigning the same number of buyers to each market (the median number of buyers across all markets with a symmetric distribution of sales among them.

[Interpretation of results to be added - Results make sense with theory]

7.2 Eliminating buyer market power

To explore the aggregate implications of buyer market power for the sellers in Colombia, I will propose a counterfactual where I eliminate buyer market power. Moving from an oligopsony structure to a perfect competition one with no strategic interactions implies changes on the level of revenues but also on the volatility of these revenues.

7.2.1 Level Effect

Under perfect competition, buyers still face upward sloping supply curves, whose shapes are determined by the cross-product elasticities of substitution (η) and within-product cross-buyers elasticity of substitution (θ). However, they do not internalize their influence over the price, but rather perceive a perfectly elastic supply curve ($\epsilon_{bjk} = 0$). Inputs prices are no longer marked down from their marginal revenue product, but rather they are equal to the marginal revenue product.
The change in the revenues of the sellers can be decomposed into two effects: a quantity effect and a price effect. In order to quantify these effects, I first simulate the model with and without market power. The total impact of buyer market power is the log difference in sellers revenues between the two scenarios:

$$\begin{aligned}\text{Total Effect} =& log \sum_{sbjk} p_{sbjk}^{PerfComp} q_{sbjk}^{PerfComp} - log \sum_{sbjk} p_{sbjk}^{Olig} q_{sbjk}^{Olig} \\ =& \underbrace{log \sum_{sbjk} p_{sbjk}^{PerfComp} q_{sbjk}^{Olig} - log \sum_{sbjk} p_{sbjk}^{Olig} q_{sbjk}^{Olig}}_{\text{Price Effect}} + \underbrace{log \sum_{sbjk} p_{sbjk}^{Olig} q_{sbjk}^{PerfComp} - log \sum_{sbjk} p_{sbjk}^{Olig} q_{sbjk}^{Olig}}_{\text{Quantity Effect}}\end{aligned}$$

Price Effect The price effect corresponds to the increase in price when removing markdowns; sellers earn higher revenues for supplying the same product to the same buyer. This effect can be thought of as a redistribution from buyers to sellers. To measure this effect, I calculate sellers' revenue using quantities from the oligopsony model baseline and prices from the perfect competition counterfactual.

Quantity Effect The quantity effect corresponds to efficiency gains. In the model, sellers trade off the price of a given buyer and a given product with their idiosyncratic shock for producing that product and supplying that buyer. This leads to misallocation: some sellers do not produce the product in which they are most productive, simply because its price index is too low. Conditional on a product, some sellers do not suppl the buyers with lower information frictions to connect with them, simply because his price is too low. Once buyer market power is removed, the trade off lessens and allows sellers to produce the product they are most productive on and supply their buyer with lower search costs/frictions. To measure this effect, I calculate sellers' revenue using prices from the oligopsony model baseline and quantities from the perfect competition counterfactual.

I find that sellers' revenues would be 31.1% higher in the absence of market power. Redistribution from buyers to sellers increases income by 24% and efficiency gains would increase sellers' revenues by 7%.[35].

7.3 Effect on Δ in revenues with ER shock:

[Still working on this, suggestions?]

$$(\Delta \sum_{sbjk} p_{sbjk}^{PerfComp} q_{sbjk}^{PerfComp}) - (\Delta \sum_{sbjk} p_{sbjk}^{Oligop} q_{sbjk}^{Oligop})$$

Example Colombian Devaluation 2015$\rightarrow$ 30% depreciation vs USD
Δ revenues oligopsony: -4% Δ revenues perfect competition: $+5\%$

[35] Although all farmers gain from perfect competition, the gains are not equally shared: increases are higher for markets with higher baseline level of buyer market concentration

8 Conclusion

This paper uncovers a key dimension in the international markets: buyer market power. I explore the effect of buyer market power in price setting, and moreover, in the transmission of exchange rate shocks across countries. Using an oligopsony model, I show that there is price discrimination in international markets and that this is explained by buyer market power. Moreover, buyer market power, and in turn, the concentration of buyers led to differences in the pass through of exchange rate shocks.

My empirical strategy focuses on Colombian exporters to the rest of the world. At the firm level, my findings suggest that bigger buyers pay lower prices, and have a lower exchange rate pass though to sellers currency. At the market level, in markets where buyers are more concentrated, prices have higher markdowns and exchange rate pass through in seller currency is lower.

This paper has important policy implications for sellers from developing countries that sell their products to large firms or multinationals abroad.

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9 Appendix

9.1 Appendix: theoretical model

9.1.1 Supply side: Frechet shocks

We assume that the shock is drawn from a nested Frechet distribution. Then,

$$H(\vec{\rho}) = \exp\left[-\sum_s B_s \left(\sum_a B_{sb}\rho_{sb}^{-\eta}\right)^{\frac{\theta}{\eta}}\right], \text{ with } \theta < \eta,$$

The seller chooses the buyer that it is going to yield the maximum profits. I will do this for firm a in sector s. The density function of choosing firm a and sector s is:

$$H_{sb}(\vec{\rho}) = -\theta \tilde{P}_s^{\theta-\eta} B_{sb}\rho_{sb}^{-\eta-1} \exp\left(-\left(\sum_{s'} \tilde{P}_{s'}^{\theta}\right)\right) d\rho_{sb}$$

where $\tilde{P}_{s'} = B_{s'}\left(\sum_{a'\in S'} B_{b'j'}\rho_{b'j'}^{-\eta}\right)^{\frac{1}{\eta}}$. In the rest of the paper, I will simplify β_{bj} and β_j to 1.

9.1.2 Supply side: share

We need to integrate two things, first the probability of choosing buyer b and product j, and second the total quantities. For a given seller, that is fixing q_s, the probability of choosing firm b and product j is the same as the probability that $\rho_{b'j'} \leq \frac{p_{sb}}{p_{b'j'}}\rho_{sb} = \frac{p_{sb}}{p_{b'j'}}\rho$.[36] Then[37]:

[36] This means that the revenue is higher in buyer b and product j.

[37] This is the probability that the shock is higher than any other shock. Specifically by looking at the equations we can see it is the probability that e_{sb} is higher that another shock (cdf of e on point $\frac{p_{sb}}{p_{b'j'}}\rho$) throughout the whole distribution of shocks e (integral part). Also, $\lambda = \int_0^\infty H_{sb}(\rho, \frac{p_{sb}}{p_{b'j'}}\rho, ...)$

$$
\begin{aligned}
\lambda_{bj} &= P(\rho_{b'j'} \leq \frac{p_{bj}}{p_{b'j'}}\rho_{bj}) \\
&= \int_0^\infty \underbrace{\exp\left(-\left(\sum_{j'} B_{j'}\left(\sum_{b'\in J'} B_{b'j'}\left(\frac{p_{bj}}{p_{b'j'}}\right)^{-\eta}\rho^{-\eta}\right)^{\frac{\theta}{\eta}}\right)\right)}_{Pr(\rho_{b'j'}\leq \frac{p_{bj}}{p_{b'j'}})} \underbrace{dH_{bj}(\rho)}_{density\ \ of\ \ \rho_{bj}} \\
&= \int_0^\infty \rho^{-\eta-1}\theta B_j B_{bj}\left(\sum_{b'\in S} B_{b'j'}\left(\frac{p_{sb}}{p_{b'j'}}\right)^{-\eta}\rho^{-\eta}\right)^{\frac{\theta-\eta}{\eta}} \exp\left(-\left(\sum_{s'} B_{s'}\left(\sum_{a'\in J'} B_{b'j'}\left(\frac{p_{bj}}{p_{b'j'}}\right)^{-\eta}\rho^{-\eta}\right)^{\frac{\theta}{\eta}}\right)\right) d\rho \\
&= \int_0^\infty \rho^{-\eta-1}\theta B_j B_{bj} p_{bj}^{\eta-\theta}\left(\sum_{b'\in M} B_{b'j'} p_{b'j'}^{\eta}\rho^{-\eta}\right)^{\frac{\theta-\eta}{\eta}} \exp\left(-\rho^{-\theta} p_{bj}^{-\theta}\left(\sum_{j'} B_{j'}\left(\sum_{b'\in j'} B_{b'j'} p_{b'j'}^{\eta}\right)^{\frac{\theta}{\eta}}\right)\right) d\rho \\
&= \int_0^\infty \theta P_j^{\theta-\eta} B_{bj} p_{bj}^{\eta-\theta}\rho^{-\theta-1}\exp\left(-\rho^{-\theta}p_{bj}^{-\theta}\left(\sum_{j'} P_{j'}^{\theta}\right)\right) d\rho \\
&= \qquad \underbrace{\frac{P_j^{\theta}}{\sum_{j'} P_{j'}^{\theta}}}_{Pr(f\ \ chooses\ \ product\ \ j)} \qquad \underbrace{\frac{B_{bj} p_{bj}^{\eta}}{P_j^{\eta}}}_{Pr(seller\ \ chooses\ \ buyer\ \ b|j)} \qquad \underbrace{\int_0^\infty -\exp(-u)du}_{=1}
\end{aligned}
$$

This expression has an intuitive interpretation: conditional on choosing product j, the probability of choosing buyer b, Pr(b—j) depends on how large the price of buyer b (numerator) is relative to the price index of product j (denominator), which is a CES aggregate of prices across buyers within a sector. The unconditional probability of choosing product j, Pr(j), then depends on how large the price index of sector s (numerator) is relative to the overall price index (denominator), which is a CES aggregate of price indexes across sectors. As the elasticities increase, the price becomes more important in determining whether a seller chooses buyer b, conditional on choosing product j. This means, the easiest is to switch from product to product, the more relevant the price ratio is.

So we get that the **share of seller's s production that is consumed by buyer b and product j** is:

$$
\lambda_{sb} = \frac{P_j^{\theta}}{\sum_{j'} P_{j'}^{\theta}}\frac{B_{bj} p_{bj}^{\eta}}{P_j^{\eta}}
$$

where $P_j = B_j \left(\sum_{b'\in B} B_{b'j} p_{b'j}^{\eta}\right)^{\frac{1}{\eta}}$.

9.1.3 Supply curve: Choice of quantity

Aggregating across sellers yields a nested CES supply curve for buyer b in product j. We know that :

$$
p_{bj} q_{bj} = \lambda_{bj} PQ
$$

The expected quantity supplied by seller w to buyer a in sector s is

$$q_{sbj} = q_s Pr(sbj)$$

Integrating over sellers yields the total quantity in product j supplied to buyer b:

$$\begin{aligned}
q_{sbjk} &= \int_0^1 Pr(sbjk) q_s dR \\
&= \int_0^1 \frac{p_{bjk}^{1+\eta}}{\sum_b P_{bjk}^{1+\eta}} \frac{(\sum_b p_{bjk}^{1+\eta})^{\frac{1+\theta}{1+\eta}}}{\sum_{j'} (\sum P_{a's}^{\eta})^{\frac{1+\theta}{1+\eta}}} q_s dR \\
&= \frac{p_{sb}^{\eta}}{\sum_a P_{sb}^{\eta}} \frac{\sum_a (p_{sb}^{\eta})^{\frac{\theta}{\eta}}}{\sum_{s'} (\sum P_{a's}^{\eta})^{\frac{\theta}{\eta}}} \underbrace{\int_0^1 p_{sb} q_s dR}_{Y}
\end{aligned}$$

Multiplying both sides by p_{sb} and summing across sectors and buyers, we have $Y = \sum_{sb} p_{sb} q_{sb}$, so that Y is total spending by buyers on sectors. So, the quantity supplied to buyer a of product x in sector s is:

$$q_{bjk} = \left(\frac{p_{bj}^{\eta}}{P_j^{\eta}}\right) \left(\frac{P_j^{\theta}}{P^{\theta}}\right) Y \tag{9.1}$$

where $P = \left(\sum_{s'} P_{s'}^{\theta}\right)^{\frac{1}{\theta}}$.

9.1.4 Supply side: Seller production function instead of endowment

the quantity a seller with productivity q_s and idiosyncratic shocks ρ_{sjk}, ρ_{sbjk} could sell [38] of product j to buyer b, is then determined by their productivity and the idiosyncratic shocks:

$$q_{sbjk} = \rho_{sbjk}^{\frac{1}{\eta}} \rho_{sjk}^{\frac{1}{\theta}} q_s \tag{9.2}$$

where q_s is a function of labor and does not depend of b. This would mean the seller uses labor to produce and wages adjust where is no longer profitable to keep on producing. Therefore, the production is bounded. An example could be $q_s = L_{sjk}$ and bringing profits for the seller: $p_{sjk} L_{sjk} - wLbjk$ and (perfect competition w=p?)

q_s is seller specific As it can be shown in Appendix 9.1.2, if the production function is seller specific then, for a given seller the probability of choosing firm b and product j does not depend on the production function. Therefore, the quantity supplied in equilibrium relative to other buyers and products would be the same as in the baseline model.

9.1.5 Demand curve: Choice of price

Bertrand Competition

[38] Note that this is not the actual quantity sold, but that quantity that a seller could sell at most to a buyer a in sector s, if they choose to supply buyer a in sector s

$$\pi_{bj} = p_{finalg}Q_{finalg} - \sum_s \frac{1}{e} p_{bj}q_{bj} \quad \text{s.t.} \quad Q_{finalg} = \left(\int_s q_{bj}^{\frac{1-\gamma}{\gamma}} ds \right)^{\frac{\gamma}{\gamma-1}} \quad and \quad q_{bj} = \frac{p_{bj}{}^{\eta-1}}{P_s{}^{\eta-1}} \frac{P_s{}^{\theta-1}}{P^{\theta-1}} Y \tag{9.3}$$

The FOC imply that:

$$[p_{bj}] : \frac{\partial(revenue)}{\partial q_{bj}} \frac{\partial q_{bj}}{\partial p_{bj}} - \frac{1}{e} \left[q_{bj} + p_{as} \frac{\partial q_{bj}}{\partial p_{bj}} \right] = 0$$

$$\frac{\partial(revenue)}{\partial q_{bj}} - \frac{1}{e} \left[q_{bj} \frac{\partial p_{bj}}{\partial q_{bj}} + p_{as} \right] = 0$$

$$\frac{\partial(revenue)}{\partial q_{bj}} - \frac{1}{e} \left[p_{bj} \frac{q_{bj}}{p_{bj}} \frac{\partial p_{bj}}{\partial q_{bj}} + p_{as} \right] = 0$$

$$\frac{\partial(revenue)}{\partial q_{bj}} - \frac{1}{e} p_{bj} \left[\frac{1}{\epsilon} + 1 \right] = 0$$

$$\underbrace{MVP_s}_{\text{Marginal Value of Product s}} - \frac{1}{e} p_{bj} \frac{1+\epsilon_{bj}}{\epsilon_{bj}} = 0$$

where ϵ_{bj} is the supply elasticity to firm a. Then, we get that

$$p_{sbj} = \frac{\epsilon_{bj}}{1+\epsilon_{bj}} e MVP_s \tag{9.4}$$

Cournot Competition

$$\pi_{bj} = p_{finalg}Q_{finalg} - \sum_s \frac{1}{e} p_{bj}q_{bj} \quad \text{s.t.} \quad Q_{finalg} = \left(\int_s q_{bj}^{\frac{1-\gamma}{\gamma}} ds \right)^{\frac{\gamma}{\gamma-1}} \quad and \quad q_{bj} = \frac{p_{bj}{}^{\eta-1}}{P_s{}^{\eta-1}} \frac{P_s{}^{\theta-1}}{P^{\theta-1}} Y \tag{9.5}$$

The FOC imply that:

$$[q_{bj}] \frac{\partial p_{bj} q_{bj}}{\partial q_{bj}} - \frac{1}{e} \left[\frac{\partial p_{bj}}{\partial q_{bj}} q_{bj} + p_{bj} \right] = 0$$

$$MVP(e) - \frac{1}{e} p_{bj} \left[\frac{\partial p_{bj}}{\partial q_{bj} p_{bj}} q_{bj} + 1 \right] = 0$$

$$p_{bj} \left[\frac{1}{\epsilon} + 1 \right] = \frac{MVP(e)}{\frac{1}{e}}$$

$$p_{bj} = \frac{\epsilon}{1+\epsilon} e MVP(e)$$

9.1.6 markdown and price setting

I begin by testing the implications of Proposition **??** of my model: bigger buyers pay lower prices. For doing so, I run the following regression:

$$log(price_{sbjkt}) = \xi BS_{bjkt} + FE_{sjkt} + X_{kt} + \epsilon_{sbjkt} \tag{9.6}$$

where $log(price_{sbjkt})$ is the price of product j, seller s charges to buyer b at destination k in period t and $X_{k,t}$ are control variables at the country and time level. To represent this relationship, I plot the bin scatter of the demeaned variables, as well as the fitted line. The slop of this line is the main coefficient of the regression (ξ). Figure 5 Panel A shows that the price of the same product, sold to the same destination in a given year is decreasing in the buyer's size. This is true, even controlling for destination and time specific variables.

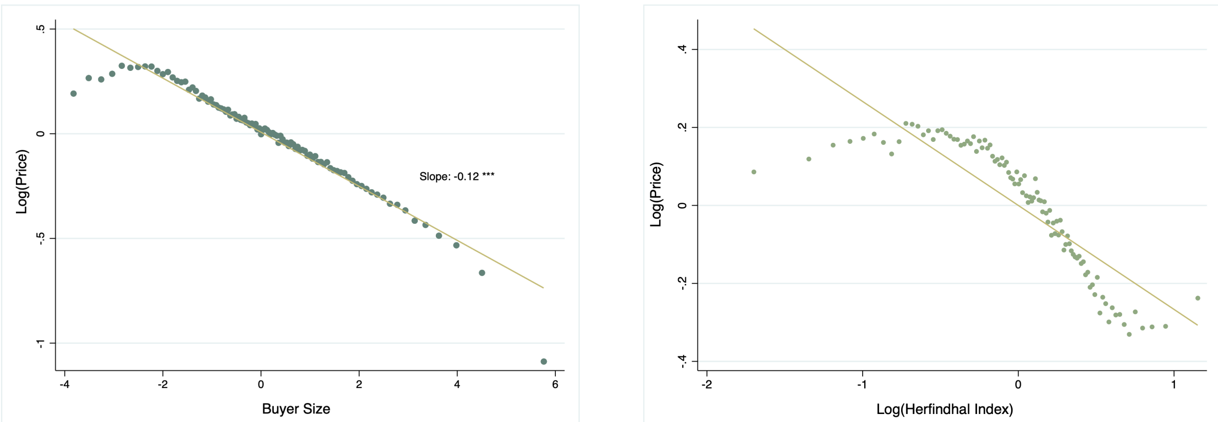
Then, I turn to the market-level predictions of the model. I aggregate Equation 9.6 at the market level such that price in a market can be expressed as a weighted average of prices for a given product in a given destination where the weights correspond to the buyers' market share. I obtain the average price of a product for a destination for a given year as a function of the concentration of the market, expressed as the market's Herfindahl-Hirschman index, $HHI_kt = \sum_{b=1}^{B} BS^2_{bjkt}$: [39]

$$log(price_{jkt}) = \xi HHI_{jkt} + FE_{jkt} + X_{kt} + \epsilon_{jkt} \tag{9.7}$$

Figure 5 Panel B shows the correlation between the market price of a product and the concentration of buyers in that given market. It can be noted how for a bigger concentration of buyers, prices tend to be lower in that market.[40]

Figure 5

A: Prop. I: Buyer Size and Price B: Prop. II: Market Concentration and Price



9.1.7 Elasticity of supply

We are missing what is the value of ϵ_{bj}. For this, we can go back to the quantity supplied and calculate it:

[39] See the Appendix for proof

[40] Given the potential endogeneity in this regression, as mention in Bresnahan (1989), in the Appendix XXX, I use an IV equal to how big is the buyer in other markets to estimate this relationship. Results hold.

$$q_{bj} = \frac{{p_{bj}}^{\eta-1}}{{P_s}^{\eta}} \frac{{P_s}^{\theta}}{P^{\theta}} Y$$

$$\epsilon = \frac{\partial q}{\partial p} \frac{p}{q} = \left[(\eta - 1) \frac{{p_{bj}}^{\eta}}{p_{bj}} \frac{{P_s}^{\theta}}{{P_s}^{\eta}} \frac{Q}{P^{\theta}} + (\theta - \eta) \frac{P_s^{\theta-\eta}}{P_s} {p_{bj}}^{\eta-1} \frac{Q}{P^{\theta}} \right] \frac{p_{bj}}{q_{bj}}$$

$$\epsilon = \left[(\eta - 1) \frac{q_{bj}}{p_{bj}} + (\theta - \eta) \frac{q_{bj}}{P_s} \right] \frac{p_{bj}}{q_{bj}}$$

$$\epsilon = (\eta - 1) + (\theta - \eta) \frac{p_{bj}}{P_s}$$

$$\epsilon_{bj} = \frac{d \ln q_{bj}}{d \ln p_{bj}} = (\eta - 1) \left(1 - \left(\frac{p_{bj}^{\eta-1}}{\sum_{a' \in s} p_{a's}^{\eta-1}} \right) \right) + (\theta - 1) \left(\frac{p_{bj}^{\eta-1}}{\sum_{a' \in s} p_{a's}^{\eta-1}} \right)$$

$$\epsilon_{bj} = (\eta - 1) \left(1 - Share \right) + (\theta - 1) \left(Share \right)$$

$$p_{bj} = \frac{1}{\frac{1}{\epsilon_{bj}} + 1} e MVP_j$$

"The elasticities of substitution at the buyer and product levels, $\eta > 0$ and $\theta > 0$, jointly affect the labor market power of firms. $\eta > 1$ is the is the supply elasticity for firms within product, and $\theta > 1$ is the supply elasticity for products. $\eta > \theta$ since its easier to find a new buyer than sell in a new sector. The share corresponds to how big a buyer is in a destination for for that product. Note that if the share increases, the elasticity of supply decreases and the markdown decreases. Intuitively, it makes sense that if we move the e to the left hand side, the price in local currency stays constant. Independently of external factors, the buyer is the one that has power and he wants to set the price equal to the marginal revenue of the input."

9.1.8 Pass Through

The starting point for this analysis is the optimal price setting equation, which we rewrite including now a destination index k:

$$p_{ask} = \frac{\epsilon_{ask}}{1 + \epsilon_{ask}} e MVP_{ask}$$

Rewriting this equation as the sum of logs. We assume that the mark-up depends on the price charged by the exporting firm relative to the aggregate industry price level in the destination country d:

$$lnp_{asd} = ln\mu_{asd} + lnMVP_{asd} + lne_d$$

So log-differentianting, we have that the log change in price $\triangle p_{asd}$ can be approximated as

$$\triangle lnp_{asd} = \triangle ln\mu_{asd} + \triangle lnMVP_{asd} + \triangle lne_d \tag{9.8}$$

We assume that the mark-down depends on the price charge by the seller from country d relative to the (log) aggregate industry price level in the origin country d, p_{sb} That is, $\mu_{asd} = \mu_{asd}(p_d - p)$

Then we get expression:

$$\triangle p_{asd} = \Upsilon_{asd}(\triangle p_{asd} - \triangle p_{asd}) + mvp_q \triangle q_{asd} + \alpha_{asd} \triangle e_d$$

where $\Upsilon_{asd} = -\frac{\mu_{asd}}{(p_d - p)}$ is the elasticity of the mark-up with respect to the relative price (contant markdownss, this = 0), $mvp_q = \frac{\partial mvp(...)}{\partial q}$ is the elasticity of the marginal value with respect to output(assumed common across firms), and $\alpha = \frac{\partial mvp()}{\partial e_d}$ is the partial-elasticity of the marginal value(expressed in destination country's currency) to the exchange rate. We assume $\frac{\partial mvp()}{\partial w} = 0$

Log demand is given by $q_{asd} = q(p_{asd} - p_s) + \triangle q_d$ where q_d denotes the log of the aggregate quantities/demand in country n. Log-differentiating,

$$\triangle q_d = -\epsilon_d(\triangle p_{asd} - \triangle p_d) + \triangle q_d$$

where $\epsilon_d = -\frac{\partial q(.)}{\partial p_d} > 0$ is the price elasticity of **supply**.

Combining these two equations and collecting terms we get:

$$\triangle p_{asd} = \frac{1}{1 + \Upsilon_{asd} + \phi_{asd}}[-\alpha \triangle e_d + (\Upsilon_{asd} + \phi_{asd}) \triangle p_{asd} + mvp_q \triangle q_d]$$

where $\phi_d = mvp_q \epsilon_d > 0$ is the partial elasticity of mvp with respect to the relative price.

Going back to (9.8) and solving for each term:

- Consider first the markdown term:

$$\text{dln}\mu_{bjk} = \Gamma_{bjk}\, \text{dln} p_{bjk}$$

with $\Gamma_{bjk} = -\frac{\partial ln\mu_{bjk}}{\partial p_{bjk}} > 0$ as the partial elasticity of bilateral markdowns with respect to the price, p_{bjk}. Note that $\frac{\partial ln\mu_{bjk}}{\partial BS_{bjk}} > 0$ is negative, because higher buyer share, lower elasticity, lower markdown.

$$\begin{aligned}
\Gamma_{bjk} &= -\frac{d \ln \mu_{bjk}}{d \ln p_{bjk}} \\
&= -\frac{d \ln \mu_{bjk}}{d \ln S_{bjk}} \times \frac{d \ln S_{bjk}}{d \ln p_{bjk}}
\end{aligned}$$

where ϵ_{asd} is the price elasticity of supply.

and

$$S_{bjk} = \frac{p_{bjk}^{\eta-1}}{\sum_x p_{bjk}^{1-\eta}}$$

$$ln(S_{bjk}) = ln(p_{bjk}^{1-\eta}) + ln(\sum_s p_{sb}^{1-\eta})$$

$$\mathrm{d}lnS_{bjk} = 1-\eta\frac{dp_{bjk}}{dp_{bjk}} - 1-\eta\frac{1}{\sum_s p_{bjk}^{\eta-1}}\frac{p_{bjk}^{\eta-1}}{p_{bjk}}dp_{bjk}$$

$$dln(S_{bjk}) = 1-\eta\,\mathrm{d}lnp_{bjk} - 1-\eta)S_{bjk}\,\mathrm{d}lnp_{bjk}$$

$$\mathrm{d}lnS_{bjk} = \Big[1-\eta-1-\eta)S\Big]\,\mathrm{d}lnp_{bjk}$$

$$\mathrm{d}lnS_{bjk} = 1-\eta(1-S_{bjk})\,\mathrm{d}lnp_{bjk}$$

$$\mathrm{d}lnS_{bjk} = 1-\eta\,\mathrm{d}ln(p_{bjk}) - 1-\eta$$

$$\mathrm{dln}\mu = \Upsilon_{sbjk}(\eta+1)(1-S_{bjk})\,\mathrm{dln}p_{bjk} \tag{9.9}$$

$$\mathrm{dln}\mu = \Gamma_{bjk}\,\mathrm{dln}p_{bjk}$$

where
$\Gamma_{bjk} = -\frac{d\ln\mu_{bjk}}{d\ln p_{bjk}} = \frac{S_{bjk}}{\left(\frac{\eta}{\theta-\eta}+S_{bjk}\right)\left(1+\frac{\theta-\eta}{\eta+1}S_{bjk}\right)} > 0$

- Consider the second term:

$$MVP = \frac{\partial revenues}{\partial q_b jk}$$

$$\frac{dlnMVP_{bjk}}{dlnp_{bjk}} = \frac{dlnMVP_{bjk}}{dlnq_{bjk}}\frac{dlnq_{bjk}}{dlnp_{bjk}}$$

$$\frac{dlnMVP_{bjk}}{dlnp_{bjk}} = \frac{dMVP}{dq_{bjk}}\frac{q_{bjk}}{MVP_{bjk}}\epsilon_{bjk}$$

$$\frac{dlnMVP_{bjk}}{dlnp_{bjk}} = (\alpha_j-1)\frac{MVP_{bjk}}{q_{bjk}}\frac{q_{bjk}}{MVP_{bjk}}\epsilon_{bjk}$$

$$\frac{dlnMVP_{bjk}}{dlnp_{bjk}} = (\alpha_j-1)\epsilon_{bjk}$$

So, given a change in bilateral exchange rate $\mathrm{d}lne_d$, as in Burstein and (2015) there is a direct and indirect effect.

The direct component of the exchange-rate pass-through is:

$$\frac{\mathrm{d}lnp_{sbj}}{\mathrm{d}lne_d} = \frac{1}{1\underbrace{-\Upsilon_{bjk}(1-\eta_{bjk})(1-S_{bjk})}_{Markdownchannel} - \underbrace{(\alpha_j-1)\epsilon_{bjk}}_{ValueChannel}}$$

Taking into account that d; np_{sbj} is in USD we can change this equation into Colombian pesos by using the following:

$$\mathrm{d}lnp_{sbj}^{dolars} = \mathrm{d}lnp_{asd}^{pesos} - \mathrm{d}lne$$

And so we get:

$$\frac{\mathrm{d}lnp_{sbjk}}{\mathrm{d}lne_d} = 1 - \frac{1}{1 \underbrace{-\Upsilon_{bjk}(1-\eta)(1-S_{bjk})}_{Markdownchannel} - \underbrace{(\alpha_j - 1)\epsilon_{bjk}}_{ValueChannel}}$$

where $\Upsilon_{bjk} = \frac{\mathrm{dln}\mu_{bjk}}{\mathrm{dln}S_{bjk}}$

9.1.9 Path Through: General Case

Log-differentiating Equation 5.5, I get that the log change in price, $dlnp_{sbj}$, can be written as:

$$dlnp_{sbjk} = \mathrm{dln}\mu_{bjk} + dlnMVP_{sbjk} + dlne_k \tag{9.10}$$

Consider first the markdown term:

$$\mathrm{dln}\mu_{bjk} = \Gamma_{bjk}\,\mathrm{dln}p_{bjk}$$

with $\Gamma_{bjk} = -\frac{\partial ln\mu_{bjk}}{\partial p_{bjk}} > 0$ as the partial elasticity of bilateral markdowns with respect to the price, p_{bjk}.

$$\begin{aligned}
\Gamma_{bjk} &= -\frac{d\ln\mu_{bjk}}{d\ln p_{bjk}} \\
&= -\frac{d\ln\mu_{bjk}}{d\ln S_{bjk}} \times \frac{d\ln S_{bjk}}{d\ln p_{bjk}}
\end{aligned}$$

Solving for the first term: $\frac{d\ln\mu_{bjk}}{d\ln S_{bjk}}$

$$\begin{aligned}
\mu_{bjk} &= \frac{1}{1+\frac{1}{\epsilon_{bjk}}} \\
\frac{d\ln\mu_{bjk}}{d\ln S_{bjk}} &= \frac{\theta(1-S_{bjk})}{\frac{1}{S_{bjk}} + \frac{\theta-\eta}{\eta+1}} \\
&= \Upsilon_{bjk} < 0 \ (by\ prop\ II)
\end{aligned}$$

Solving for the second term:

$$\begin{aligned}
S_{bjk} &= \frac{p_{bjk}^{\eta+1}}{\sum_x p_{bjk}^{1+\eta}} \\
lnS_{bjk} &= lnp_{bjk}^{1+\eta} + ln(\sum_s p_{bjk}^{1+\eta}) \\
\mathrm{d}lnS_{bjk} &= (1+\eta)\frac{dp_{bjk}}{p_{bjk}} - (1+\eta)\frac{1}{\sum_s p_{bjk}^{\eta+1}}\frac{p_{bjk}^{\eta+1}}{p_{bjk}}dp_{bjk} - \sum_{z\neq b}(1+\eta)\frac{p_{zjk}}{\sum_b p_{bjk}^{1+\eta}}\frac{{p_{zjk}}^{1+\eta}}{p_{zjk}}\frac{dp_{zjk}}{dp_{bjk}}dp_{bjk}\frac{p_{bjk}}{p_{bjk}} \\
dlnS_{bjk} &= (1+\eta)\,\mathrm{dln}p_{bjk} - (1+\eta)S_{bjk}\,dlnp_{bjk} - (1+\eta)\sum_z S_{zjk}\frac{p_{bjk}}{p_{zjk}}\frac{dp_{zjk}}{dp_{bjk}}\,\mathrm{dln}p_{bjk} \\
\mathrm{d}lnS_{bjk} &= (1+\eta)(1-S_{bjk} - \sum_z S_{zjk}\frac{d\ln p_{zjk}}{d\ln p_{bjk}})\,\mathrm{d}lnp_{bjk}
\end{aligned}$$

Finally,

$$\mathrm{dln}\mu_{bjk} = \Upsilon_{sbjk}(\eta_{bjk}+1)(1-S_{bjk} \underbrace{- \sum_z S_{zjk}\frac{d\ln p_{zjk}}{d\ln p_{bjk}}}_{Indirect})\,\mathrm{dln}p_{bjk} \tag{9.11}$$

$$\frac{\text{dln}\mu_{bjk}}{\text{dln}p_{bjk}} = \underbrace{\Gamma^*_{bjk}}_{Direct}$$

– ER shock will shift the price offer by buyer z to that firm, p_{zjk}.

– The change in price p_{zjk} will change the quantity sold, q_{zjk}, which its magnitude captured by ϵ

– The change in quantities will induce the change in buyer share S_{bjk} (of which magnitude is captured by S_{zjk}). This change in the buyer share S_{bjk} will alter the price p_{bjk} , both through the change in markdown and revenue channel.

– These additional shifts in the price p_{bjk} work as additional ER shocks on buyer b.

9.1.10 Proof of Proposition 3: Log linearization and First Order Approximation

$$p_{bjk} = \mu_{bjk} e_k MVP_{bjk}$$

$$ln p_{bjk} = \ln \mu_{bjk} + \ln e_k + \ln MVP_{bjk}$$

$$\mathrm{dln} p_{bjk} = \frac{\mathrm{dln}\mu_{bjk}}{\mathrm{dln}S_{bjk}} \frac{\mathrm{dln}S_{bjk}}{\mathrm{dln}p_{bjk}} \mathrm{dln}p_{bjk} + \mathrm{dln}e_k + (1-\alpha)\epsilon_{bjk}\, \mathrm{dln}p_{bjk}$$

Starting from the pass through equation:

$$\mathrm{dln}p_{\mathrm{sbj}} = \frac{1}{1 + \underbrace{\Gamma_{bjk}}_{Mark\ down\ channel} + \underbrace{\Phi_{bjk}}_{Marginal\ Revenue\ Channel}} \mathrm{dln}e_d$$

$$\mathrm{dln}p_{\mathrm{bjk}} = \frac{1}{1 - \frac{\mathrm{dln}\mu_{bjk}}{\mathrm{dln}S_{bjk}}(1+\eta)(1-S_{bjk}) + (1-\alpha_j)\epsilon_{bjk}} de_k \quad where\ \Upsilon = \frac{\mathrm{dln}\mu_{bjk}}{\mathrm{dln}p_{bjk}}$$

Doing a first order approximation in S_{sbjk} and dividing by $\mathrm{dln}e_d$:

$$\frac{\mathrm{dln}p_{\mathrm{sbjk}}}{d\ln e_d} \approx \frac{1}{1+\bar{\Upsilon}_{bjk}(1-\eta)\left(1-\bar{S}_{\mathrm{bjk}}\right)+(1-\alpha_j)\bar{\epsilon}} + \frac{\left.\frac{\partial \Upsilon_{bjk}}{\partial S_{sbjk}}\right|_{\bar{S}_{sbjk}} \cdot (1+\eta)(1-\bar{S}_{bjk}) - \bar{\Upsilon}_d(1+\eta)\cdot \left.\frac{\partial \epsilon_{bjk}}{\partial S_{bjk}}\right|_{\bar{S}_{bjk}}(1-\alpha_j)}{\left[1+\bar{\Upsilon}_{bjk}(1-\eta)\left(1-\bar{S}_{\mathrm{bjk}}\right)+(1-\alpha_j)\bar{\epsilon}\right]^2}(S_{bjk}-\bar{S}_{bjk})$$

Separating terms multiplied by BS and $\bar{BS}$:

$$\frac{\mathrm{dln}p_{\mathrm{axsd}}}{\mathrm{dln}e_d} \approx \left[\frac{1}{1+\bar{\Upsilon}_{bjk}(1-\eta)\left(1-\bar{S}_{\mathrm{bjk}}\right)+(1-\alpha_j)\bar{\epsilon}} - \frac{\left.\frac{\partial \Upsilon_{d}}{\partial S_{sbjk}}\right|_{\bar{S}_{sbjk}} \cdot (1+\eta)(1-\bar{S}_{bjk}) - \bar{\Upsilon}_d(1+\eta)\cdot \left.\frac{\partial \epsilon_{bjk}}{\partial S_{bjk}}\right|_{\bar{S}_{bjk}}(1-\alpha_j)}{\left[1+\bar{\Upsilon}_{bjk}(1-\eta)\left(1-\bar{S}_{\mathrm{bjk}}\right)+(1-\alpha_j)\bar{\epsilon}\right]^2} \cdot \bar{S}_{bjk}\right.$$
$$\left. + \left[\frac{\left.\frac{\partial \Upsilon_{d}}{\partial S_{sbjk}}\right|_{\bar{S}_{sbjk}} \cdot (1+\eta)(1-\bar{S}_{bjk}) - \bar{\Upsilon}_d(1+\eta)\cdot \left.\frac{\partial \epsilon_{bjk}}{\partial S_{bjk}}\right|_{\bar{S}_{bjk}}(1-\alpha_j)}{\left[1+\bar{\Upsilon}_{bjk}(1-\eta)\left(1-\bar{S}_{\mathrm{bjk}}\right)+(1-\alpha_j)\bar{\epsilon}\right]^2}\right] \cdot S_{bjk}\right.$$

Getting together the terms with $\frac{\Delta \ln p_{\mathrm{axsd}}}{\Delta \ln e_d}$ and taking common factor of terms with BS and $\bar{BS}$:

$$\frac{\mathrm{dln}p_{\mathrm{bjk}}}{\mathrm{dln}e_d} \approx \alpha_{bjk} + \beta_{bjk} S_{bjk}$$

where:

$$\alpha_{bjk} = \left[\frac{1}{1+\bar{\Upsilon}_{bjk}(1-\eta)\left(1-\bar{S}_{\mathrm{bjk}}\right)+(1-\alpha_j)\bar{\epsilon}} + \frac{\left.\frac{\partial \Upsilon_{d}}{\partial S_{bjk}}\right|_{\bar{S}_{bjk}} \cdot (1+\eta)(1-\bar{S}_{bjk}) - \bar{\Upsilon}_d(1+\eta)\cdot \left.\frac{\partial \epsilon_{bjk}}{\partial S_{bjk}}\right|_{\bar{S}_{bjk}}(1-\alpha_j)}{\left[1+\bar{\Upsilon}_{bjk}(1-\eta)\left(1-\bar{S}_{\mathrm{bjk}}\right)+(1-\alpha_j)\bar{\epsilon}\right]^2}\right]$$

$$\beta_{bjk} = \left[\frac{\left.\frac{\partial \Upsilon_{d}}{\partial S_{bjk}}\right|_{\bar{S}_{bjk}} \cdot (1+\eta)(1-\bar{S}_{bjk}) - \bar{\Upsilon}_d(1+\eta)\cdot \left.\frac{\partial \epsilon_{bjk}}{\partial S_{bjk}}\right|_{\bar{S}_{bjk}}(1-\alpha_j)}{\left[1+\bar{\Upsilon}_{bjk}(1-\eta)\left(1-\bar{S}_{\mathrm{bjk}}\right)+(1-\alpha_j)\bar{\epsilon}\right]^2}\right]$$

$\rightarrow \beta$ is the coefficient of interest

9.1.11 Corollary 1

In this equation, κ is the effect of an exogeneous shock on the payroll Herfindhal. To derive the expression, plug in $\mu_{jkt} = 1 + \epsilon_{jkt}^{-1}$ and differentiate:

$$\begin{aligned}\kappa = \frac{d\mu_{jkt}}{dX} =& \frac{d(1+\epsilon_{jkt}^{-1})}{dX} \\ =& \Big[\frac{d(1+\epsilon_{jkt}^{-1})}{dHHI_{jkt}} \frac{dHHI_{jkt}}{dX}\Big] \\ =& \Big[\frac{d(1+\epsilon_{jkt}^{-1})}{dHHI_{jkt}} \kappa_t\Big] \\ =& \Big(\frac{1}{\theta} - \frac{1}{\eta}\Big)\kappa_t\end{aligned}$$

I then compute the standard errors for κ_t under the assumption that the effect on concentration and the input supply parameters are independent. It follows that:

$$\begin{aligned}Var(\kappa_t) =& Var\left[\left(\frac{1}{\theta} - \frac{1}{\eta}\right).\kappa_t\right] \\ =& Var\left[\left(\frac{1}{\theta} - \frac{1}{\eta}\right)^2\right] \mathbb{E}[\kappa_t^2] - \left[\mathbb{E}\left(\frac{1}{\theta} - \frac{1}{\eta}\right)\right]^2 [\mathbb{E}(\kappa_t)]^2 \\ =& Var\left[\left(\frac{1}{\theta} - \frac{1}{\eta}\right) + \left[\mathbb{E}\left(\frac{1}{\theta} - \frac{1}{\eta}\right)\right]^2\right]\left[Var(\kappa_t) + [\mathbb{E}(\kappa_t)]^2\right] - \left[\frac{1}{\theta} - \frac{1}{\eta}\right]^2 [\mathbb{E}(\kappa_t)]^2\end{aligned}$$

whose components can all be plugged-in using sample estimates.

9.1.12 If CES buyer production function

As shown in equation 5.13, the marginal revenue channel depends on the production function of the buyers, since is related to how the product bought is used for production. In my baseline model, I propose a Cobb Douglas production function, where α_j corresponds to the Cobb Douglas parameter for product j Note also that if there were constant returns to scale in the production function the marginal revenue channel would be equal to zero, leading to a more complete pass-through.

If

$$Q_{finalgood} = \Big(\int_s z_{sbk} q_{sbk}^{\frac{1-\gamma}{\gamma}} ds\Big)^{\frac{\gamma}{\gamma-1}}$$

- Consider the second term:

$$\text{dln}MVP$$

$$revenue = P_{sb}Q = P_{sb}\Big[\int_s (q_{sb}^{\frac{\gamma-1}{\gamma}})^{\frac{\gamma}{\gamma-1}}\Big]$$

$$\frac{\partial revenue}{\partial q_{sb}} = P_{sb}\frac{\gamma}{\gamma-1}\frac{\int_s (q_{sb}^{\frac{\gamma-1}{\gamma}})^{\frac{\gamma}{\gamma-1}}}{\int_s (q_{sb}^{\frac{\gamma-1}{\gamma}})}\frac{\gamma-1}{\gamma}\frac{q_{sb}^{\frac{\gamma-1}{\gamma}}}{q_{sb}}$$

$$\frac{\partial revenue}{\partial q_{sb}} = P_{sb}\frac{Q}{Q^{\frac{\gamma-1}{\gamma}}} q_{sb}^{-\frac{1}{\gamma}}$$

$$\frac{\partial revenue}{\partial q_{sb}} = P_{sb}\frac{Q}{q_{sb}}^{\frac{-1}{\gamma}}$$

$$lnMVP = lnP_{sb} - \frac{1}{\gamma}lnQ + \frac{1}{\gamma}lnq_{sb}$$

$$\text{d}lnMVP = \frac{\text{d}lnP_{sb}}{\text{d}lnp_a s} + \frac{1}{\gamma}\frac{\text{d}lnQ}{\text{d}lnp} + \frac{1}{\gamma}\frac{\text{d}lnq}{\text{d}lnp}$$

$$\mathrm{d}lnMVP = -\frac{1}{\gamma}\frac{dlnQ}{\mathrm{d}lnq_{sb}}\frac{\mathrm{d}lnq_{sb}}{\mathrm{d}lnp_{sb}}\mathrm{d}lnp_{sb} + \frac{1}{\gamma}\epsilon\mathrm{d}lnp_{as}$$

$$\mathrm{d}lnMVP = \frac{1}{\gamma}\frac{\mathrm{d}lnQ}{\mathrm{d}lnq_{bs}}\frac{q}{Q}\epsilon\mathrm{d}lnp_{sb} - \frac{1}{\gamma}\epsilon\mathrm{d}lnp_{as}$$

$$\mathrm{d}lnMVP = (S_{bjk} - 1)\frac{1}{\gamma}\epsilon\mathrm{d}lnp_{bjk} \tag{9.12}$$

So, given a change in bilateral exchange rate $\mathrm{d}lne_k$, as in Burstein and (2015) there is a direct and indirect effect.

The direct component of the exchange-rate pass-through is:

$$\frac{\mathrm{d}lnp_{bjk}}{\mathrm{d}lne_d} = \frac{1}{1 \underbrace{-\Gamma(1-\eta)(1-S_{bjk})}_{Markdownchannel} \underbrace{-\frac{1}{\gamma}\epsilon_{bjk}(1-S_{bjk})}_{ValueChannel}}$$

Proof of Proposition 3: Log linearization and First Order Approximation if CES

From now on, I replace $\mathrm{d}ln$ for Δ. Starting from the pass through equation:

$$\Delta p_{\mathrm{sbj}} = \frac{1}{1 + \Gamma_d\epsilon_d(1-S_{bjk}) + \frac{1}{\gamma}\epsilon_d(1-S_{bjk})}\Delta e_d$$

Common factor:

$$\Delta p_{\mathrm{bjk}} = \frac{1}{1 + \varepsilon_d\left[\Gamma_{bjk} + \frac{1}{\gamma}\right]\left(1 - S_{\mathrm{bjk}}\right)}\Delta e_d$$

Log-linearizing in S_{bjk} and dividing by Δe_d:

$$\frac{\Delta p_{\mathrm{sbjk}}}{\Delta e_d} \approx \frac{1}{1 + \bar{\varepsilon}_d\left[\bar{\Gamma}_{axs} + \frac{1}{\gamma}\right]\left(1 - \bar{S}_{\mathrm{sbjk}}\right)} +$$
$$\frac{\left.\frac{\partial \varepsilon_d}{\partial BS_{sbjk}}\right|_{\bar{S}_{sbjk}} \cdot \left[\bar{\Gamma}_{axs} + \frac{1}{\bar{\gamma}}\right](1-\bar{S}_{bjk}) + \bar{\varepsilon_d} \cdot \left.\frac{\partial \Gamma_{axs}}{\partial S_{bjk}}\right|_{\bar{S}_{bjk}}(1-\bar{S}_{\mathrm{bjk}}) + \bar{\varepsilon_d}\left[\bar{\Gamma}_{axs} + \frac{1}{\gamma}\right]}{\left[1 + \bar{\varepsilon_d}\left[\bar{\Gamma}_{axs} + \frac{1}{\gamma}\right]\left(1 - \bar{S}_{\mathrm{bjk}}\right)\right]^2}(S_{bjk} - \bar{S}_{bjk})$$

Separating terms multiplied by S_{bjk} and $\bar{S}_{bjk}$:

$$\frac{\Delta \ln p_{\mathrm{axsd}}}{\Delta \ln e_d} \approx \left[\frac{1}{1 + \bar{\varepsilon}_d\left[\bar{\Gamma}_{axs} + \frac{1}{\gamma}\right]\left(1 - \bar{S}_{\mathrm{bjk}}\right)}\right.$$
$$\left. + \frac{\left.\frac{\partial \varepsilon_d}{\partial S_{bjk}}\right|_{\bar{S}_{bjk}} \cdot \left[\bar{\Gamma}_{axs} + \frac{1}{\bar{\gamma}}\right](1-\bar{S}_{bjk}) + \bar{\varepsilon_d} \cdot \left.\frac{\partial \Gamma_{axs}}{\partial S_{bjk}}\right|_{\bar{S}_{bjk}}(1-\bar{S}_{\mathrm{bjk}}) + \bar{\varepsilon_d}\left[\bar{\Gamma}_{axs} + \frac{1}{\gamma}\right]}{\left[1 + \bar{\varepsilon_d}\left[\bar{\Gamma}_{axs} + \frac{1}{\gamma}\right]\left(1 - \bar{BS}_{\mathrm{sbjk}}\right)\right]^2}\right] \cdot \bar{BS}_{sbjk}$$
$$+ \left[\frac{\left.\frac{\partial \varepsilon_d}{\partial BS_{sbjk}}\right|_{\bar{BS}_{sbjk}} \cdot \left[\bar{\Gamma}_{axs} + \frac{1}{\bar{\gamma}}\right](1-\bar{BS}_{sbjk}) + \bar{\varepsilon_d} \cdot \left.\frac{\partial \Gamma_{axs}}{\partial BS_{sbjk}}\right|_{\bar{BS}_{sbjk}}(1-\bar{BS}_{\mathrm{sbjk}}) + \bar{\varepsilon_d}\left[\bar{\Gamma}_{axs} + \frac{1}{\gamma}\right]}{\left[1 + \bar{\varepsilon_d}\left[\bar{\Gamma}_{axs} + \frac{1}{\gamma}\right]\left(1 - \bar{BS}_{\mathrm{sbjk}}\right)\right]^2}\right] \cdot BS_{sbjk}$$

Getting together the terms with $\frac{\Delta \ln p_{\text{axsd}}}{\Delta \ln e_d}$ and taking common factor of terms with BS and $\bar{BS}$:

$$\frac{\Delta \ln p_{\text{axsd}}}{\Delta \ln e_d} \approx \alpha_{sbjk} + \beta_{sbjk} BS_{sbjk}$$

where:

$$\alpha_{sbjk} = \Bigg[\frac{1}{1 + \bar{\varepsilon}_d \left[\bar{\Gamma}_{axs} + \frac{1}{\gamma} \right] \left(1 - \bar{BS}_{\text{sbjk}}\right)} + \Bigg[\frac{ \frac{\partial \varepsilon_d}{\partial BS_{sbjk}} \Big|_{\bar{BS}_{sbjk}} \cdot \left[\bar{\Gamma}_{axs} + \frac{1}{\bar{\gamma}} \right] (1 - \bar{BS}_{sbjk}) + \bar{\varepsilon_d} \cdot \frac{\partial \Gamma_{axs}}{\partial BS_{sbjk}} \Big|_{\bar{BS}_{sbjk}} \left(1 - \bar{BS}_{\text{sbjk}}\right) + \bar{\varepsilon_d} \left[\bar{\Gamma}_{axs} + \frac{1}{\gamma} \right] }{ \left[1 + \bar{\varepsilon_d} \left[\bar{\Gamma}_{axs} + \frac{1}{\gamma} \right] \left(1 - \bar{BS}_{\text{sbjk}}\right) \right]^2 } \Bigg]$$

$$\beta_{sbjk} = \Bigg[\frac{ \frac{\partial \varepsilon_d}{\partial BS_{sbjk}} \Big|_{\bar{BS}_{sbjk}} \cdot \left[\bar{\Gamma}_{axs} + \frac{1}{\bar{\gamma}} \right] (1 - \bar{BS}_{sbjk}) + \bar{\varepsilon_d} \cdot \frac{\partial \Gamma_{axs}}{\partial BS_{sbjk}} \Big|_{\bar{BS}_{sbjk}} \left(1 - \bar{BS}_{\text{sbjk}}\right) + \bar{\varepsilon_d} \left[\bar{\Gamma}_{axs} + \frac{1}{\gamma} \right] }{ \left[1 + \bar{\varepsilon_d} \left[\bar{\Gamma}_{axs} + \frac{1}{\gamma} \right] \left(1 - \bar{BS}_{\text{sbjk}}\right) \right]^2 } \Bigg]$$

$\rightarrow \beta$ **is the coefficient of interest**

9.1.13 Increasing relationship between markdown channel and buyer size

Start by the markdown equation: $\mu_{bjk} = 1 + \epsilon_{bjk}^{-1}$ where $\epsilon_{bjk} = \eta + (\theta - \eta) S_{bjk}$

$$markdown\ channel = \frac{\partial \ln \mu_{bjk}}{\partial \ln p_{bjk}} = \frac{\partial \mu_{bjk}}{\partial S_{bjk}} \frac{\partial S_{bjk}}{\partial p_{bjk}} \frac{p_b jk}{\mu_{bjk}}$$

$$\frac{d\mu_{bjk}}{dS_{bjk}} = -[\eta + (\theta - \eta) S_{bjk}]^{-1} (\theta - \eta)$$

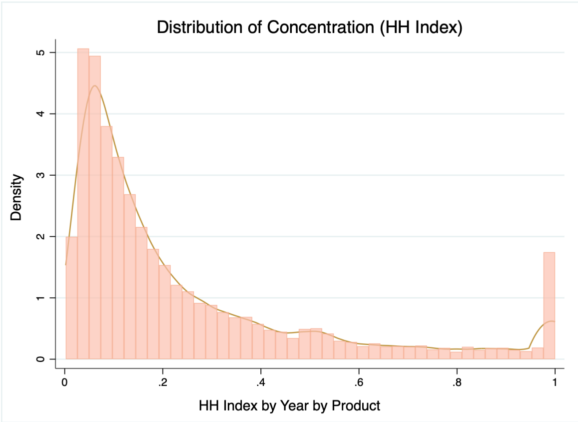
$$markdown\ channel = \frac{\partial \ln \mu_{bjk}}{\partial \ln p_{bjk}} = \frac{-(\eta + 1)(1 - S_{bjk}) S_{bjk}}{\left(\frac{\eta}{\theta - \eta}\right) \left(\eta + (\theta - \eta) S_{bjk} + 1\right)}$$

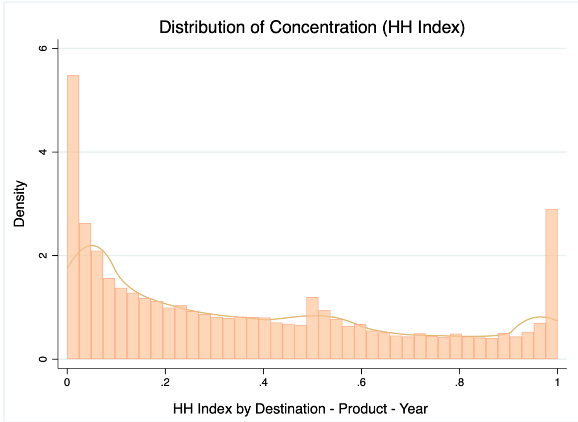
Note that for values $\eta > \theta > 1$

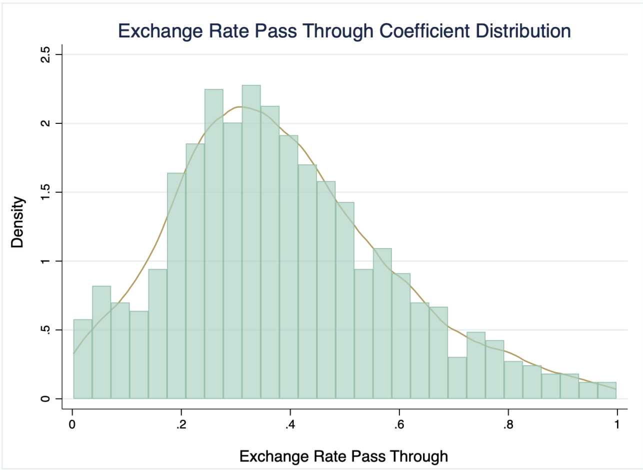
$$\frac{markdown\ channel}{dS_{bjk}} > 0$$

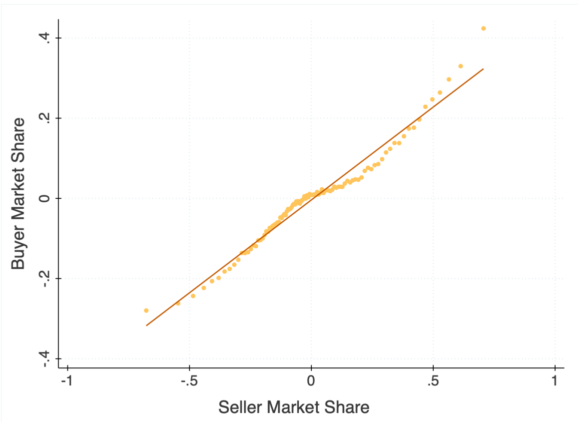
9.2 Appendix: empirical part

9.2.1 Variables Distribution









9.2.2 Price dispersion: monthly

One could think that, as the exchange rate is very volatile, then the price differences found could be attributed to different exchange rates instead of the same seller discriminating among buyers. To check for this, I check price dispersion at the month level. It can be observe that price discrimination even happens at the price level.

The standard deviation of log(price) within seller-country-month-unit-HS10 is 0.5302. At the HS6 level, it is 0.5627.

Figure 6: Export value explained by multi-buyers

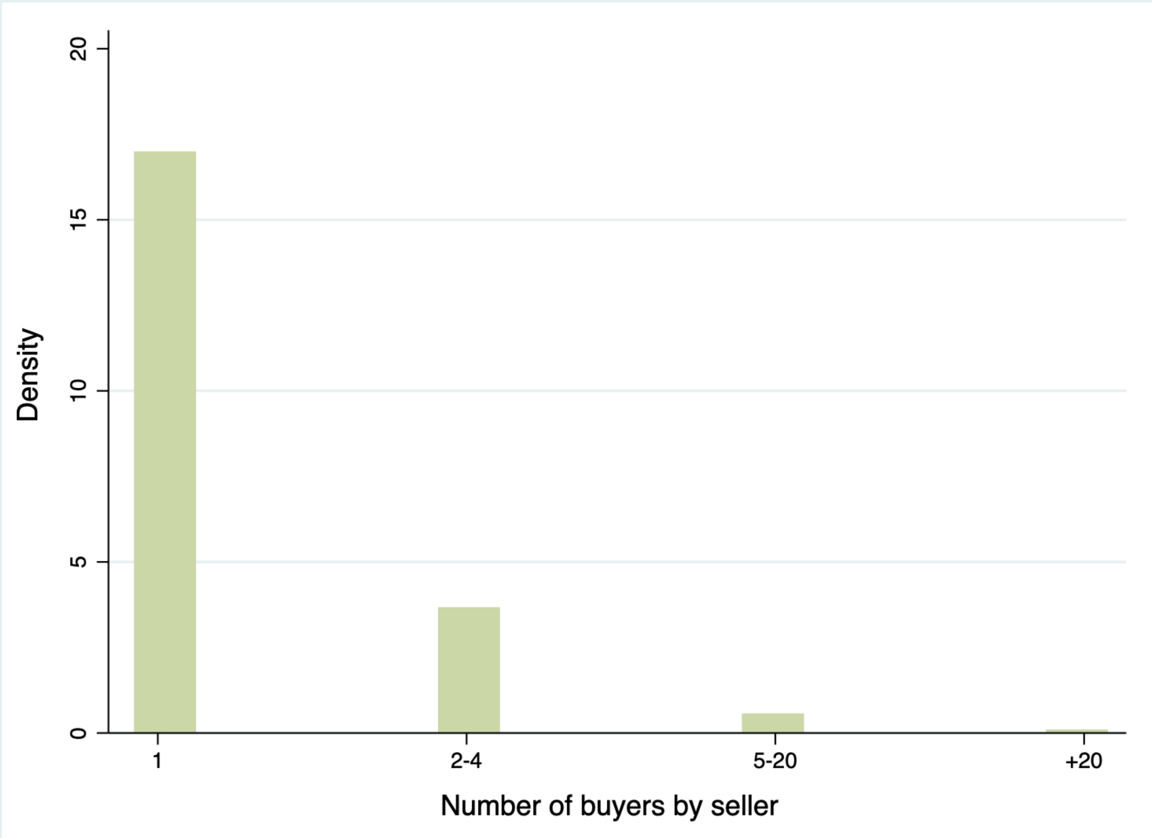
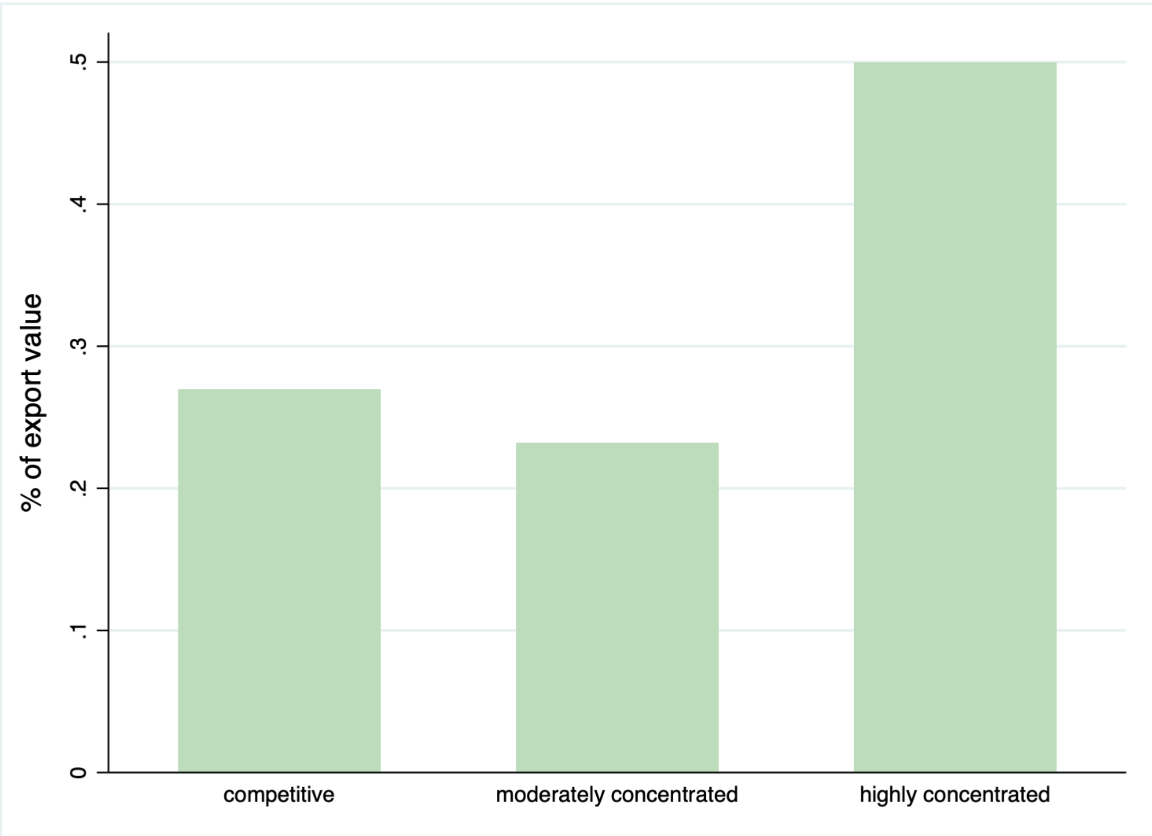
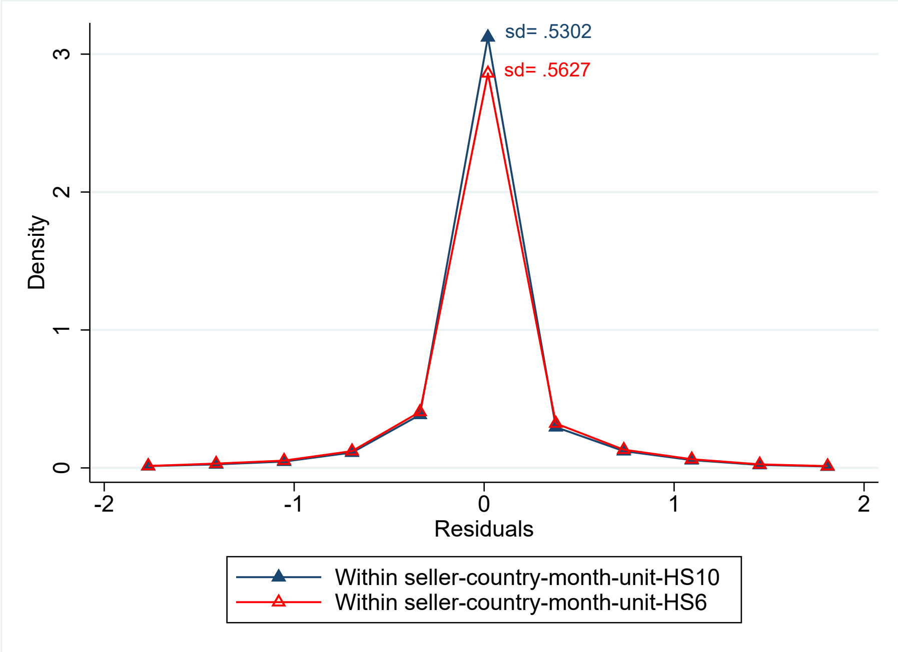


Figure 7: Export value explained by multi-buyers





	Products	Products with different prices	%
HS6	3654	2299	62,9
HS10	4889	2811	57,5

9.2.3 Mechanism: consistency with seller side results

In this section, I detailed how my paper is consistent with the existent literature on the sellers power in a monopolistic competition environment. In the presence of seller market power, sellers charge a mark up above their marginal cost. In the presence of a cost shock (an exchange rate shock would work in the same way), firms with higher market share internalize this shock (Atkeson and Burstein, 2008; Amiti, Itskhoki and Konings, 2014). In other words, firms that have more market power, that is, charging higher mark ups, adjust their mark up in order to keep prices more stable in the currency of the buyer. They keep quantities more stable by keeping prices more stable. This corresponds to a more incomplete pass through for sellers with higher market share.

In the presence of buyer market power, the mechanism works analogously, although it bring the opposite outcome. Buyers that have more market power, that is, buyers who charge a lower markdown, adjust more their markdowns in order to keep prices more stable in the currency of the seller. This in turn, cause prices to be less stable in the currency of the buyer and results in a more complete pass through. The underlying mechanism here happens because, as the buyer faces a supply curve, to keep quantities more stable, he needs to let the prices they accept change prices more.

9.2.4 Robustness: Seller market power

In the theoretical appendix **??** I propose an alternative theoretical model that takes into account the power of the seller. In this section, I include a variable in the baseline regressions that will allow us to isolate the buyer market power effect from the seller side. It can be shown, that estimates are still significant and have the expected sign.

	(1)	(2)	(3)
	$\triangle$ Log(Prices)	$\triangle$ Log(Prices)	$\triangle$ Log(Prices)
L($\triangle$ER)	0.203***	0.0637**	0.0970***
	(0.0691)	(0.0259)	(0.0261)
S_{t-1}	-0.0613***	-0.0358***	-0.0373***
	(0.00848)	(0.00499)	(0.00559)
L($\triangle$ER) $\times$ S_{t-1}	-0.240**	-0.153***	-0.404***
	(0.113)	(0.0557)	(0.0547)
$Seller\ Size_{t-1}$		-0.0227***	-0.0171***
		(0.00432)	(0.00461)
L($\triangle$ER) $\times$ $Seller\ Size_{t-1}$		0.0784	0.0736
		(0.0480)	(0.0449)
Country - HS - Seller FE	x		
Period - Seller FE	x		
HS - Period FE		x	
Country FE		x	
Country - HS FE			x
Year FE			x
N	484804	510893	511830

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

9.2.5 Robustness: Length of contracts and volatility unrelated to exchange rate shocks

Barro (1977) and Carlton (1991) argue that buyer-seller prices could be less responsive to shocks due to the use of contracts which specify fixed prices for a period of time. Given the existence of long-term relationships might be more likely to use either implicit or explicit contracts, they could exhibit lower pass through of shocks (Heise, 2019). importer-exporter-product (HS10) triplets in the data. In this section, I will examine the potential connection between relationship length and size of the buyer. This could potentially bias (upward) the estimators if the length of the relationship implies lower pass-through.

Table 7 shows different specifications that aim to control for the length of the relationship in my baseline regression. Column (1) adds buyer seller fixed effects, and Columns (2)-(3) include two different measures of relationship length: length of a relationship in the triplet buyer-seller-HS10 and length of a relationship buyer-seller. I include these two meassures given that it could be the case firms, that are already trading in other products are more likely to have fixed contracts.

Table 7

	(1)	(2)	(3)
	$\triangle$ Log(Prices)	$\triangle$ Log(Prices)	$\triangle$ Log(PricesBS)
lERchange	-0.125	0.231**	0.268**
	(0.170)	(0.113)	(0.115)
lagbuyersize1	-0.180***	-0.0897***	-0.0863***
	(0.0181)	(0.0109)	(0.0106)
lERchange $\times$ lagbuyersize1	0.00648	-0.324**	-0.312**
	(0.186)	(0.127)	(0.128)
ltenureany		0.0222**	
		(0.0101)	
lERchange $\times$ ltenureany		-0.000628	
		(0.0674)	
ltenurehs			0.00627
			(0.0123)
lERchange $\times$ ltenurehs			-0.0373
			(0.0774)
Seller - Buyer FE	x		
Seller - period FE	x	x	x
Dest - HS - Seller FE	x	x	x
N	273577	385461	385461

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

In all the cases, even though the fact that longer relationships have less change in prices in the buyer currency, they do not seem to be explaining the mechanism this paper proposes.

9.2.6 Robustness: prices in reported US dollars

In this section, I report the same regressions than before with the only difference that the dependent variable corresponds to the price in US dollars. In my dataset, information is reported in both US dollars and Colombian pesos. Although it is expected the variable corresponding to Colombian pesos is a more accurate measure, given it is directly the profit received by Colombian sellers after the transaction is reported in customs.

	(1)	(2)	(3)	(4)	(5)
	△ Log(Prices)	△ Log(Prices)	△ Log(Prices)	△ Log(Prices)	△ Log(Prices)
L(△ ER)	0.103***	0.137***	0.094***	0.172***	-
	(0.022)	(0.023)	(0.022)	(0.066)	
BS_{t-1}		-0.022***	-0.024***	-0.038***	-0.019***
		(0.003)	(0.004)	(0.006)	(0.003)
L(△ER)xBS_{t-1}		-0.106***	-0.076**	-0.156*	-0.179***
		(0.037)	(0.038)	(0.081)	(0.049)
HS - Year FE	x	x			
HS-Year-Sell FE			x	x	
Country FE	x	x	x	x	
Buyer FE				x	
HS-Year-Country FE					x
N	325404	325404	325404	325404	325404

Standard errors in parentheses * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

9.2.7 Robustness: Dominant Currency Paradigm

In this section, I replicate my findings following the data cleaning and specification of Gopinath et al. (2020). First, I restrict the data to the manufacturing sector, using the HS codes proposed in the paper. Second, I start as a benchmark specification with Gopinath et al. (2020)'s main regression, that is, including only destination-industry-seller. The relevant difference with my specification is that in their study they do not include time fixed effects. The reason for this is their variable of interest (the US dollar to Colombian pesos exchange rate) is at the year level.

It can be shown how when including the time fixed effects, the coefficient changes, and becomes smaller but still significant and preserves the sign.

	(1)	(2)	(3)
	$\triangle$ Log(Price)	$\triangle$ Log(Price)	$\triangle$ Log(Price)
L($\triangle$ ER) = α	0.887***	0.464***	0.108*
	(0.284)	(0.162)	(0.0601)
BS_{t-1}		-0.0170	-0.0330***
		(0.0103)	(0.00934)
L($\triangle$ER)xBS_{t-1} = β		-0.395**	-0.149**
		(0.196)	(0.0721)
Country-HS-Seller	x	x	x
HS - Period FE			
HS - Period - Seller FE			x
Year FE		x	
N	165100	170796	163463

Standard errors are clustered at the country-time level and are shown in parentheses * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

9.2.8 Colombia Time Series