Essays on International Economics and Macroeconomics

by

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“Already Dedicated”

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ABSTRACT

This dissertation consists of three essays on international economics and macroeconomics. Its primary focus is on understanding how heterogeneous firms operating in global markets determine their prices optimally, react to foreign shocks such as exchange rate movements, and how they behave as buyers of inputs in international markets. Additionally, the dissertation highlights the importance of firms' financial decisions, not only concerning domestic banks but also by allowing for trade credit to their foreign buyers. Each essay explores one of these aspects in a specific setting. Chapter I investigates the market power of large buyers in international markets during exchange rate shocks; Chapter II examines the trade credit effect on export prices; and Chapter III explores how a credit supply shock in foreign currency affects borrowing and import decisions.

In Chapter I, titled "Buyer Market Power and Exchange Rate Pass-through" I explore the effect of buyer market power on the exchange rate pass-through. Using a dataset from Colombia that includes the universe of Colombian exporters, I demonstrate a high degree of concentration of sales in larger foreign buyers, granting them market power. As a result, these large buyers can negotiate prices below the marginal productivity of the input, resulting in a markdown or discount. Furthermore, in the event of an exchange rate shock, prices for large buyers show less responsiveness compared to prices for small buyers in the seller's currency. Lastly, I examine a counterfactual scenario where I eliminate buyer market power; if there were no buyer market power, seller revenues would increase, but they would also become more volatile.

In Chapter II, titled "Bank Loans, Trade Credit, and Export Prices: Evidence from Exchange Rate Shocks in China" George Cui, Xiasheng Guo, and I explore how the effects of exchange rate shocks on international prices (i.e., exchange rate pass-through) vary with trade credit. Using a Chinese dataset containing information on export prices of Chinese firms, as well as their bank statements, we examine the effects of trade credit. We find that firms that issue trade credit have higher and less volatile prices. To understand the mechanism behind these patterns, we introduce an open economy model of monopolistic competition in international markets with heterogeneous firms and domestic financial markets. The model reveals a trade credit premium channel: exchange rate shocks affect domestic

banks' expectations of exporters' profits, which, in turn, impacts the interest rates (financial costs) offered to exporters and, consequently, the trade credit interest rate included in the exporting price.

Finally, in Chapter III, titled "From Tax Amnesty to Bank Credit: The Transmission of Large Scale Asset Repatriation through Bank-to-Firm Relationships" Federico Bernini, Paula Donaldson, Ezequiel Garcia Lembergman, and I examine the firm-level effects of a foreign currency credit supply shock. We leverage the large and unprecedented inflow of dollar deposits that resulted from a tax amnesty in Argentina as a source of plausibly exogenous variation in bank-level funding. Our findings indicate that banks more exposed to the shock increased their supply of both dollar and peso loans compared to less exposed banks. The improved access to credit had a positive impact on firm imports, both on the intensive and extensive margins and employment. These results suggest that the tax amnesty had real macroeconomic effects by alleviating dollar funding constraints of firms in the private sector.

CHAPTER I

Buyer Market Power and Exchange Rate Pass-through

1.0 Abstract

This chapter studies the role of buyer market power in determining the response of international prices to exchange rate changes (i.e., exchange rate pass-through). Using a novel dataset of the universe of Colombian export transactions that links Colombian exporters (sellers) to their foreign importers (buyers), I document three facts: (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. (iii) Markets with a 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—a market with large number of sellers and a few buyers—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; a price below the marginal product value for the buyer. Most importantly, these markdowns are flexible and play a role when adjusting prices to exchange rate shocks. I derive a model-based equation relating pass-through to buyer size and estimate it on the micro transaction level data for Colombia. I find that after an exchange rate shock, sellers connected to larger buyers face more moderate changes in their prices in the seller currency (i.e., lower exchange rate pass-through) than those connected to small buyers. Pass-through ranges from 1% for firms connected with the largest buyers and up to 17% for firms connected with the smallest buyers. I use the estimates from the empirical analysis to calibrate the model and propose a counterfactual where buyer market power is eliminated. Under this scenario, sellers' revenues increase; however, the price in seller currency is more responsive to exchange rate shocks.

1.1. Introduction

Large firms dominate many sectors of the global economy. It has become increasingly clear that this phenomenon has important macroeconomic consequences (Autor et al., 2020; Gutiérrez and Philippon, 2019; De Loecker et al., 2020). In the context of international markets, a vast group of small exporting firms often sell their goods to just a handful of large, multinational buyers. For example, the top one percent of importers account for 83.5% of U.S. imports (Bernard et al., 2018). This raises the question of how the presence of large buyers affects prices and price dynamics in export markets. In particular, when there is an exchange rate shock, do large firms leverage this buyer market power to increase their profits? What are the consequences for smaller connected firms?

This paper studies buyer market power in international markets and its impact on exchange rate pass-through. Exchange-rate pass-through corresponds to the change in international prices in the seller's currency as a response to a change in the exchange rate. I combine a novel transaction-level dataset covering the universe of Colombian exports with an oligopsony model of buyer market power in international trade. The main conclusion is that buyer market power moderates the response of international prices to exchange rate shocks. The main mechanism behind this effect is that large firms have *more* variable markdowns and can use this as a tool to maintain more stable prices. When the Colombian currency appreciates, U.S. buyers absorb the shock by reducing their markdowns. The result is that the prices Colombian exporters receive respond less.

I begin by documenting stylized facts on Colombian export markets. This paper uses data on exports from Colombia to the rest of the world from 2007 to 2020. I exploit the granularity of my data, containing identifiers of buyer, seller, product, destination country, and year in each transaction. Export data are matched to data on bilateral exchange rates for each year and destination country. I define a *market* as a product-destination-year combination. I find that (i) sales are concentrated among a few large foreign buyers in each market, (ii) a given seller faces different prices for different buyers of the same products and destination country, and (iii) markets with a higher concentration of sales among buyers display more moderate changes in market average prices after an exchange rate shock (i.e., 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 illuminates its consequences for price determination in international transactions. In my model, sellers are located in the home country and buyers are in foreign countries. On the supply side, buyers face a nested CES supply curve from sellers. The supply curve is microfounded with a discrete-choice problem, where sellers are price takers and choose which product to produce and which buyer to supply. On the demand side, buyers observe the quantities supplied and choose the price they are willing to pay for a product. Given a finite number of buyers, they act strategically, internalizing their influence over prices. In equilibrium, buyers pay sellers a price marked down from the marginal revenue of the product.

The first theoretical result is that markdowns are increasing in the buyer's market share—that is, larger buyers have greater markdowns. Aggregating the firm-level markdowns across all firms in a market, I find market-level average markdowns are increasing in buyer market concentration. Additionally, markdowns depend on sellers' within-product cross-buyer elasticity of substitution and the cross-product elasticity of substitution. Lower elasticities correspond to greater markdowns. Intuitively, if substitution across buyers and products is costly for sellers, buyers have more market power and higher markdowns.

The second theoretical result is that the price response to exchange rate shocks varies with buyer market share. This is a novel source of exchange rate pass-through dispersion that, to my knowledge, has not been previously studied in the literature. The overall effect is driven by two offsetting mechanisms: a markdown channel and a marginal-revenue channel.

On the one hand, the markdown channel implies that following a change in the exchange rate, buyers adjust their markdowns, keeping prices more stable in the seller's currency. Larger buyers tend to have more variable markdowns and adjust their markdowns more elastically. In response to the stable price, sellers do not substitute away from that buyer.

On the other hand, the marginal-revenue channel implies that, following a change in the exchange rate, a standard price effect induces sellers to change their quantity supplied, which in turn affects marginal revenue. Because sellers have a lower supply elasticity in concentrated markets—intuitively, the costs to finding another buyer are higher for these sellers—larger buyers face smaller changes in marginal revenue. In contrast to the markdown channel, prices in the seller's currency are more volatile.

I then take the model to the data and estimate the exchange rate pass-through elasticity. The richness of the transaction-level data allows me to regress buyer-seller-product prices on the exchange rate and on an interaction between the exchange rate and the buyer market share. The measure of buyer market share is based on my model and corresponds to the share of the sales in a market account to a given buyer. In this way, I differentiate the exchange rate pass-through for larger and smaller buyers. I control by a variety of fixed effects including seller time to account for sellers' marginal cost, and year-product-country fixed effects to isolate the differences between markets, comparing across buyers with different market shares.[1]

[1]Note that even though this might drop the exchange rate coefficient, the coefficient of interest—the one

I find that larger buyers face a lower exchange rate pass-through to prices in the seller's currency, ranging from 1% for the largest buyers to 17% for the smaller ones. Thus, when the currency of the seller's country depreciates, sellers in concentrated markets face attenuated price increases (in the seller's currency) relative to exporters that sell to smaller buyers.

The results thus reveal that the markdown channel is more empirically relevant than the marginal-revenue channel. Intuitively, larger buyers internalize the upward-sloping supply curve and are aware that each additional unit they buy increases the price of every other unit. As a result, buyers strategically purchase fewer units, increasing prices by less than if the seller supply curve were flat. In the event of a depreciation of the seller currency, gains for the large buyer come at the expense of lower prices earned by the seller.

I proceed by quantifying the markdowns for large firms and estimating how they change in response to an exchange rate shock. In the model, two elasticities govern the magnitude of this effect: the cross-product elasticity of supply and the within-product cross-buyer elasticity of supply. I propose an approach that integrates (i) empirical estimates of the exchange rate pass-through elasticities, (ii) moments from the cross-section of prices and (iii) a simulated method of moments to estimate these elasticities by indirect inference. I find the markdowns for the average firms are around 15% and that they adjust by 3% in response to a 10% exchange rate shock.

Finally, I use the model to simulate a counterfactual economy with no buyer market power. In a perfectly competitive economy, sellers' revenues are higher due to a price effect (i.e., the absence of markdowns) as well as a quantity effect (i.e., they adjust quantities in response to higher prices). However, revenues in the seller currency are more elastic in response to international shocks, potentially generating greater volatility.

I illustrate my findings with an example. Starbucks, a large U.S. buyer of Colombian coffee, receives a higher markdown (i.e., a price discount) than smaller U.S. firms buying coffee from Colombia. All else equal, Starbucks is thus able to pay lower prices for coffee. Moreover, prices paid by Starbucks in the seller currency (i.e., the COP, Colombian peso) are less responsive to exchange rate shocks. In the aggregate, if the U.S.–Colombia coffee market is dominated by large buyers like Starbucks, the average market price for coffee is also reduced and less responsive to shocks. In a counterfactual world where Starbucks and other large firms did not have such market power, the sellers in developing countries would increase their revenues because they would sell at a higher price. However, these sellers would charge prices that respond more to shocks which would bring volatility to their revenues.

This paper contributes to three strands of the literature. First, it contributes to the literature on international pricing response to exchange rate changes (Amiti et al., 2014; Auer

for the interaction term—does not change.

and Schoenle, 2016; Burstein and Gopinath, 2014; Gopinath et al., 2020). While most of these papers focused on the seller side, a theoretical contribution of this paper is to introduce buyer market and a buyer-concentration effect. Empirically, the detailed buyer–seller data I use in this research allows me to quantify the role of buyer–seller relationships in determining the exchange rate pass-through and to quantify the markdown response.

Second, this paper relates to the literature on market power (De Loecker et al., 2020; Atkeson and Burstein, 2008a; De Loecker et al., 2016). In particular, a growing body of work on buyer market power in labor markets uses olipsonony and monopsony models to explain why workers' wages are marked down from their marginal products (Berger et al., 2022; Azar et al., 2019; Lamadon et al., 2022; Felix, 2022). My theoretical approach most closely resembles Berger et al. (2022) in labor markets in the U.S. and Zavala (2022) in agricultural value chains in Ecuador. I draw the modeling tools from this literature, but apply them to an international-trade setting with buyers having oligopsony power over the sellers. I contribute to this literature by showing the implications of buyer market power on international prices.

Third, I contribute to a nascent literature on buyer–seller links, global value chains, and shock transmissions (Devereux et al., 2017; Huneeus, 2018; Alviarez et al., 2022; Lim, 2018; Hottman and Monarch, 2020; Dhyne et al., 2021). Because of data availability, most of these papers focus on firm-to-firm transactions in the domestic context while my paper and a few others (Adão et al., 2022; Bernard et al., 2019) analyze the international markets. I contribute to this literature by documenting the existence of price dispersion for the same seller, product and destination in the international setting. Additionally, I estimate the cross-buyer elasticity of substitution, a key parameter that had not been previously estimated.

The rest of the paper proceeds as follows. Section 1.2 presents my data and empirical setting together with some key stylized facts on buyer–seller relationships in Colombia and their consequences for exchange rate pass-through. Section 1.3 presents the model that links buyer market concentration to export prices, yielding a specification for estimating the effect of buyer market power on exchange rate pass-through. Section 1.4 presents my empirical strategy and its link to my theoretical model. Section 1.4 also uses the estimates from the empirical part to calibrate the model and estimate key elasticities to quantify the markdown channel. Section 1.5 proposes a counterfactual scenario with no buyer market power. Section 1.6 concludes.

1.2. Data

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

1.2.1 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 foreign firms during 2007–2020.[2] The data come from the Colombian National Directorate of Taxes and Customs (DIAN; Dirección de Impuestos y Aduanas Nacionales de Colombia).[3] For each transaction, DIAN reports the value and quantity shipped (in USD and in COP), 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 rates from International Financial Statistics of the International Monetary Fund (IMF). In particular, I use the monthly nominal bilateral exchange rate expressed as local currency per USD.

1.2.2 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 U.S. is Colombia‘s largest trading partner, representing about 41% of Colombia‘s exports. In addition, as the COP has depreciated against the USD and other leading currencies several times over the last decades, my data also presents 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 50869 Colombian firms producing 6941 different HS10-level goods[4] exported to 54 different countries during 2007–2020.

Table 1.1 summarizes the main descriptive statistics relevant for my analysis. In each year

[2]In the appendix, we include robustness checks conducted with data at the transaction level for importing firms.

[3]This dataset was accessed through Datamyne.

[4]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's or girls' cotton panties versus knitted or crocheted panties.

of data, an average of 13382 sellers trade with 39028 buyers each year.[5] Each combination of destination and HS10 product includes, on average, 4.55 buyers, suggesting only a few buyers for a large number of sellers. Each of these buyers buys on average 3.68 products from Colombia.

Table 1.1: Annual Summary Statistics

Variable	Mean	SD
# Products	6941	91
# Sellers	13382	5479
# Buyers	39028	2914
# Buyers by destination $\times$ product	4.6	23
# Products by buyer	3.7	9

Notes: In this table products are at the 10-digit Harmonized System level.
Source: Colombian Customs Data.

1.2.3 Facts

Small sellers in Colombia sell their products to large firms abroad. In this section, I document three 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 relevant not only for price setting in international markets, but also for price 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, (ii) sellers price discriminate across buyers in international markets, and (iii) the exchange rate pass-through coefficient is negatively correlated with the concentration of buyers in a market. These facts motivate the oligopsony model in Section 1.3 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

I explore the well-known dominance by large firms of the markets in my data. I define a market as a destination $\times$ product $\times$ year, 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 they contribute to the total value bought in each market. Figure 1.1,

[5] Note that these buyers correspond to all possible destinations.

Panel A shows that the value of the exports bought by the top three buyers along in each market accounts for 78% percent of exports from Colombia, suggesting the high degree of buyer concentration in Colombia's export market. For example, for the coffee market into the U.S. for a certain year, this would mean Starbucks, Peets Coffee and Dunkin Donuts buy most of Colombia's coffee sold to the U.S., by value.

Second, I calculate the degree of concentration of sales by using a standard measure of concentration, the Herfindhal-Hirschman 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.

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

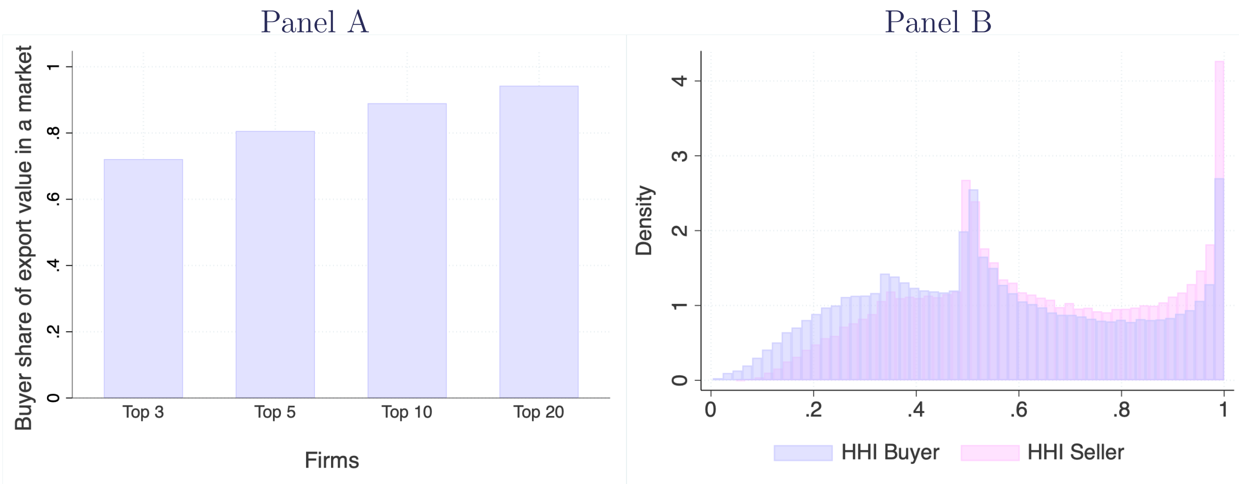
I then define the HHI.

$$HHI_{jkt} = \sum_b S_{bjkt}^2 \tag{1.2.1}$$

Figure 1.1, 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 a considerable number 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 for sellers comparing the concentration of buyers in Colombian markets with the concentration of sellers. Figure 1.1, Panel B indicates the concentration of export flows among buyers is as important as the concentration among sellers, and therefore, it could have important economic implications.

Figure 1.1: Buyer market concentration



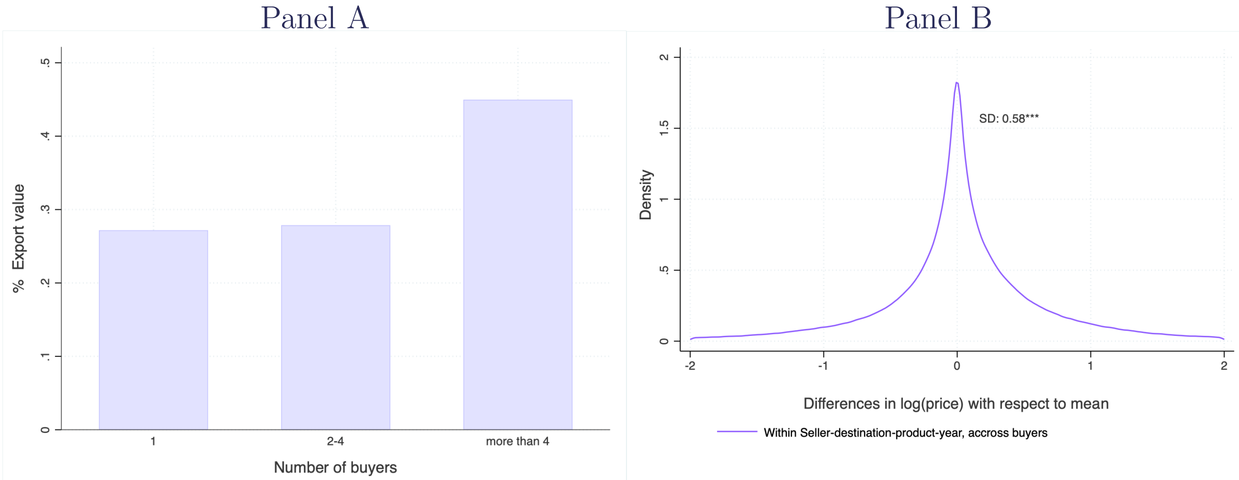
Notes: This figure shows the concentration of Colombian exports among foreign buyers. Panel A shows how much of the export value in a market, where market is defined as destination country × HS10 product × year, corresponds to the top buyers. Top buyers are ranked by their purchases in the given market. Panel B shows the distribution of the HHI using equation 1.2.1 for the buyer market share (blue) and the seller market share (pink).

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 receive different prices for the same product among their buyers.

Figure 1.2, Panel A shows a significant number of multibuyer firms in Colombian export markets. In my sample, these firms account for roughly 80% of the exports value of the country. To date, no empirical evidence exists on price discrimination for buyers in international markets. I document this new stylized fact for sellers (exporters) in Colombia. As documented in Figure 1.2, Panel B, the same firm, exporting the same product to the same destination in the same year, receives different prices from different buyers. This is true even controlling for sector × destination × year fixed effects 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 received by one firm for the same product to the same destination across similar buyers is around 0.58%. This suggests specific buyers have characteristics that affect the price a firm sets considerably.

Figure 1.2: Export value explained by multibuyer sellers and top buyers and price dispersion



Notes: This figure shows characteristics of multibuyer sellers. Panel A highlights that sellers with more than one buyer account for half of the export value on average per market. Panel B illustrates the price dispersion after including product fixed effects, country of destination fixed effects and year fixed effect. The blue line includes also seller fixed effects. That is, for a given seller, product, year and country of destination, prices have a standard deviation of 0.58%.

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 in COP, react to a change in the exchange rate. For every market, destination–product, I run the following regression.

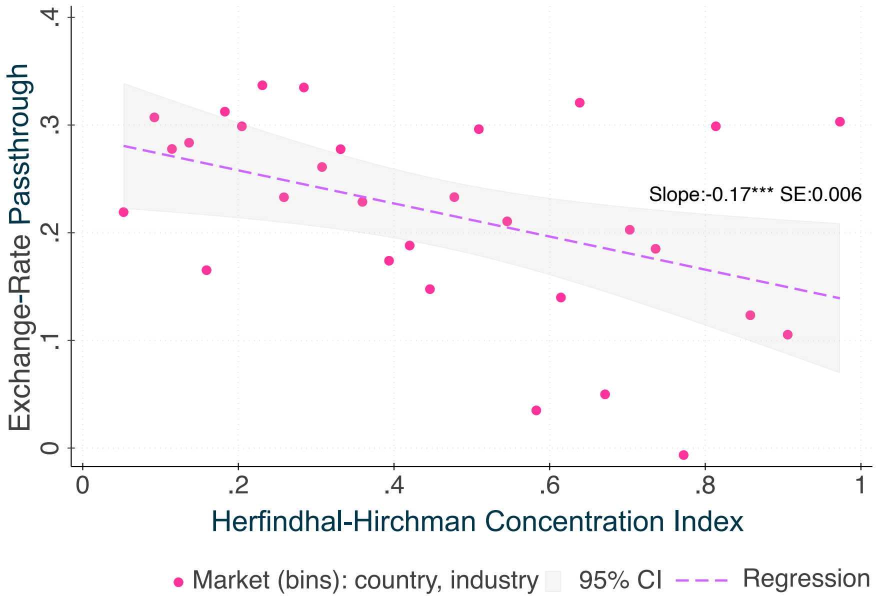
$$\Delta \ln p_t = \underbrace{\psi_{jk}}_{\substack{\text{Exchange} \\ \text{rate} \\ \text{pass-through}}} \Delta \ln e_{kt} + \epsilon_t \tag{1.2.2}$$

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

Figure 1.3 presents the coefficients of my regression on a bin scatter plot. 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 fewer 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 channel for this effect. Given that buyers are large and have buyer market power, this affects how prices are adjusted.[6]

[6]I have just shown that this relationship holds in the cross section for the different industries. In Section

Figure 1.3: Exchange Rate Pass-through and the Concentration Index



Notes: This figure shows regression 1.2.2, which accounts for correlations between the exchange rate pass-through coefficient for a given market and the HHI defined as equation 1.2.1.

1.3. The Model

I develop an oligopsony model in international markets with an infinitely many sellers located in the home country and a few large buyers in each foreign market. This concentration of demand gives the buyers market power and allows them to choose the prices they pay.[7] 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.[8] 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, more heterogeneous sellers' costs lead to greater consequences of buyers' market power.

A.0.2.6 of the appendix, I also show this relationship holds in the time series for Colombia.

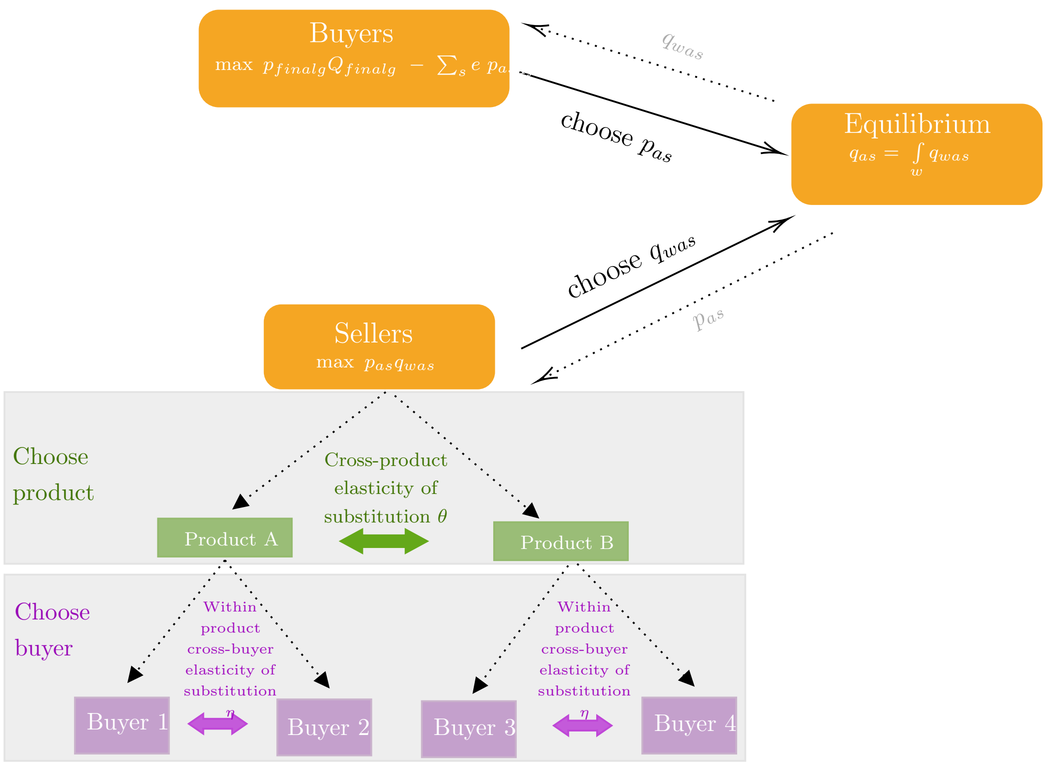
[7]In my baseline model, buyers compete á la Bertrand. However, in Appendix A.0.1.5, I additionally solve for Cournot competition.

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

1.3.1 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. Figure 1.4 summarizes the model structure with notation explained in the text.

Figure 1.4: Model Structure



Notes: This figure displays a diagram of the structure of the model. The upper part shows how quantities and prices are determined in equilibrium. The lower part illustrates the seller input supply decision according to the discrete choice framework.

1.3.2 Seller Supply Function

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

To begin, each Seller s has an endowment, $q_s \sim \psi$, and can decide to allocate it to the production of any product–buyer combination. As the seller produces more of a product for a buyer, he less has left of this endowment to use for another product and buyer: $\sum_{bj} q_{sbj} = q_s$. Also, sellers with more of the endowment, q_s, can produce more.

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 determine the supply. A higher shock for Buyer b and Product j mean the seller can supply more if he chooses that buyer and product. Intuitively, 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:[9]

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

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. 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.

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}. For example, he has a machine more suitable for either of those beans. If he produces coffee, he could either sell it to Starbucks or Peet's Coffee depending on the search costs, ρ_{sbjk}. For example, he already sold before to Starbucks' so has some relationship with them, or he matches better with Starbucks packaging preference. 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

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

probability that $(\Pr\big(revenue_{b',j',k} < revenue_{b,j,k}\big)\forall b', j' \neq b, j)$. 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:[10]

$$\lambda_{bjk} = \underbrace{\frac{P_{jk}^{1+\theta}}{\sum_{j'k} P_{j'k}^{1+\theta}}}_{\text{Pr(chooses Product } j)} \underbrace{\frac{P_{bjk}^{1+\eta}}{P_{jk}^{1+\eta}}}_{\text{Pr(chooses Buyer b—j)}} \tag{1.3.1}$$

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 in Appendix A.0.1.2.

Aggregating across sellers yields a nested CES upward-slopping supply curve for Buyer b in Product j, Country k:[11]

$$q_{bjk} = \left(\frac{p_{bjk}^{\eta}}{P_{jk}^{\eta}}\right)\left(\frac{P_{jk}^{\theta}}{P_k^{\theta}}\right)Y \tag{1.3.2}$$

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

1.3.2.1 Interpreting Elasticities

There are intuitive interpretations of the parameters θ and η.[12] 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

[10]All destinations here will differ on the exchange rate, and they might also have different elasticities. More details on this in Section 1.3.2.1.

[11]See Appendix A.0.1.3 for derivations and intuitions on how prices relative to the price index relate to quantity.

[12]The interpretation of elasticities is inspired by Berger et al. (2022) and Zavala (2022).

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 cost shocks are more strongly correlated across buyers than across products, (ii) there is more heterogeneity in the productivity of producing different products than in the costs of connecting with two different buyers,[13] and (iii) sellers are more substitutable within products than across products from the buyer's point of view.

1.3.3 Buyer's Profit Maximization

There is a finite number of buyers in Foreign Country k. Each buyer purchases her inputs to produce a final good to sell in her home country. A buyer can buy different inputs from different countries.[14] Her production function is CES:

$$Q_{finalg} = \left(\int_{jk} z_b q_{bjk}^{\frac{1-\sigma}{\sigma}} \, djk \right)^{\frac{\sigma}{\sigma-1}}, \tag{1.3.3}$$

where $z_b \sim O$ is an idiosyncratic productivity term, which is the only source of ex-ante heterogeneity across buyers.

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, 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 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 1.3.3, and the quantity supplied by the seller, equation 1.3.2.

$$\max_{p_{bjk}} p_{finalg} Q_{finalg} - \sum_{origin,j} \frac{1}{e_k^{origin}} p_{bjk} q_{bjk} \quad \text{s.t.} \quad Q_{finalg} = \left(\int_{jk} z_{bjk} q_{bjk}^{\frac{1-\sigma}{\sigma}} \, dj \right)^{\frac{\sigma}{\sigma-1}} \quad \text{and} \quad q_{bjk} = \frac{{p_{bjk}}^{\eta}}{{P_{jk}}^{\eta}} \frac{{P_{jk}}^{\theta}}{P^{\theta}} Y \tag{1.3.4}$$

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.[15] The second term corresponds to the costs paid for the inputs (they

[13]Note that, in the empirical analysis, this condition holds for the same destination and in the same period.
[14]Note that he can also buy the *same* input j from different countries.
[15]I relax this assumption in Appendix A.0.1.11 and assume these buyers charge markups.

buy different products from different countries), 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 to convert the costs to local currency. The subindex k indicates the country of the buyer, while the superindex *origin* corresponds to the country of the seller.[16] This term is defined as foreign currency per unit of home currency.

The first-order condition (FOC) can be written as

$$p_{bjk} = \underbrace{\frac{1}{\mu_{bjk}}}_{mark\,down:\mu_{bjk}>1} \times \underbrace{MRP_{bjk}}_{marginal\ revenue\ product} \times e_k, \tag{1.3.5}$$

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 in Destination k.

Equation 2.4.8 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.[17]

Some relevant intuitions can be derived from equation 2.4.8. First, MRP_{bjk} is expressed in buyer's currency and the markdown has no unit so, 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 market (that is, if 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

[16]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.

[17]Note that this is equivalent to Berger et al. (2022) on labor-market power where the wage is equal to the markdown times the marginal productivity of labor. 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, just to hold down the price paid for prior units.

higher the price.[18]

1.3.4 Buyer Market Power and Supply Elasticity

The elasticity of supply allows us to better understand how prices are determined. Given Bertrand competition,[19] the elasticity of supply has the following closed form.

$$\epsilon_{bjk} = \eta(1 - S_{bjk}) + \theta S_{bjk}, \tag{1.3.6}$$

where

$$S_{bjk} = \frac{p_{bjk}q_{bjk}}{\sum_b p_{bjk}q_{bjk}} = \frac{p_{bjk}^{\eta+1}}{\sum_{b'\in B} p_{b'jk}^{\eta+1}} \tag{1.3.7}$$

is the relative size of Buyer b and Product j in Destination k. This variable is key given that together with the elasticities it determines the buyer's market power.

Focusing on equation 1.3.6, 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. With many buyers, they exert less influence, and sellers can always switch to other buyers of the same product or input. However, as the number of buyers decreases, the relevance relies on the potential substitution between products, θ.

Finally, I arrive at my first theoretical result. Rearranging equation 1.3.6, 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.

Proposition 1. 1. The markdown of Buyer b for Product j in Destination k is increasing in that 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

[18] 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 by a change in quantities and so also not affected by a change in prices (or exchange rate).

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

that buyer's market 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.

1.3.5 Concentration

In this section, I aggregate my previous results at the market level. Aggregating the right-hand side of equation 1.3.7 across all firms in a local market, weighting each firm by its 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

$$\mu_{jk} = \frac{\overline{MRP}_{jk}}{\bar{p}_{jk} e_k} = 1 + \epsilon^{-1} = 1 + \eta HHI_{sk} + \theta(1 - HHI_{sk}) \tag{1.3.8}$$

where $\overline{MRP}_{jk}$ and $\bar{p}_{jk}$ are Market j's (revenue-weighted) average marginal revenue of 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 HHI.

Proof. See appendix.

After obtaining an equation for equilibrium price and after showing how it depends on the markdown,[20] I can now finally investigate the relationship of the markdowns to price adjustments caused by exchange rate shocks.

1.3.6 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 country-pair level, Δe_k, 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

[20]In Appendix A.0.1.6, I show the relationship between size and price level.

prices chosen by all the other buyers of Seller s.[21] Consistent with my assumption in the buyer profit-maximization problem, I assume that when Buyer b chooses the new bilateral price, she takes as given both prices and quantities of all other pairs. In other words, this means focusing on the direct effect of the shock on the price, p_{bjk}.[22]

Log-differentiating equation 2.4.8, and using the result in Proposition 6, I rewrite the log change in price, $\text{dln}p_{bjk}$, as[23]

$$\text{dln}p_{bjk} = \text{dln}\mu_{bjk} + \text{dln}MRP_{bjk} + \text{dln}e_k. \tag{1.3.9}$$

Solving for each term, I derive

$$\begin{aligned} \text{dln}\mu_{sbjk} &= \frac{\text{dln}\mu_{bjk}}{\text{dln}S_{bjk}} \frac{\text{dln}S_{bjk}}{\text{dln}p_{bjk}} \, \text{dln}p_{bjk} && (1.3.10) \\ &= \Upsilon_{sbjk}(\eta+1)(1-S_{bjk}) \, \text{dln}p_{bjk} && (1.3.11) \\ &= \Gamma_{bjk} \, \text{dln}p_{bjk}, && (1.3.12) \end{aligned}$$

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 $\Gamma_{bjk} = \frac{\text{dln}\mu_{bjk}}{\text{dln}p_{bjk}} < 0$.

$$\begin{aligned} \text{dln}MRP_{sbjk} =& \frac{\text{dln}MRP_{sbjk}}{\text{dln}p_{bjk}} \, \text{dln}p_{bjk} && (1.3.13) \\ =& \frac{-1}{\sigma}(1-x_{bjk})\epsilon_{bjk} \, \text{dln}p_{bjk} && (1.3.14) \\ =& \Phi_{bjk} \, \text{dln}p_{bjk}, && (1.3.15) \end{aligned}$$

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 1.3.6.

Substituting equations 1.3.10–1.3.13 into 1.3.9, 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

[21] Intuitively, by affecting the price and quantities for other buyer–seller pairs, a given shock may affect the price. p_{bjk}, through changes in buyer market share. Section A.0.1.9 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.

[22] I validate this assumption in the next section, where I show that the effect of the country-pair-level shock to 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.

[23] 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.

market share, S_{sbjk}, and fundamentals. Proposition 3 characterizes the direct component of the pass-through of an 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:

$$\frac{dp_{bjk}}{de_k} = \frac{1}{1 + \underbrace{\Gamma_{bjk}(\eta, \theta, S_{bjk})}_{Mark\ down\ channel(+)} + \underbrace{\Phi_{bj}(\varphi_j, S_{bjk})}_{Marginal\ Revenue\ Channel(-)}} \tag{1.3.16}$$

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 1.3.16 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 $\nu = \{\eta, \theta, \varphi\}$.

1.3.6.1 Aggregate Level

Next, I calculate the average exchange rate pass-through by sector and destination, in terms of the HHI.

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

$$\psi_{jk} = \frac{dp_{jk}}{de_k} = \frac{1}{1 + \underbrace{\tilde{\Gamma}_{jk}(\eta, \theta, HHI_{jk})}_{\text{Mark down channel (+)}} + \underbrace{\tilde{\Phi}_{jk}(\varphi_j, HHI_{jk})}_{\text{Marginal Revenue Channel (-)}}}, \tag{1.3.17}$$

where $\widetilde{\Gamma}_{jk} = \frac{d\mu_{jk}}{de_k}$ and $\tilde{\Phi}_{bjk} = \frac{\text{dln}MVP}{\text{dln}e_k}$

Proof. See appendix.

1.3.7 Channels

In this section, I decompose the overall exchange rate pass-through effect into markdown and marginal-revenue channels. From my theoretical model, I derive an expression to quantify each of these channels in the empirical part in Section 1.4.4.

1.3.7.1 Markdown Channel

The markdown channel is driven by the endogenous response of the buyer's market share to the shock. Following a positive exchange rate shock ($\uparrow e_k$, a devaluation of the home country), the buyer reduces her markdown and increases the price in the buyer currency (compensating for the shock and keeping the price more stable in the seller currency) such that the seller does not substitute away from that buyer. In other words, she internalizes the upward-sloping supply curve in equation 1.3.2: Each additional unit she purchases 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.[24] Therefore, the markdown channel operates differently for buyers with different market shares: Higher market share leads to 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.

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.

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

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.

$$\frac{dmarkdown\,channel}{dS_{bjk}} > 0$$

Proof. Differentiate equation 1.3.8 with respect to S_{bjk}. See Appendix A.0.1.14 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 conditions must hold for a positive exchange rate shock to increase the markdown of Buyer b in Product j, and 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 market 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 her competitors, the more she can mark prices down without sellers easily leaving because there are fewer buyer options nearby

[24]Equation 1.3.10 shows Γ_{bjk} depends on S_{bjk}, and Appendix 1.3.7.1 shows the relationship is increasing.

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 changes.

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).[25]

1.3.7.2 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 1.3.13, I get the following expression for the marginal-revenue channel.

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

It can be seen that the marginal-revenue channel depends on (i) σ, the parameter for elasticity of substitution in the buyer's CES production function, (ii) x_{bjk}, the share of input j in the buyer's production costs, and (iii) the elasticity of supply.[26] I 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 $\sigma \to \infty$, 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.[27]

Second, a higher x_{bjk} yields a more-relevant product for the buyers' production. If $x_{bjk} = 1$, input j is the only input and the marginal revenue will be constant, where increasing one unit of the input will increase the marginal revenue the same amount. If that were the case, then

[25] For this section, I borrow some labor-market intuitions from Berger et al. (2022); Felix (2022).

[26] As shown in equation 1.3.13, the marginal-revenue channel depends on the buyer's production function because 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 A.0.1.13.

[27] If the production function were Cobb Douglas, then $\sigma = 1$. This case is explored in the Appendix A.0.1.13.

the buyer's market share would be irrelevant for this channel because, again, this channel would be shut down.

Third, a higher elasticity of supply yields a bigger 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.

1.4. Estimation

In this section, I use the data on Colombian exporters to test the theoretical model of the effect of 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 Appendix A.0.2.8.

1.4.1 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 1.3.16 cannot be directly estimated since pass-through ψ_{sbjk} is not observed in the data. I can, nonetheless, identify the theoretical coefficients in the relationship between pass-through and buyer market share. Therefore, I step back to the decomposition of the log price change in equation 1.3.9.

1.4.1.1 Linearization

To estimate the effect of an exchange rate shock on prices for buyers with different market shares, after linearizing on the buyer market share, S_{bjk}, I calculate a first-order approximation, replace the differential d with a time difference Δ and rearrange to derive Proposition 5.

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

$$\psi*_{bjk} \approx \mathbb{E}\left[\frac{\Delta p_{bjk}}{\Delta e_k}\right] = \alpha_{jk} + \beta_{jk} S_{bjk}. \tag{1.4.1}$$

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

$$\psi*_{jk} \approx \mathbb{E}\left[\frac{\Delta p_{jk}}{\Delta e_k}\right] = \alpha_{jk} + \beta_{jk} HHI_{jk}, \tag{1.4.2}$$

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

Proof. See appendix.

The pass-through elasticity, $\psi*_{bjk}$, measures the buyer-product-destination price's equilibrium log change relative to the log change in the bilateral exchange rate, averaged across all possible states of the world and economic 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 the product-destination universe. 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 from 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 is

$$\Delta p_{s,b,j,k,t} = \underbrace{[\alpha + \beta S_{b,j,k,t-1}]}_{Exchange\ rate\ pass\ through} \Delta e_{kt} + \underbrace{\tau_{s,j,k} + \tau_{s,t}}_{Fixed\ Effects} + \epsilon_{s,b,j,k,t} \tag{1.4.3}$$

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 (COP seller currency per 1 unit buyer currency—Destination k). That is, an increase in e_k corresponds to the bilateral depreciation of seller currency, COP, relative to the Destination k buyer currency. $\tau_{s,j,k}, \tau_{s,t}$ are destination-product-seller fixed effect, year-seller fixed effect.[28]

I estimate parameters α and β with values averaged across seller, product, destination, and period. The regression equation 2.3.1 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 A.0.1.2.[29] 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 to the exchange rate produces no change in

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

[29] 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.

the seller-currency prices (COP), and a proportional change (to the change in the exchange rate) in the buyer currency (rest of the world currency).[30]

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 to 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 exchange rate 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 1.3, 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.[31] 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 characteristics of the buyer–seller relationship such as tenure, different products, etc. More robustness checks on this can be found in Appendix A.0.2.8.

1.4.2 Firm-Level Main Empirical Findings

In Table 1.2, I present the results for my benchmark empirical specification, equation 2.3.1. To explore the underlying mechanisms behind the equilibrium relationship between pass-through and buyer market share, I begin with a simpler specification and build up my benchmark empirical specification, equation 2.3.1. As the equation includes different sets of fixed effects, we go from the least-saturated regression to the more-demanding fixed effects.

Table 1.2 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

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

[31] 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).

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 a 50% market share has only a 5% pass-through.

Table 1.2: Effect of Buyer's Market Share on Exchange Rate Pass-through

	(1) $\triangle \ln(Price)$	(2) $\triangle \ln(Price)$	(3) $\triangle \ln(Price)$	(4) $\triangle \ln(Price)$
$\ln(\triangle ER) = \alpha$	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)
$\ln(\triangle ER) \times S_{t-1} = \beta$		-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

Notes: Results from equation 2.3.1. The dependent variable corresponds to the log change of prices. ΔER and S_{t-1} are the bilateral exchange rate and the buyer market share, respectively. Products are defined at the HS10 level. Standard errors are clustered at the country-time level and are shown in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

To better understand the results from my regression, Table 1.3 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 greater than 20%.

These results reflect that the dominant mechanism is the markdown channel: 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 raises the price of every other unit.[32] 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,

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

Table 1.3: Firms with Different Levels of Exchange Rate Pass-through

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

Notes: The table shows the number of firms and the mean value for buyer market share S_t for the different categories of exchange rate pass-through coefficients. α and β correspond to the estimates from Table 1.2.

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.

1.4.3 Aggregation at the Market Level

In this section, I explore the market level exchange rate pass-through. I start from the theoretical equation 1.4.2, and obtain the following regression at the market level.

$$\Delta p_{s,k,t} = [\alpha + \beta HHI_{s,k,t}]\Delta e_{kt} + FEs + \epsilon_{s,k,t}, \tag{1.4.4}$$

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 HHI.[33]

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 address 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, and I can account accurately for the effect of buyer market concentration. Results for this regression are shown in Table 1.4. When exports are more concentrated among a few buyers, the exchange rate pass-through for the average market price is lower.

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

[33]We summarize the distribution of the HHI and the exchange rate pass-through at the market level in the appendix.

Table 1.4: Effect of Market Concentration on Average Exchange Rate Pass-through

	(1) $\triangle\ln(Price)$	(2) $\triangle\ln(Price)$	(3) $\triangle\ln(Price)$	(4) $\triangle\ln(Price)$
L($\triangle$ ER) $=\alpha$	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($\triangle$ER) $\times$ HHIbuyer $= \beta$	-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($\triangle$ER) $\times$ 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

Notes: The table shows results for equation 1.4.4. HHIbuyer and HHIseller correspond to the HHI for sales concentrations among buyers and sellers, respectively. They are calculated by using equation 1.2.1 with the market share of the buyers and sellers. Standard errors are clustered at the country-time level and are shown in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

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 strongly influences the exchange rate pass-through.

1.4.4 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 (see Section 1.4.2) and (ii) new moments from the cross-section, into (iii) a simulated method of moments routine in which all unknown parameters are estimated jointly.

1.4.4.1 Challenges for Estimation

Equation 1.3.16 shows that the pass-through term, $\frac{dp_{sbjk}}{de_k}$ is a function of three parameters—η, θ, φ—and S_{bjk}. Once we linearize on buyer market shares, S_{bjk}, I have two coefficients (equation 1.4.1) which I obtain from running the regression in the data. The sizes 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.[34] 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.

1.4.4.2 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 A.0.3.1 provides further details.[35]

Estimates for η and θ To estimate η and θ, I proceed in three steps: (1) Estimate equation 1.4.1 in the actual data. (2) Simulate equation 1.4.1 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 1.4.1 in the actual data already in section 1.4.2 and obtain $\hat{\alpha}$ and $\hat{\beta}$. To simulate equation 1.4.1, I use the following procedure. First, I draw the productivity of each buyer from an exogenous distribution.[36] 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

[34]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 measured using how prices respond to a well-identified shock. The structural elasticity is a partial equilibrium concept answering the counterfactual: How much firms change supply, holding their competitors' q_{sbjk} constant. The reduced-form elasticity includes all other firms' responses.

[35]I follow a top-down approach related to Berger et al. (2022) and Zavala (2022).

[36]This is needed to have nonsymmetric buyer market shares.

match the coefficients I estimated from the actual data (coefficients from Table 1.2) such that

$$(\hat{\eta}, \hat{\theta}) = \text{argmin}_{\eta,\theta} \left\{ \|\hat{\alpha} - \alpha(\eta, \theta)\| + \|\hat{\beta} - \beta(\eta, \theta)\| \right\}.$$

Estimate for φ_j I take advantage of the data available for Colombia and use cross-sectional 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: $\boldsymbol{\epsilon_k}$, $\boldsymbol{z_b}$ and Others I assume that (log) buyers productivity, $log\, z_b$ and log changes in exchange rate shocks, Δe_k, follow normal distributions.

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

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 numbers of products and buyers are also chosen to match the data from Colombia.

1.4.4.3 Parameter Estimates

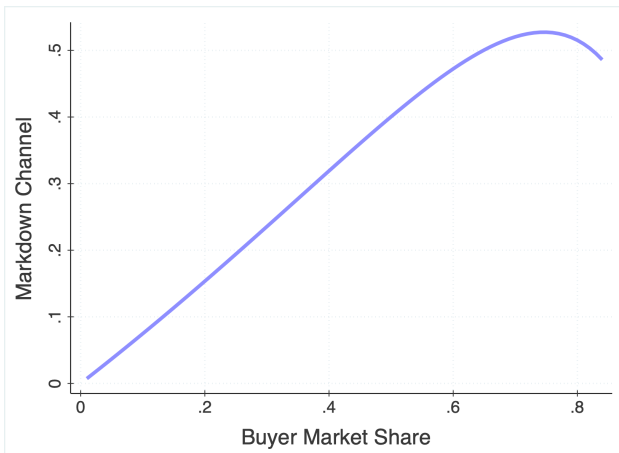
Table 1.5: Summary of parameters

Parameter	Description	Value	Moment	Model	Data
A. Assigned					
N	Number of products	6983			
M_j	Number of buyers per product	17			
μ_{e_k}	Mean of $\ln ER$ changes	0.03			
$\sigma^2_{e_k}$	SD of $\ln ER$ changes	0.1			
B. Estimates					
θ	Across-product substitutability	1.11	Baseline pass-through $\hat{\alpha}$	0.181	0.175
η	Across-buyer substitutability	4.23	Interaction buyer share $\hat{\beta}$	-0.243	-0.241
σ	Input substitutability	0.3	Relative price level	0.012	0.013
z	Productivity shifter	0.05	Average firm size	0.21	0.23

1.4.4.4 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 1.5 shows the markdown channel is bigger for buyer with larger market shares, once I plug in the estimates for the elasticities.

Figure 1.5: Markdown Channel and ERPT varies with size



Notes: Figure plots buyer market share on the x-axis and changes in the markdowns (or the markdown channel) on the y-axis. Buyer market share is defined as the share of the market, defined as destination country x product x year, purchased by a given buyer.

1.5. Counterfactual: Eliminating Buyer Market Power

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

1.5.1 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-buyer elasticity of substitution (θ). However, they do not internalize their influence over the price. Rather, they perceive a perfectly elastic supply curve ($\epsilon_{bjk} = \infty$). Input prices are no longer marked down from their marginal-revenue product.

The change in the sellers' revenues can be decomposed into two effects: a quantity effect and a price effect. 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:

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

1.5.1.1 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.

1.5.1.2 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 supply the buyers with lower information frictions to connect with them, simply because their prices are too low. Once buyer market power is removed, the tradeoff 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%.[37]

1.5.2 Effect on Δ in Revenues with Exchange Rate Shocks

In the rest of this section, I quantify the welfare effects of buyer market power by comparing the volatility of the revenues faced by the sellers in an oligopsony structure to those in perfect competition.

To this end, consider a single consumer, a seller in the home country, whose income is equal to the revenues y_t obtained from exporting their products. Revenues from exports are the only source of income such that $c_t = y_t$. At the same time, revenues in each period follow a random walk:

$$Y_t = Y_{t-1} e^{\mu} e^{-1/2\sigma^2} \epsilon_t,$$

where $\ln(\epsilon_t)$ is a normally distributed random variable with mean 0 and variance σ^2. Under these assumptions $E(e^{-(1/2)\sigma^2}\epsilon_t) = 1$. Preferences over such consumption paths are assumed to be

$$\mathbb{E}\left[\sum_{t=0}^{\infty} \beta^t \frac{((1+\lambda)C_t^{PerfComp})^{1-\gamma}}{1-\gamma}\right],$$

where β is a subjective discount rate, γ is the coefficient of risk aversion, and the expectation is taken with respect to the distribution of shocks ϵ_t.

I compare the utility difference for a seller in an oligopsony structure with one in perfect competition. An extremely risk-averse consumer would prefer the case in oligopsonistic competition. I quantify this utility difference by multiplying the perfect competition path by a constant factor $1 + \lambda$ in all dates and states, choosing λ so the seller is indifferent between the oligopsony and the compensated perfect-competition path. Therefore, λ is chosen to solve

$$\mathbb{E}\left[\sum_{t=0} \beta^t \frac{((1+\lambda)C_t^{PerfComp})^{(1-\gamma)}}{1-\gamma}\right] = \mathbb{E}[\sum_{t=0} \frac{\beta^t}{1-\gamma} C_t^{Olig^{(1-\gamma)}}].$$

Canceling, takings logs and collecting terms gives

$$\lambda \approx \frac{1}{2}\gamma(\sigma^2_{PerfComp} - \sigma^2_{Oligop}).$$

[37] 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.

Note that the compensation parameter λ—the welfare gain from eliminating volatility from buyer market power—depends of three terms: the risk-aversion parameter γ, the amount of risk present in each case $\sigma^2_{PerfComp}$, and $\sigma^2_{PerfComp}$. The last two terms correspond to variance of the ϵ_t for each case.

To estimate λ, estimates of these parameters are needed. As both scenarios have a different variance for their change in revenues, I use the results from the empirical section to estimate this where the variance of the income is

$$\delta^{\Delta Y_t} = (\hat{\alpha} + \hat{\beta} S_{bjkt})^2 \delta^{\Delta e_{kt}}.$$

I plug in $S_{bjkt} = 0$ for the perfect competition case, and I assign $S_{bjkt} = 1$ to the oligopsony case, obtaining 0.0008 and 0.000003, respectively. Seeing this agent as a representative seller in a developing country, I use estimates of the coefficient of risk aversion, γ. In macroeconomics and finance, this coefficient ranges from 1 (lowest risk aversion) to 5 (highest risk aversion). I pick a coefficient of 1 and calculate λ:

$$\lambda \approx 0.0004$$

From the literature, these welfare losses of a monetary-policy regime are low, but they are on the order of magnitude of Lucas (2003). Comparing this lambda with Lucas (2003) (0.0005), I can conclude buyer market power accounts for 80% of the costs of welfare related to eliminating the whole business cycle in the U.S. when evaluating the volatility of the sellers' income in Colombia.

Taking into account both effects, the level effect for the price and the effect related to the volatility of the revenues, we can explain why the mentioned parameters (i.e., the elasticities, risk premium, utility function, etc.) matter in understanding how sellers are affected by buyer market power in international markets.

1.6. Conclusion

This paper studies buyer market power in international markets and its impact on the exchange rate pass-through. I combine a novel transaction-level dataset covering the universe of Colombian exports that crucially contains information on the identity of the foreign buyer for the period 2007–2020 with an oligopsony model of buyer market power in international trade. The main conclusion is that buyer market power is relevant in determining the exchange rate pass-through.

Theoretically, buyer market power has implications for price determination and for how these prices react to exchange rates. First, buyers with higher market share have a higher markdown, and so a lower price, all else equal. Second, buyer market power has consequences for the exchange rate pass-through. The overall effect is driven by two offsetting mechanisms: a markdown channel and a marginal-revenue channel.

My empirical strategy focuses on estimating the Colombian exports' pass-through elasticity 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, ranging from 1% for the largest to 17% for the smaller buyers. The mechanism behind this is that large buyers' greater market power leads to *more* variable markdowns. 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.

Finally, I calibrate the model and obtain key elasticities that allow me to simulate a counterfactual scenario where buyers have no market power. Under this scenario, sellers receive higher prices but their revenues are more responsive to exchange rate shocks. In this setting, seller currency devaluations are much common than appreciations. On balance, sellers are less likely to benefit from reduced volatility than to be disadvantaged by attenuated revenue gains during depreciation episodes.

This paper has important policy implications for sellers from developing countries who sell their products to large firms. Even though when selling to a large firm they might receive marked down prices, these prices are more stable during exchange rate shocks. Countries in Latin America frequently have devaluations, so this mechanism prevents them from suffering a harsher consequence of the shock. On the other hand, multinationals abroad might find it less appealing to connect with small sellers.

In the last decades, concentration of sales in large, multinational firms has been increasing, raising many questions for future research. At the firm level, future work could focus on exploring which kinds of buyers are the best investment for small sellers in developing countries in the long run. At the same time, which markets contribute more to the growth of these small firms. Relevant policy questions at the market level remain unanswered: How does the market structure in terms of concentration of two different countries affect when they engage in trade? How does that market structure affect the propagation of shocks.

CHAPTER II

Bank Loans, Trade Credit and Export Prices: Evidence from Exchange Rate Shocks in China

This is joint work with Jingyuan (George) Cui and Xiaosheng Guo

2.0 Abstract

This paper studies how the effects of exchange rate shocks on international prices (i.e., exchange rate pass-through) vary with trade credit. We put together a dataset that contains customs data and bank statements for the universe of Chinese exporters for the period 2001-2012. We start by documenting some stylized facts. First, exporters' international prices respond significantly less for products sold by exporters issuing more trade credit (more complete exchange rate pass-through). Second, the interests paid by exporters to domestic banks respond to exchange rate shocks. Third, we observe substantial complementarity between trade credit and bank loans. We introduce an open economy model of monopolistic competition in international markets with heterogeneous firms and domestic financial markets to explain these patterns. The mechanism is exporters can grant trade credits to the importers with the trade credit interest rate implicitly embedded in the exporting price. There is a trade credit premium channel: exchange rate shocks affect domestic banks' expectations of exporters' profits, and, in this way, impact interest rates (financial costs) offered to exporters and, in turn, the trade credit interest rate in the exporting price. Our findings and theory call for policy attention to firms' financial conditions when dealing with inflation through supply chains.

2.1. Introduction

One fundamental question in international economics is why large movements in exchange rates have small effects on the prices of internationally traded goods (incomplete exchange rate pass-through). Recent literature has emphasized different mechanisms through which the exchange rate might affect export prices: import intensity (Amiti et al., 2014), productivity (Atkeson and Burstein, 2008b). At the same time, it has been shown financial constraints and trade credit affect firms' domestic pricing decisions (Gilchrist et al., 2017; Hardy et al., 2022; Almut, Balleer; Nikolay, Hristov; Dominik, 2017; Kohn et al., 2020). If this is the case, can financial constraints and trade credit also affect the international prices set by the firm? Can trade credit explain part of the heterogeneity in exchange rate pass-through?

This paper focuses on evaluating the effect of trade credit and bank loans on the pricing decisions of firms in international markets and on price dynamics when there is an exchange rate shock (i.e., exchange rate pass-through). To this end, we combine a rich dataset from China containing information on firms' balance sheets and export prices with a theoretical model of firm heterogeneity in a monopolistic competition framework that introduces financial markets in the home country and trade credit between exporters and importers. Our main finding is that trade credit and financial markets play a role in international price setting and in how these prices react to exchange rate shocks.

We begin our analysis by introducing a conceptual model of how trade credit could have an effect on the degree of exchange rate pass-through. The exporters are located in the home country and grant trade credit to importers from foreign countries. For this trade credit to be profit-maximizing for exporters, the importers need to pay an implicit interest rate embedded in the product price. As the trade credit interest rate reacts with changes in the exchange rate, it constitutes of a new mechanism determining exchange rate pass-through.

Based on our conceptual model, we use a dataset from China for the period 2000-2011 for our analysis. We combine three datasets into one panel: (i) a dataset of Chinese firms' balance sheets containing long term debt, trade credit, and interests costs, (ii) customs data which corresponds to transaction-level data for the universe of exports for China; and (iii) bilateral exchange rates from the International Monetary Fund.

Using this novel dataset, we document some stylized facts on Chinese export markets. First, we find export prices in producer currency react less to exchange rate shocks for an exporter with a higher ratio of trade credit (receivables) over sales than for an exporter with a lower ratio. In other words, firms issuing more trade credit have a more complete exchange rate pass-through to producer currency price. This effect is more predominant for devaluations.

Second, we find a negative correlation between interest costs paid by exporters to domestic banks (i.e., their bank loans) and changes in the exchange rates. As interest costs correspond to a *proxy* for the interest rate, our evidence suggests that domestic banks change the interest rate charged to exporters with changes in the exchange rate. This is because exchange rate fluctuations will make export prices more competitive in international markets.

Third, we find trade credit and bank loans are complements for exporting firms. For exporters to issue trade credit to their buyers, they need to rely on domestic banks to lend them money. This complementarity is heterogenous in the firm size: firms with higher market share have a stronger complementarity.

Motivated by these stylized facts, we develop an open economy model with three agents;

exporters, importers, and domestic banks. Exporters and domestic banks are located in the home country while importers are the firms in foreign countries. The model has two key sections: the export market and the financial markets.

In the export market, the supply side corresponds to firms in a monopolistic competition framework. The novelty in this section is that we introduce both nominal exchange rates and trade credit. On the demand side for these exported products, we assume the importers can finance themselves by borrowing from their domestic banks and exporters.

In the financial market, the exporter borrows from domestic banks. The interest rate paid to these banks is endogenously set by the aggregate savings and borrowings levels in the home country. Given the average net worth of the exporter increases with an increase of the exchange rate (e.i., depreciation), the model is set such that the aggregate borrowing level reacts to changes in the exchange rate.

The first theoretical result of the model is that the equilibrium price depends on three terms: the variable markup, the marginal cost, and a financial term. The financial term is a function of the interest rate exporters get from domestic banks and the trade credit, measured as the ratio between the firm trade credit and sales. The higher the trade credit, the higher the price. The higher the domestic bank interest rate, the higher the price.

The second theoretical result is that the price response to exchange rate shocks varies with the trade credit level: firms that issue more trade credit relative to their sales level set prices that react less with changes in the exchange rate. This result is consistent with our empirical findings.

The mechanism behind these results is the following: exporters face lower financial costs from banks when the home currency depreciates, and this change of interest rate will pass on to trade credit implicit interest rate. In other words, as the firms sell in international markets, the expected sales/returns of exporting firms increase with home currency depreciation. On the other hand, domestic banks in a perfectly competitive framework maximize profits by choosing firm-specific interest rates given the firm's expected sales/returns. Bank loan interest rates are positively correlated with trade credit interest rates. Therefore, the trade credit interest rate decreases when the home currency depreciates.

Our paper contributes to three different strands of the literature. First, it contributes to the literature on the international pricing response to exchange rate changes. There is a big body of literature that focuses on different reasons why the exchange rate pass-through is incomplete, such as markup adjustment, local costs, or barriers to prices adjustment (Amiti et al., 2014; Atkeson and Burstein, 2008b; Campa and Goldberg, 2005; Gopinath et al., 2010; Burstein and Gopinath, 2014; Auer and Schoenle, 2016; Berman et al., 2012). This paper sheds light on an understudied source for incomplete exchange rate pass-through which is trade credit and bank loans. Together with this paper, Strasser (2013) explores the effects of credit constraints on exports responses to shocks in terms of prices and quantities in international markets. Our contribution to this literature corresponds to a theoretical model disentangling the mechanism through which trade credit and bank loans are connected and how this, in turn, affects the degree of exchange rate pass-through.

Second, our paper contributes to the literature relating firms' liquidity constraints and pricing decisions. Liquidity constraints can be divided into financial constraints related to domestic banks and trade credit. As regards bank loans, Gilchrist et al. (2017) shows that liquidity-constrained firms increased prices during the Great Recession in 2008, while unconstrained firms decreased prices. In contrast, Kim (2021) finds that a negative credit supply shock decreases output prices during the Lehman Brothers' failure. In terms of trade credit, Amberg et al. (2021) finds firms issuing more trade credit increased product prices significantly more during the Great Recession. All of this literature focuses on the domestic prices of firms, while our paper expands into the international markets and, at the same time, combines in a model both mechanisms of the trade credit one and the financial constraints related to bank loans.

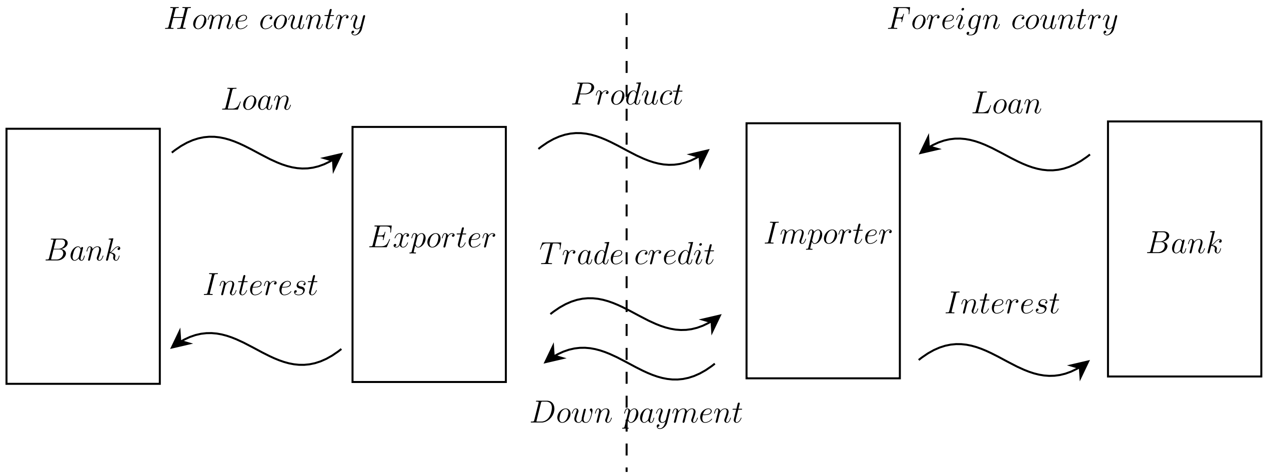
Third, this study relates to the body of work on trade credit and liquidity propagation. On the one hand, Desai et al. (2016) shows US multinationals use trade credits to shift capital from low-tax places to high-tax places. On the other hand, Lin and Ye (2018) finds multinationals' trade credit provision for Chinese firms is significantly affected by global liquidity shocks. This paper connects trade credit and bank loans. We first exploit the variation of our data and find the relationship between the bank loan interests and trade credit. Then, our model identifies the theoretical connection behind this result.

This paper is organized as follows. Section 2 proposes a conceptual model of prices including trade credit. Section 3 corresponds to the data and some empirical findings. Section 4 presents a model that accounts for the empirical patterns and details a mechanism behind these patterns. In Section 5, we calibrate the model. Section 6 proposes a counterfactual and Section 7 concludes.

2.2. A Conceptual Model

How do trade credits affect exchange rate pass-through? In this section, we use a simple conceptual model to answer this question. The conceptual model will guide our empirical regression and will be formalized in the theoretical model.

Figure 2.1: Trade and Financial Relationships



Notes: This figure provides an illustration of the trade and financial relationships of the economy. On the trade relationship, the exporter sells products to the importer and receives payments. The financial relationship between the export and the importer emerges when the exporter only requires a partial down payment and grants a trade credit to the importer. Both the exporter and the import can borrow from banks in their own countries.

Consider an exporter in the home country selling a product to a foreign buyer, or importer (Figure 2.1). The exporter sets the product price in the importer's currency, $P^* = P \times E$, where E is the exchange rate defined as exporter's currency/importer's currency and P is the price in the exporter currency. Suppose the price of the product is set with no trade credit being granted:

$$P^* = \frac{\epsilon}{\epsilon - 1} MC \times E^{-1} \tag{2.2.1}$$

where ϵ is the importer's demand elasticity; MC is the exporter's marginal cost in exporting country's currency unit [1]. From equation 2.2.1, we derive the following equation for the exchange rate pass-through with no trade credits:

$$\frac{dp}{de} = \frac{d\mu}{de} + \frac{d(mc)}{de} \tag{2.2.2}$$

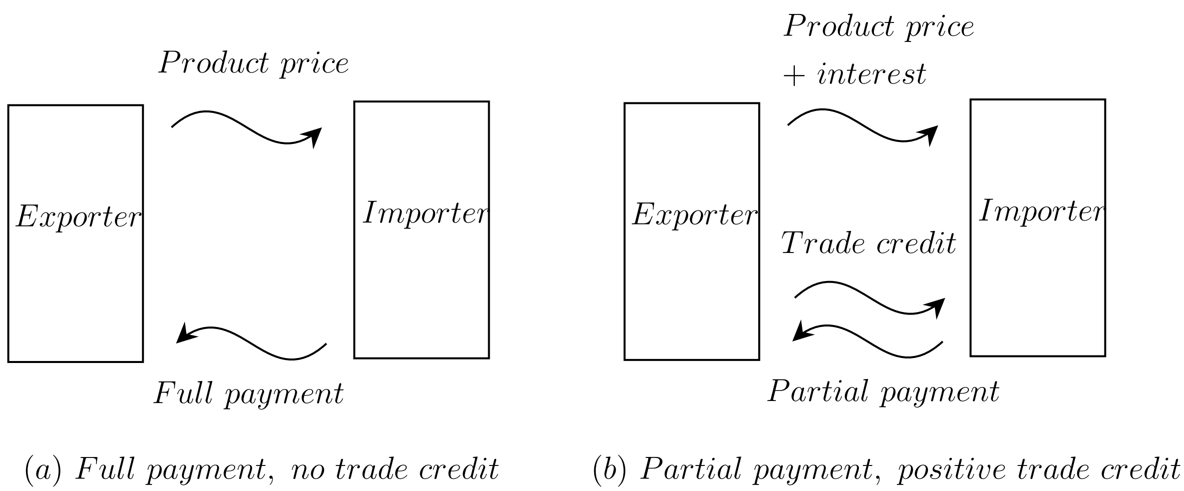
where $p = logP$, $\mu = \log \frac{\epsilon}{\epsilon - 1}$, $mc = \log MC$, and $e = logE$. Equation 2.2.2 summarizes two channels of the channels of incomplete exchange rate pass-through that have been studied in the literature: the markup response [2] ($\frac{d\mu}{de} > 0$) or the marginal cost response ($\frac{d(mc)}{de} > 0$) [3].

[1] For this example, we use the standard setting with monopolistic competition and variable markups as in Atkeson and Burstein (2008b)

[2] This channel assumes firms' have variable markups that vary via the response of the demand elasticity to exchange rate changes (Burstein and Gopinath, 2014)

[3] This channel is explored in studies such as Amiti et al. (2014); Berman et al. (2012)

Figure 2.2: Trade Credit Utilization and the Exporting Price



Notes: Panel (a) illustrates the case where the exporter asks full payment and grants no trade credit. The observed exporting price is the product price. Panel (b) illustrates the case where the exporter asks partial payment and grants positive trade credits. The observed exporting price is the product price and an implicit interest rate (trade credit premium).

In this scenario, we introduce trade credit (Figure 2.2). Suppose the exporter allows the importer to pay for the products after a certain maturity period τ. That is, the exporter grants trade credit to the importer. Trade credit is desirable for the importer due to financial constraints. For example, an importer without cash could import inputs and sell final goods to consumers. After collecting cash from the consumers, the importer can pay the exporter back. However, as issuing trade credit is costly for the exporter, the importer needs to pay an implicit interest rate that is embedded in the product price. Following Amberg et al. (2021), we assume there is a trade-credit premium in the product price:

$$P^T = P \times exp(r\tau) \tag{2.2.3}$$

where r is the implicit annual interest rate of trade credit and τ is the maturity of the trade credit, in number of net days divided by 365.

With trade credit being granted, the exchange rate pass-through is:

$$\frac{dp^T}{de} = \frac{d\mu}{de} + \frac{d(mc)}{de} + \tau\frac{dr}{de} + r\frac{d\tau}{de} \tag{2.2.4}$$

In our empirical exercise, we focus on the role of $\tau\frac{dr}{de}$ in Equation 2.2.4. The variation of exchange rate pass-through across exporters could be explained by the different degrees of trade credit utilization and the adjustment of the implicit interest rate.

2.3. Data and relevant patterns

2.3.1 Data

Our sample of firms is drawn from two sources of data in China. First, we obtain the firm-level balance sheet data from the survey of Chinese manufacturing firms conducted by the National Bureau of Statistics of China. The survey covers more than 190,000 manufacturing firms' performance from 2000 to 2011. In this survey data, we are able to find the variables describing the firm's credit condition including trade credit (recorded on the balance sheet as account receivables), long-term debt, and interest costs. Together with this, we include variables that indicate the firm's size such as annual employment and sales. [4]

Second, we include a panel from customs that corresponds to the universe of Chinese trade transactions to 76 destination countries. It comprises data on trade values and trade prices for each transaction of a firm to a certain destination country in a given year. We merge the two datasets for the period 2000 to 2011 and construct the sample to conduct empirical analysis.[5]

In addition to the firm panel, we also use the annually averaged nominal bilateral exchange rates from IMF to construct the exchange rate shocks at the importing-country level. Figure 2.3 shows the bilateral exchange rate shocks fluctuation from the year 2000 to 2011. Before 2005, the Chinese government implemented a fixed exchange rate policy targeted at US dollars. As a result, there were no bilateral exchange rate shocks between China and US before 2005. Table 2.1 is the summary of the key variables we use in the empirical part.

Figure 2.3: Times Series of Change in Exchange Rates

Notes: This figure shows the exchange rates fluctuations from 2000 to 2011. In the vertical axis, the annual

[4]These variables are mainly used in the robustness checks.

[5]To avoid noise in the survey, we deleted unusual entries including negatives of key variables in the balance sheet and missing data.

exchange rate is calculated as Chinese RMB per 1 unit of exporting destination's currency averaged from monthly data.

Table 2.1: Summary of Statistics

Variable	Mean	Std. dev.	Min	Max
Exporting prices	3351.702	332123.7	3.06e-06	1.63e+08
Export values	452078.1	1.08e+07	1	5.40e+09
Receivables	147343.2	1606957	1	5.28e+07
Interest costs	4144.873	50314.75	-707406	2821463
Sales	887535.5	6846421	56	1.92e+08
Employment	1068.278	5278.498	1	198971

Notes: This table summaries the data. The total observations in the sample are 5,773,343. The panel data is at the firm-product-destination-year level. The exporting prices and values are from transaction-level custom data. Receivables, interest costs, sales and employment are from the firm-level balance sheets. Part of the interest costs observations are negative because those firms received more interest income than the interest expenses they paid to creditors.

2.3.2 Stylized Facts

In this section, we establish basic facts about the role that trade credit plays in the exporters' market. We shed light on three relationships; the relationship between trade credit and bank loans, trade credit and export prices, and the exchange rate and bank loans.

2.3.2.1 Fact I: Larger trade credit share indicates more complete exchange rate pass-through

We begin by exploring how exporters that issue trade credit change their prices as a result of an exchange rate shock. Equation 2.3.1 shows our main specification.

$$\Delta p_{i,j,k,t} = \underbrace{[\alpha + \beta rec_{i,0}]}_{1-ERPT} \Delta e_{k,t} + n_{i,t} + \underbrace{\varphi_{j,k} + \varphi_t}_{Fixed\ Effects} + \epsilon_{i,j,k,t} \tag{2.3.1}$$

where $\Delta p_{i,j,k,t}$ is the log change in price of good j denominated in producer-currency (Chinese RMB) from exporting firm i to destination country k at time t. $\Delta e_{k,t}$ is the log change of bilateral exchange rate (Chinese RMB per 1 unit of destination k's currency). An increase in $e_{k,t}$ corresponds to the depreciation of Chinese RMB relative to the destination-k currency. $rec_{i,0}$ is firm i's trade credit (receivables) over total sales in the first year of dataset. $n_{i,t}$ is log of employment of firm i at time t that captures remaining firm-level effects on ERPT. We also control for time fixed effects and product-destination fixed effects.

Since we are using the exporting prices, a complete exchange rate pass-through is when $\alpha + \beta rec_{i,t} = 0$. The coefficient β indicates to what extent firm-level trade credit changes the pass-through to exporting prices when there exist bilateral exchange rate shocks. Table 2.2 reports the regression results.

Column (1) shows the plain regression without controlling for trade credit shares. However, column (2) result shows that a 10% increase in trade credit share leads to a 1.24% higher exchange rate pass-through. The robustness check in columns (3)-(5) in which control for last-year trade credit share and employment demonstrate similar estimates of β. While a firm with no trade credit has a pass-through of 95.08% (= 1 - 0.0492), a firm with a 7% trade credit share (median) has a pass-through of 95.95% (= 1 - 0.0492 + 0.124$\cdot$ 0.07). The estimate of β indicates that firms with a larger share of trade credit relative to sales exhibit higher pass-through into destination-currency export prices.

Table 2.2: Regression Results

	(1) $\Delta p_{i,j,k,t}$	(2) $\Delta p_{i,j,k,t}$	(3) $\Delta p_{i,j,k,t}$	(4) $\Delta p_{i,j,k,t}$	(5) $\Delta p_{i,j,k,t}$
$\Delta e_{k,t}$	0.0314**	0.0492***	0.0281*	0.0497***	0.121***
	(0.0146)	(0.0176)	(0.0159)	(0.0176)	(0.0424)
$rec_{i,0}$		-0.00991**		-0.00778*	-0.00801*
		(0.00426)		(0.00412)	(0.00410)
$\Delta e_{k,t} \times rec_{i,0}$		-0.124***		-0.125***	-0.134***
		(0.0473)		(0.0476)	(0.0468)
$rec_{i,t-1}$			-0.000123*		
			(0.0000681)		
$\Delta e_{k,t} \times rec_{i,t-1}$			-0.00819***		
			(0.00264)		
$n_{i,t}$				0.00219***	0.00183***
				(0.000542)	(0.000574)
$\Delta e_{k,t} \times n_{i,t}$					-0.0111*
					(0.00588)
Product-destination FE	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes
Obs	1443809	1443809	1110858	1443809	1443809

Notes: This table reports the results of regression results from Equation 2.3.1 Standard errors are reported in parenthesis.* Significant at 10%.** Significant at 5%.*** Significant at 1%. All columns have year-level and product-destination-level fixed effect controls.

2.3.2.2 Fact II: Interest costs decrease in response to home currency depreciation

We ran Equation 2.3.2 to examine how firm's loan-related costs react to exchange rate shocks.

$$c_{i,t} = \alpha + \beta \Delta e_{i,t} + \varphi_i + \varphi_t + \epsilon_{i,t} \tag{2.3.2}$$

where $c_{i,t}$ is the log finance costs or log interest costs of exporter i at time t. φ_i and φ_t are firm and time fixed effects. $\Delta e_{i,t}$ is the firm-level exchange rate shocks constructed as

$$\Delta e_{i,t} = \sum_{k \in \Omega_{i,t}} \Delta e_{k,t} \times \Gamma_{i,k,t}$$

where $\Gamma_{i,k,t}$ is the exporting share of firm i to destination k in period t. $\Omega_{i,t}$ is the a set of exporting countries of firm i in period t. The regression results are shown in Table 2.3.

Table 2.3: Regression Results

	(1)	(2)	(3)	(4)
	$c^F_{i,t}$	$c^I_{i,t}$	$c^F_{i,t}$	$c^I_{i,t}$
$\Delta e_{i,t}$	-0.339***	-0.566***	-0.158***	-0.149**
	(0.0919)	(0.0989)	(0.0575)	(0.0640)
Period	Yes	Yes	Yes	Yes
Firm	No	No	Yes	Yes
N	183118	183118	148458	148458

Notes: This table reports the results of regression results from Equation 2.3.2. Standard errors are reported in parenthesis.* Significant at 10%.** Significant at 5%.*** Significant at 1%.

Finance costs and interest cost can approximate firm's credit level and interest rate. Table 2.3 shows that when Chinese RMB depreciates, the loan-related costs decrease, which is in favor of what we discussed in the conceptual model. Home currency depreciation is at the advantage of exporting firms, who are expected to enlarge export. The higher profitability in the future enables them to borrow more loan from local bank at a lower cost because of lower default risks. As a result, the interest costs are lowered. This effect pass on to the implicit trade credit interest rate, indicating that exporters are willing to lend to downstream foreign firms at a lower cost.

We also run Equation 2.3.2 using trade credit share to examine if firms adjust their trade credit share upon exchange rate fluctuations. Table 2.4 shows that firm-level trade credit share does not response to exchange rate shocks generally, aligning with the assumption that trade credit value is exogenous in the determination of exchange rate pass-through mechanism.

Table 2.4: Regression Results

	(1)	(2)
	$rec_{i,t}$	$rec_{i,t}$
$\Delta e_{i,t}$	-0.0121	-0.00526
	(0.00636)	(0.00753)
Period	No	Yes
Firm	Yes	Yes
N	277919	277919

Notes: This table reports the results of regression results from Equation 2.3.2. Standard errors are reported in parenthesis.* Significant at 10%.** Significant at 5%.*** Significant at 1%.

2.3.2.3 Fact III: Higher trade credit is associated with higher bank loans

Not all Chinese exporters grant trade credit to their foreign buyers. One of the reasons for this is that trade credit is costly for the exporters given it poses a liquidity constraint. However, Chinese firms have access to a broad range of financial instruments that can mitigate or help cover the cost of trade credit. We explore the relationship between trade credit and bank loans for Chinese exporters [6].

Figure 2.4: Correlation between trade credit share and bank loans

[6]Studies such as Hardy et al. (2022) analyze the relationship between these instruments but from the perspective of the firms receiving trade credit from their suppliers. In this paper, we shift the focus to the suppliers granting trade credit and how the extent of trade credit is related to their access and costs of bank loans.

Notes: This figure shows the relationship between trade credit and bank loans for small and big firms. In the vertical axis, the debt share corresponds to bank loans/sales and in the horizontal axis trade credit/sales.

Figure 2.4 illustrates the interplay between trade credit and bank loans. In both panels, the debt share is denoted as the ratio between bank loans and sales at the firm level. The trade credit share corresponds to the ratio between the trade credit and sales. The plot is a biscatter showing the relationship between these two variables for two types of firms: small firms and large firms.

The main takeaway is that the higher the trade credit granted by the exporter, the higher the debt that firm holds with the domestic banks. The intuition behind this finding is that exporters might face a financial constraint while offering trade credit and will solve it by taking loans from domestic banks.

Figure 2.4 also reveals the strength of the relationship between trade credit and bank loans varies with firm size. Small firms find it harder to substitute away granting trade credit with bank loans. A potential reason for this is small firms have less access to bank loans, while large firms might be automatically connected with banks willing to grant them credits. The lack of access could be translated into higher interests costs of bank loans

This fact corresponds to a key intuition for our theoretical model. It motivates the existence of a connection between domestic banks behavior with exporters' trade credit. In the Appendix, we include some more detailed statistics on the relationship between trade credit and other financial instruments.

2.4. Model

In this section, we formalize the idea using a theoretical model consistent with the data. The model captures a trade credit channel in exports price setting and a domestic financial market connected to this channel.

We develop a real small open economy model of monopolistic competition [7] in which exporters are located in the home country and importers correspond to foreign buyers. We introduce three key elements: trade credit, exchange rates and domestic banks.
To begin with, we allow exporters to issue trade credit. In this model, the importer pays for the product in two steps: (i) pays a portion of the price upfront (i.e., down payment), and (ii) pay the remaining portion when they receive the product (i.e., trade credit).[8]

Second, we introduce the nominal exchange rate. The exchange rate will connect prices charged by the exporters and prices received by the importers. The nominal exchange rate will be nontrivial for the choice of the equilibrium price, and will, in turn, affect how prices react to changes in the exchange rate. This will be the case even under the common assumption of constant markups and marginal cost for the exporter.

Third, we include financial markets into our model. Specifically, the importer and the exporter borrow from banks in their own countries. We assume the interest rate in the exporter's country is endogenously set by the domestic aggregate saving and borrowing levels [9], while the interest rate is exogenously set in the importer's country. This setting enables us to capture the interest rate response to exchange rate changes: when home currency depreciates, the aggregate export changes, leading to an change in the aggregate

[7] Our model takes as baseline standard models of monopolistic competition in trade (Krugman, 1980; Melitz, 2003)

[8] For the trade credit block, we follow Cun et al. (2022)

[9] We adopt this relationship from Tirole (2010)

borrowing.

2.4.1 Model Setup

In the model, there are two countries: the exporting country and the importing country. In the exporting country j, there are N exporters indexed by $k = 1, ..., N$. Each exporter produces a unique intermediate input. In the importing country, there is a continuum of competitive firms. They import inputs from the exporters and combine the inputs to produce a final good.

There is one period in the model. In the following subsections we introduce the importer's and the exporter's problems together with details about the financial market.

2.4.2 Importer's Problem

In the importing country i, the representative importing firm is not endowed with any cash. Thus, to purchase inputs, she has to seek external financing. The external financing is assumed to be two-fold: on the one hand, the importer can borrow from a bank in the same country at an exogenous interest rate, r_i. The upper limit of bank loans (in importer's currency) is X_i^*. On the other hand, she can borrow trade credit from the exporter. As we discussed in the previous section, the exporter divides the full payment into a down payment and a trade credit. The down payment share is defined as $\phi(k)$ ($0 \leq \phi(k) \leq 1$), and the trade credit share in turn is defined as $1 - \phi(k)$. Since the importer has zero cash in hand, she has to borrow from the bank to fund for the down payment. We assume the down payment share $\phi(k)$ is exogenously given and is i.i.d. across exporters and importers [10]. The importer chooses quantity to import for each input, $Q_i(k)$.

The importer's maximization problem is:

$$\underset{\{Q_i(k)\}_{k\in J_i}}{max} \left[\int_{k\in J_i} Q_i(k)^{\frac{\epsilon-1}{\epsilon}} dk\right]^{\frac{\epsilon}{\epsilon-1}} - \int_{k\in J_i} p_i^*(k)Q_i(k)dk - r_i \int_{k\in J_i} \phi(k)p_i^*(k)Q_i(k)dk \tag{2.4.1}$$

s.t.

$$\int_{k\in J_i} \phi(k)p_i^*(k)Q_i(k)dk \leq X_i^* \tag{2.4.2}$$

where J_i is the mass of inputs available to the importer in country i, $\phi(k)$ is the down payment share and r_i is the bank interest rate in the importer's country. $p_i^*(k)$ is the price of input k denominated in currency of importer's country.

Solving the problem, we obtain the equilibrium quantity

$$Q_i(k) = [1 + (r_i + \bar{\lambda})\phi(k)]^{-\epsilon}(p_i^*(k))^{-\epsilon}y_i \tag{2.4.3}$$

where $y_i \equiv \left[\int_{k\in J_i} Q_i(k)^{\frac{\epsilon-1}{\epsilon}} dk\right]^{\frac{\epsilon}{\epsilon-1}}$, $\bar{\lambda} = \lambda(P_i^*, y_i; \{\phi(k)\}_k, r, X_i)$ and $P_i^* = [\int_k p_i^*(k)^{1-\epsilon}dk]^{\frac{1}{1-\epsilon}}$.

[10]This technique assumption enable us to separate shadow price from the price index in the importer problem.

2.4.3 Exporter's Problem

In the exporting country j, exporter k is not endowed with any cash. In order to finance labor payments, the exporter can either use the down payment provided by the importer or borrow from a bank in country j at an interest rate r_j. The interest rate is endogenously determined by the aggregate supply and demand in the financial market.

A firm producing input k from country j faces the following problem:

$$\max_{p_i^*(k),b(k)} \quad p_i^*(k)eQ_i(k) - a(k)w_jQ_i(k) - fw_j - b(k)r_j \tag{2.4.4}$$

s.t.

$$Q_i(k) = [1 + (r + \bar{\lambda})\phi(k)]^{-\epsilon}(p_i^*(k))^{-\epsilon}y_i \tag{2.4.5}$$

$$\phi(k)p_i^*(k)eQ_i(k) + b(k) = a(k)w_jQ_i(k) + fw_j \tag{2.4.6}$$

where e is the exchange rate (exporter currency/ importer currency), f is the fixed costs, r_j is the bank interest rate in exporter's country and $b(k)$ is the borrowing from banks.

Solving for the problem, we have the equilibrium price in importing country's currency :

$$p_i^*(k) = e\frac{\epsilon}{\epsilon - 1}a(k)w_j\frac{1 + r_j}{1 + r_j\phi(k)} \tag{2.4.7}$$

Thus, the equilibrium price in the exporting country's currency is:

$$p_i(k) = \frac{\epsilon}{\epsilon - 1}a(k)w_j\frac{1 + r_j}{1 + r_j\phi(k)} \tag{2.4.8}$$

Note that the equilibrium price depends on different terms. First, it depends on the exporters' markup which is a function of the elasticity of demand, ϵ. Second, it depends on the marginal cost of production , $a(k)w_j$, corresponding to the hired labor multiplied by the wage. Third, the price depends on a novel trade credit term. This term is governed by r_j and $\phi(k)$. An increase in $\phi(k)$ (higher down payment, lower trade credit) leads to less "trade credit premium" in the price and in turn a lower product price. An increase in r_j leads to a higher product price, meaning a partial pass-through of financial cost into product price.

In the expression for the price the only term that depends on the exchange rate corresponds to the interest rate $r_j = r_j(e)$. In section **??** we characterize this relationship and explain the mechanism behind it.

From Equation 2.4.8, we compute the exchange rate pass-through:

$$\frac{\partial \log p_i(k)}{\partial \log e} = \frac{1 - \phi(k)}{(1 + r_j)(1 + r_j\phi(k))}\frac{\partial r_j}{\partial \log e} \tag{2.4.9}$$

From the equation above, it can be seen the exchange rate pass-through depends on the trade credit share $1 - \phi(k)$. When the trade credit share is higher, the first term $\frac{1-\phi(k)}{(1+\mu_k)(1+\mu_k\phi(k))}$ increases. We formalize this in Proposition 6.

Proposition 6. The pass-through of a bilateral exchange rate shock to the price decreases in the trade credit share, if $\frac{\partial r_j}{\partial \log e} < 0$:

$$\frac{\partial^2 \log p_i(k)}{\partial \log e \partial \log \phi(k)} < 0$$

Proof. See Appendix for proof.

Moreover, our empirical results indicate $\frac{\partial r_j}{\partial \log e}$ is negative (i.e., the implicit interest rate decreases with the home currency depreciating). We attribute this finding to the fact that banks would lower the interest rates to exporting firms in the event of depreciation. The reason for this to happen in banks expect exporters to increase their sales abroad, becoming more productive and lowering the probability that these exporters default on their debts. In the appendix, we propose alternative ways in which this channel can affect.

2.5. Conclusion

It is well-known financial factors play a key role in firms' price-setting behavior. In this paper, we explore this role in international markets. Mainly, we focus on the effect of trade credit on how export prices adjust exchange rate changes — exchange rate pass-through.

Our main finding is that financial frictions play a key role in exporting price setting. Exporters charge their foreign buyers a price that includes a trade credit premium corresponding to the trade credit they issue. Moreover, the prices of an exporter issuing a high ratio of trade credit to sales are less responsive to exchange rate shocks than the prices of an exporter with a low one. The mechanism behind this is that the implicit interest rate embedded in the exporting price endogenously responds to exchange rate changes. The higher degree of trade credit utilization the firm has, the more the exchange pass-through is affected by the implicit interest rate.

There are relevant policy implications that can be drawn from these findings. First, trade credit has a direct effect on price. That is firms, that can issue trade credit to their foreign buyers and in turn, borrow from domestic banks to sustain their liquidity and obtain some insurance against exchange rate shocks. Second, in a time of supply chain congestion, inflation, and dramatic exchange rate fluctuations, policymakers should pay attention to the financial conditions of the exporters and importers.

Given our findings some questions arise in related topics. For example, if exchange rate shocks have an effect on the interest costs domestic banks offer, do exporters' countries of destination have an effect on the financial system in a country? Another potential contribution could be to test the theory in other countries and in other time periods. Our model informs us that the interest rate could respond to the exchange rate in both directions depending on the productivity distribution of firms. It would be interesting to see the results in different economic contexts.

CHAPTER III

From Tax Amnesty to Bank Credit: The Transmission of Large Scale Asset Repatriation through Bank-to-Firm Relationships

This is joint work with Federico Bernini, Paula Donaldson and Ezequiel Garcia-Lembergman

3.1. Abstract

We study the firm-level effects of a foreign currency credit supply shock. We exploit the large and unprecedented inflow of dollar deposits that followed a tax amnesty in Argentina as a source of plausibly exogenous variation in bank-level funding. We leverage the heterogeneous exposure of domestic banks to the tax amnesty to build bank-specific funding shocks. We find that more exposed banks increase their supply of both dollar and peso loans relative to less exposed banks. We then leverage the heterogeneous exposure of firms to different banks to get firm-level variation in credit supply. We find that firms with greater exposure to the shock significantly increase both peso and dollar borrowing. The improved access to credit had a positive impact on firm imports, both on the intensive and extensive margins. We find a sizable impact for imports of capital goods and an increase in employment among more exposed firms. Our results suggest that the tax amnesty had real macroeconomic effects by relaxing dollar funding constraints.

3.2. Introduction

Funding shocks to banks can have substantial impacts on financial intermediation, potentially leading to reduced access to credit and adverse effects on firms' real outcomes (Bernanke, 1983; Khwaja and Mian, 2008). In developing countries, sudden stops and subsequent reversals of international capital flows are the most common form of funding shocks. A defining characteristic of those shocks is that they affect the cost of funds in foreign currencies, typically US dollars. Yet, we know little about whether the currency denomination of bank funding shocks is important in shaping their effect on the real economy.

In this paper, we study the consequences of foreign currency funding shocks on bank lending behavior and its effects on firms and workers. We exploit the large and unprecedented inflow of dollar deposits that followed a tax amnesty in Argentina as a source of exogenous variation in dollar funding costs across domestic banks. First, we use within-firm and across banks variation to show that banks that were more exposed to the tax amnesty lent more. Then, we exploit variation across-firms, which stems from their pre-existing bank relations, and show that more exposed firms had higher credit growth than less exposed ones. We find that even though our effects are stronger for dollar borrowing, pesos borrowing also responded positively for more exposed firms. Lastly, we show that the increased access to credit impacted various aspects of firm performance. We find that firm exposure to the funding shock had a strong and positive effect on imports in both the intensive and extensive margins, as well as on employment.

Determining the real consequences of foreign currency bank funding shocks requires combining detailed bank-to-firm data categorized by currency type and an exogenous inflow of foreign currency to banks. We build a unique dataset by combining three distinct sources of data for Argentina from 2015 to 2018. The first is the administrative credit registry data from the Central Bank of Argentina, which contains information on every firm-to-bank transaction by the currency of the transaction. The second is the Argentina customs data, which provides a complete picture of firm-level exports and imports by destination and product at the Mercosur's Common Nomenclature (8-digit level). The third is the official data on employment and wages, which covers the entire universe of Argentine firms.

We leverage *across-bank* variation in foreign currency funding which resulted from banks' heterogeneous exposure to Argentina's 2016 tax amnesty. The tax amnesty law enabled individuals who had previously concealed assets from the tax authority to reveal them and provided incentives to repatriate them to the country. As a result of the tax amnesty, more than 6 billion dollars were repatriated to national bank accounts, causing foreign currency deposits (mainly in US dollars) to surge, while peso deposits remained largely unaffected by the policy. The influx of foreign currency deposits, equivalent to 1.4% of GDP, led to a nearly twofold increase in the stock of dollar-denominated private sector deposits in domestic banks. Consequently, this policy bolstered bank funding by increasing their dollar deposits. For identification, we exploit the fact that there was substantial variation in individual bank exposure to the shock and detailed bank balance sheet data to precisely determine the amount of funds that each bank received due to the tax amnesty.

We structure the empirical analysis in three steps. First, we examine the impact of the dollar inflows resulting from the tax amnesty on banks' lending decisions, which is known as the bank lending channel. Second, we examine the effects of being connected to exposed banks on firm borrowing behavior. Third, we analyze the effects on firms' performance and workers.

We begin by investigating the existence of a bank lending channel by exploring whether banks that were more exposed to the liquidity boom changed their lending behavior. To address this question, we leverage the fact that not all banks were equally exposed to the dollar influx. We measure each bank's level of exposure as the ratio between dollar deposits received during the tax amnesty and its total deposits. We isolate the effect of bank-level exposure on bank lending by running a *within-firm* regression, as proposed by Khwaja and Mian (2008). Concretely, we regress credit growth for each bank-firm pair on bank exposure and firm fixed effects, for the sub-sample of multi-bank firms. The inclusion of firm fixed effects means that we only exploit variation within-firms across banks to identify the effect of bank exposure on credit supply.

After performing a balance test that shows there is no presence of systematic differences across banks with varying levels of exposure to the shock, our *within-firm* analysis reveals that banks in the 75^{th} percentile of exposure granted 8% more credits than banks in the 25^{th} percentile to the same average firm.

Next, we examine the effects on firms' borrowing behavior and on firms' performance. For identification, we leverage the fact that not all firms were equally exposed to the liquidity shock since they were borrowing from different banks before the tax amnesty. We construct firm-level exposure as the weighted average of bank exposure, where the weights are proportional to the borrowing of the firm from each bank before the tax amnesty. The intuition is that a firm is more exposed to the shock if it was already connected to those banks that received more dollars (as a share of their deposits). Our identifying assumption is that in the absence of the tax amnesty, firms connected to high-exposure banks would have followed a similar trend to firms not connected to them. We provide evidence in favor of our identification assumption by showing that the pre-trends across more exposed and less exposed firms are not significantly different before the tax amnesty.

We first test if the positive effects we found in the *within-firm* exercise carry onto firms' total borrowing as it could be the case that firms were only substituting debt across banks. We find that the latter was not the case. More exposed firms experienced an overall increase in bank credit relative to less exposed ones. We find particularly strong effects for firms that are allowed to borrow in dollars (mainly exporters) but we also observe an increase in pesos borrowing by firms with no access to dollar credit. This suggests that a dollar funding shock could have spillover effects on the market for pesos loans through the lending decisions of individual banks.

Lastly, we investigate how the increased access to credit affected firm imports, wages, and employment. We find that more exposed firms increase importing activities, both in the intensive and extensive margin of imports. In particular, we observe a substantial increase in imports of capital goods, which suggests that access to credit directly affected firm investment. Preliminary results show that employment also increased for more exposed firms.

Overall, our findings highlight the importance of foreign currency funding shocks for the real economy and suggest that policies aimed at managing these shocks may have important implications for firms and workers. Additionally, we provide a new rationale for tax amnesties, an important policy in many developing countries. Recent studies have primarily analyzed these policies in terms of their impact on tax revenues and government spending. However, our results demonstrate that tax amnesties can also have real macroeconomic effects through banks' and firms' decisions, which adds an important dimension when weighing the costs and benefits of the policy.

This paper sits at the intersection of four strands of literature. First, the paper relates to the literature that identifies the economic effects of credit supply shocks by isolating the bank lending channel. Papers in this strand include Kashyap and Stein (2000); Amiti and Weinstein (2011); Khwaja and Mian (2008); Schnabl (2012); Federico et al. (2023); Mora (2013); Chodorow-Reich (2014); Herreño (2020); Paravisini (2008), among others. We contribute to this literature by uncovering a new dimension to understand the bank lending channel: the currency of the credit supply shock. Specifically, we exploit the regulatory framework of a tax amnesty program in Argentina to identify a credit supply shock that was induced by an inflow of deposits in foreign currency to banks and study the lending decisions of the banks after the shock.

Second, the paper relates to the literature that studies financial constraints and firms' performance (Levchenko et al. (2010); Chor and Manova (2012); Caggese and Cuñat (2013); Manova (2012, 2008); Paravisini et al. (2015b,a); Federico et al. (2023)). While these papers focus on the role of credit in facilitating exporting, our analysis focuses on the impact of credit constraints on importing. Specifically, we demonstrate that credit availability can have a significant impact on firms' ability to engage in importing activities and invest in foreign capital goods. On this ground, our paper highlights that importing is not an easy activity, and financial constraints can limit the scope of firms to find inputs abroad.

Third, the paper is related to the literature exploring the drivers of firms' foreign currency debt choices in emerging economies (such as Calvo (2002); Galindo et al. (2003); Allayannis et al. (2003); Kamil (2012);

Brown et al. (2011); Degryse et al. (2012); Brown et al. (2014); Hardy (2018)). The richness of our data and the regulatory environment of the tax amnesty provides an ideal scenario to show novel patterns about the relationship between dollars and pesos debt.

Finally, the paper relates to recent literature that studies the consequences of tax amnesties. These papers focus on the impact of these policies on taxation, government revenues, and public spending, as seen in studies such as Londoño-Vélez and Tortarolo (2022), Langenmayr (2017), and Lejour et al. (2022). For example, Londoño-Vélez and Tortarolo (2022) finds that an Argentinian tax amnesty resulted in a progressive improvement in tax compliance, increased government revenue, and expanded social transfers. Our study is the first to analyze how tax amnesties impact the macroeconomy through the lending decisions of banks exposed to them. We show that more exposed banks increase credit supply to firms connected to them. As a result of the increased access to credit, the performance of these firms improves, leading to positive outcomes in importing activities and employment. On this ground, our results suggest that tax amnesties have the potential to affect welfare through other channels, that go beyond wealth redistribution through government tax revenues and spending. Specifically, we argue that banks play a key role in reallocating the influx of funds across firms, thus, shaping the overall welfare effects of these policies.

The rest of the document is structured as follows. Section 3.3 describes the details of the tax amnesty and context on the institutional and regulatory framework of Argentina's domestic financial system. Section 3.4 outlines the empirical approach and our main findings. Lastly, Section 3.5 concludes.

3.3. Context and Data

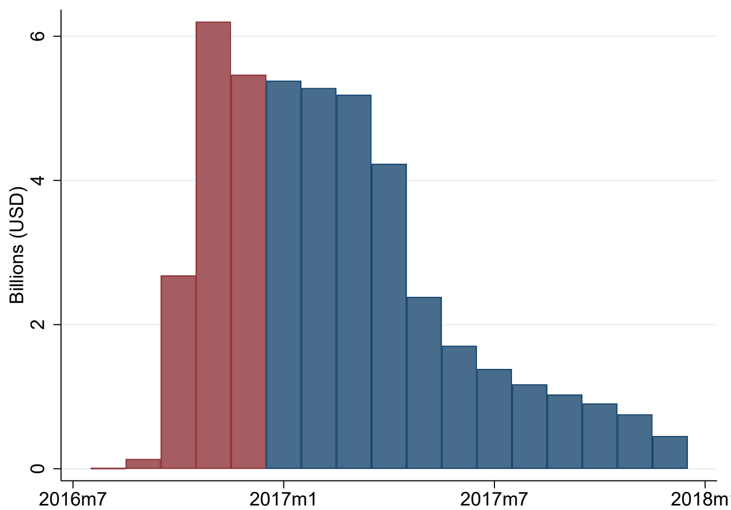
In July 2016, Argentina passed a tax amnesty law which allowed citizens that had been concealing assets from the tax authority to disclose them and pay a small penalty for their past tax evasion. The tax amnesty was part of a broader government effort to achieve budget balance. The policy was instrumental to this goal because it had the immediate effect of increasing tax revenue through the collection of one-time penalties and an effect on future expected tax revenues by increasing the tax base.

Argentina's 2016 tax amnesty stands out as one of the largest tax amnesties of the world. The amount of assets disclosed was equivalent to 19% of GDP and it implied a doubling of the wealth tax base. Londoño-Vélez et al. (2022) provide a detailed analysis of the fiscal side of this episode. Below we provide details on the aspects that are relevant to the present study.

Citizens could disclose any kind of asset subject to wealth taxes, regardless of the geographical location where this were held (*i.e.* Argentina or abroad). Concretely, the type of assets disclosed included: stocks, portfolio investments, residential property, cars, foreign currency checking accounts and foreign currency cash holdings, among others. A large portion of these assets was held abroad,in particular, foreign currency checking accounts, housing and other financial investments. Foreign currency cash holdings were mostly held at peoples home (e.g. underneath the mattress), therefore, outside of the domestic financial system.

In this paper we are interested in the specifics of disclosing foreign currency holdings, either kept in bank accounts abroad or at home. Importantly, citizens who chose to declare holdings in bank accounts abroad were given the option to keep those funds abroad or repatriate them to a domestic bank. The latter option was subject to a smaller penalty to incentivize asset repatriation. On the other hand, foreign currency cash holdings (i.e. US dollars kept at home) could only be disclosed by making a deposit at a domestic bank. Lastly, the time window to deposit cash holdings or repatriate funds from a foreign bank account into the domestic financial system was from August 2016 to December 2016. During this period, citizens that opted to declare cash or repatriate foreign currency had to open a special foreign currency bank account at a bank of their choice and deposit the money. Additionally, they were required to park declared funds in those accounts for six months unless they applied them to purchase government debt securities. The amount of foreign currency deposits (mostly, US dollars) that flew into domestic banks was equivalent to 1.4% of GDP and implied almost a doubling of the stock of private dollar deposits in domestic banks. This occurred within a very short window of around three months as most funds were declared between October-December 2016. This inflow of dollar deposits into domestic banks is the funding cost shock that this paper studies[1].

Figure 3.1: Aggregate Stock of Deposits in *Special Accounts*

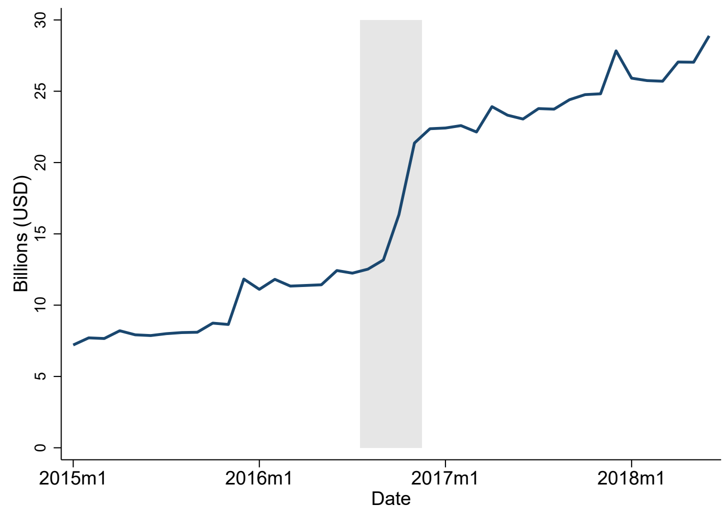


Data are in billions of US dollars. The red bars correspond to the months of the tax amnesty window. Each bar corresponds to the aggregate stock of dollar deposits in the checking accounts created to deposit disclosed dollar holdings. The figure shows how after the 6-month parking period funds gradually flow out of the special accounts into traditional dollar checking accounts.

Figure 3.1 shows the aggregate stock of dollar deposits held in the specially created bank accounts. The inflow of tax amnesty funds was concentrated during the last quarter of 2016 even though the tax amnesty window opened in August 2016. After the 6-month parking period, depositors could transfer their holdings to their standard dollar checking accounts which is why we see a gradual decline in deposits in Figure 3.1. Figure 3.2 helps contextualize the relevance of the tax amnesty shock. It plots the evolution of total dollar deposits held by the private sector in domestic banks. Tax amnesty funds explain over 80% of the increase in dollar deposits during the last semester of 2016.

[1]Note that this excludes from the analysis any foreign currency holdings at bank accounts abroad that citizens did not choose to repatriate.

Figure 3.2: Private Sector Dollar Deposits



Data are in billions of US dollars. The shaded region corresponds to the tax amnesty window.

3.3.1 Institutional Background

The tax amnesty resulted in an increase in dollar deposits at domestic banks. Pesos deposits were largely unaffected by the policy given that a large portion of household's savings is denominated in dollars for historical and institutional reasons. Therefore, the policy under analysis increased bank funding by raising its dollar liabilities. There are a number of features of the institutional and regulatory arrangement of the domestic financial system which are key to understanding how domestic banks can intermediate these funds.

The first of these features is that banks are subject to strict regulations in terms of currency-risk exposure, which prevents banks from using these dollar funds to finance positions in pesos, at least on a large scale basis. It precludes a scenario in which the inflow of dollar deposits *directly* triggers an expansion in pesos lending. Similarly, currency mismatch regulations restrict the use of pesos funding to finance dollar positions. In sum, these regulations create a close link between dollar deposits and a bank's ability to extend dollar credit. This link becomes even more relevant when we take into account the relative underdevelopment of domestic dollar equity markets, future markets and bank-level regulations in terms of exposure to dollar-denominated sovereign debt. The lack of alternative dollar assets in which to take position reinforces the link mentioned above.

Secondly, only a subset of domestic firms are allowed to borrow in dollars from domestic banks. The main recipients of dollar credit are exporters. These firms take up an average of 70% of dollar credit to private non-financial firms during the time period under analysis[2]. In addition to them, a few other firms are allowed to borrow in dollars from domestic banks, namely: firms that regularly supply exporters, firms importing capital goods, firms with securities backed by foreign banks or firms investing abroad. This regulation makes it likely that if banks responded to the increase in dollar funds by extending more dollar credit, then the most likely recipients of such expansion are exporting firms. Put together, these two regulations create strong

[2]This participation is even higher if we restrict the analysis to properly productive dollar-denominated credit lines (i.e. excluding mainly corporate credit card spending abroad).

incentives for banks to intermediate the increase in dollar funding by extending dollar credit. The latter, in turn, can only be granted to a reduced subset of firms comprised mainly by exporting firms.

3.3.2 Datasets

We combine four datasets: i) bank-level balance sheet data obtained from the Central Bank of Argentina (BCRA); ii) firm-level data on exports and imports from the Argentinian Customs Office; iii) firm-to-bank data on domestic credit compiled by the Central Bank of Argentina (BCRA); and iv) administrative records on firm-level employment and average wages from the Social Security Office (ANSES). All datasets are collected at monthly frequency and cover the years from 2014 to 2018.

We employ bank-level balance sheets to recover information on banks' assets, liabilities, core capital, and profits. We complement balance sheets with bank-level performance indicators (e.g. leverage ratios, return on assets and average interest rates) which are published by the Central Bank. Importantly, the balance sheet registers the amount of dollar deposits that each bank received during the tax amnesty. Banks were required to inform the outstanding stock of deposits in the checking accounts which were specially created for the tax amnesty. Section 3.4 provides more detail on how we employ this information to construct the exposure of banks to the tax amnesty shock. We restrict the analysis to banking institutions that had a participation in total deposits of at least 0.05% during our sample period. This leaves us with 28 domestic banks that take up over 97% of aggregate deposits.

We use Credit Registry data to obtain firm-level credit indicators. We employ two datasets within the Credit Registry. Our primary source of information contains detailed firm-bank level data on monthly total outstanding loans. This dataset covers all firms that have debt with domestic banks between 2014 and 2018. We complement this information with a second dataset that started being recorded in August 2015. This additional dataset contains dis-aggregated information on the currency composition of firm-level debt. For each firm we observe the level of pesos and dollar debt over time. We restrict the analysis to firms with total outstanding loans of at least $16K$ (constant December 2016 pesos)[3] and drop the top 1% of observations to limit the influence of outliers.

Lastly, we gather information from several sources to obtain a comprehensive picture of the consequences of the policy on firms real performance. We utilized comprehensive customs data encompassing the universe of firm-level exports and imports transactions. This dataset covers the period from 2014 to 2018. It provides quarterly reported information on the value (in US dollars) of exports and imports for each firm, categorized by country (origin/destination) and product at the 6-digit level. We linked this dataset to fiscal files generated by the Fiscal Administration of Public Revenue (AFIP) using unique firm identifiers to enrich our analysis. This allowed us to obtain additional information on formal employment, average wages, and firms' main sector of activity. Consequently, we were able to construct firm-level measures of employment, exports, imports, and payroll for the years spanning from 2014 to 2018.

[3]This was equivalent to roughly 1000 US dollars in 2016)

3.4. Estimation

3.4.1 Bank and Firm Exposure

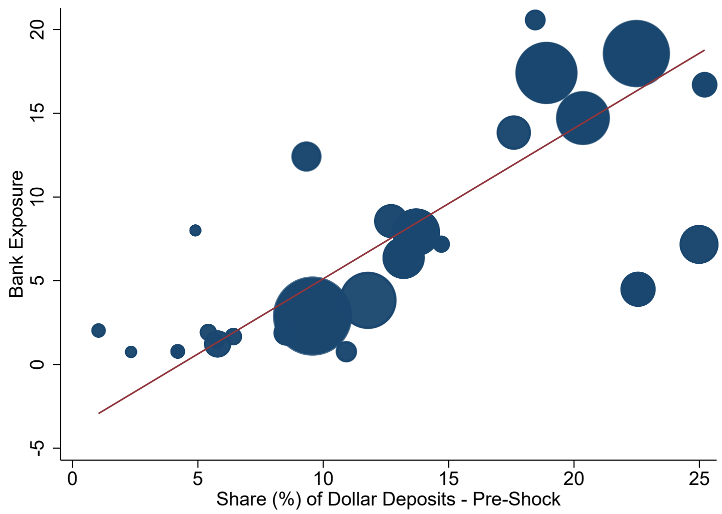
The balance sheet of domestic banks records the stocks held at the special accounts which allows us to capture the increase in bank dollar funding attributable to the tax amnesty. For each bank b, we compute the average dollar deposits reported in these special accounts between Oct-2016 and Dec-2016. We refer to this object as the *tax amnesty funds* received by bank b. Next, we compute the ratio between this object and total private sector deposits (i.e. both pesos and dollar denominated deposits) available to bank b at the start of the tax amnesty. We use average total private sector deposits during 2016Q2, the quarter that precedes the start of the tax amnesty, as the baseline period. Our measure of bank exposure, which we denote as S_b, can be expressed as:

$$S_b = \frac{Tax\ Amnesty\ Funds_b}{D_{b,0}^{Total}} \times 100 \tag{3.4.1}$$

where $D_{b,t}^{Total}$ are average quarterly total deposits and $t = 0$ corresponds to the quarter before the start of the tax amnesty. S_b measures the importance of the inflow of dollar funds relative to the existing liquidity of each bank. Average bank exposure was 10% with a standard deviation of 10 p.p.. For the most exposed banks, the liquidity shock accounted for close to 20% of their previous deposit liabilities.

We find that variation in bank exposure correlates well with the share of dollar deposits that a bank had before the tax amnesty. In particular, banks that had higher shares of dollar deposits, which we denote with $s_{b,pre}^{usd}$, received more tax amnesty funds, measured as a share of their total deposits. The most likely explanation for this is that citizens where more likely to deposit their funds on banks where they already had an existing dollar checking account, hence giving way to the patterns observed in the data. Figure 3.3 plots bank exposure against the share (%) of dollar deposits before the shock and shows that they line up well. The advantage of our bank exposure measure, relative to $s_{b,pre}^{usd}$, is that it directly captures the increase in loanable funds attributable to the tax amnesty. For this reason, we employ S_b as our preferred measure of bank-level exposure to the shock.

Figure 3.3: Bank Exposure



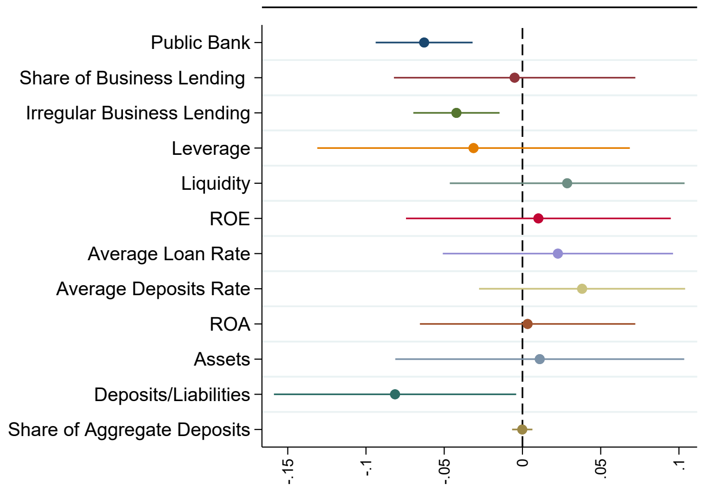
Observations are weighted by the share of each bank in aggregate deposits. The share of dollar deposits in the $x-axis$ is the average share for $2016Q2$.

To assess whether there are any other systematic differences in observables across banks with different levels of exposure, we perform a balance test. We regress a battery of individual bank characteristics on each bank's exposure to the tax amnesty. We measure baseline characteristics X_{b0} as the yearly average for the year before the tax amnesty and weight regressions according to each bank's share in total lending to firms. Formally, we run the following regressions:

$$X_{b0} = \alpha_0 + \alpha_1 S_b + \epsilon_b$$

where X includes characteristics such as public ownership, share of business lending, leverage, liquidity, bank size, and loans to assets ratio, among others. Figure 3.4 plots estimates for α_1. Reassuringly, banks are balanced across almost all characteristics considered. This suggests that the inflow of dollars after the tax amnesty was not targeted to specific banks. Exceptions are public ownership and the ratio of deposits in total liabilities (which highly correlates with public ownership). Later on, we control for public ownership in all our specifications.

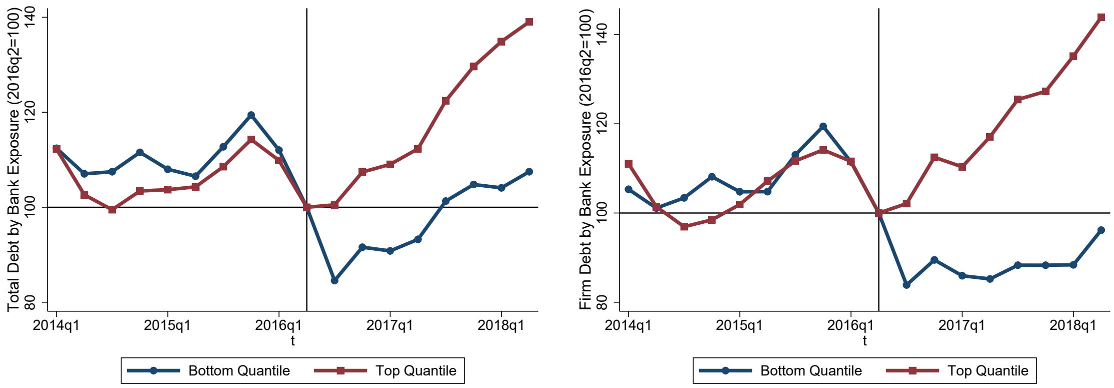
Figure 3.4: Balance Test



Bank characteristics are averages of the year before the tax amnesty. All variables were standardized with the exception of the participation of each bank in aggregate deposits (our *proxy* for bank size). Regressions are weighted by the share of each bank in total private sector lending. *Public Bank*: = 1 if bank is publicly owned. *Share of Business Lending*: weight of lending to firms in total lending. *Irregular Business Lending*: share of business loans in default risk. *Leverage*: assets over equity. *Liquidity*: ratio of liquid assets over total assets. *ROE*: return on equity. *Average Loan Rate*: average interest rate on local currency loans. *Average Deposit Rate*: average interest rate on local currency deposits. *ROA*: return on assets. *Assets*: total assets. *Deposits/Liabilities*: participation of deposits in total liabilities. *Share of Aggregate Deposits*: participation of each bank in aggregate deposits.

Figure 3.5 explores whether banks with different levels of exposure to the tax amnesty performed differently in terms of total lending to private non-financial firms. We compare between banks in the top and bottom quartile of exposure. For the latter, the liquidity shock represented less than 2% of their pre-existing lending capacity while for banks in the top quartile it represented at least 12%. For each group of banks, the figure tracks the evolution of total lending, expressed in constant 2016 pesos, taking the quarter before the start of the amnesty as base period. Importantly, both groups of banks seem to be experiencing similar debt dynamics during the two years preceding the tax amnesty which alleviates pre-trends concerns. In addition, during the *post* amnesty period we observe that more exposed banks lent more than less exposed ones. These dynamics illustrate that our bank funding shock is effectively capturing some differential access to loanable funds by banks during this period. To strengthen this point we restrict the sample to firms that were borrowing from both banks at the top and bottom quartiles of exposure in 2016Q2 and we compute how their debt with each of these banks evolved. The right-side panel of Figure 3.5 shows our results. Importantly, since every firm in this sample appears in both the red and blue lines it follows that the higher debt growth for banks with higher exposure cannot be attributed to changes in individual firms' credit demand.

Figure 3.5: Top *vs* Bottom Bank Exposure
Total Credit



(a) Across Banks (b) Within Firms & Across Banks

In Panel (a) firm level debt is added up for each exposure quantile. Panel (b) restricts the sample to firms that had debt with banks at both the top and bottom quantile of exposure in $2016Q2$. We construct the evolution of their real debt from each of these group of banks. In other words, firms appear in both the red and blue lines. In both cases the base period is $2016q2$ and total credit is expressed in Dec-2016 constant pesos.

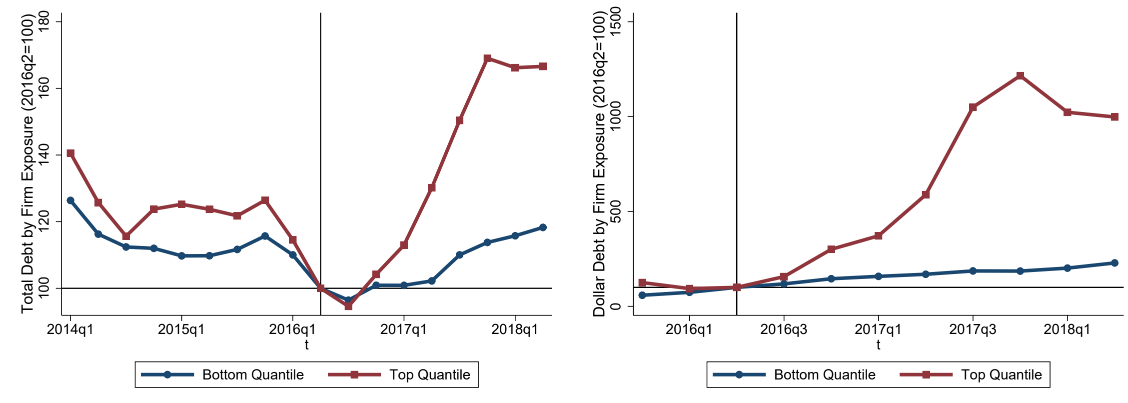
We argue that the heterogeneous exposure of firms to different banks provides a source of plausibly exogenous variation in the credit supply faced by individual firms. We capture this heterogeneity by constructing firm-level exposure as follows:

$$S_i = \sum_b \omega_{ib}^{Start} S_b$$

where S_i is firm's i exposure to the shock and ω_{ib}^{Start} is the weight of bank b on firm's i total borrowing at the start of the amnesty. In words, the exposure of firm i is a weighted average of the exposure of the banks from which firm i was borrowing from at the onset of the tax amnesty.

Figure 3.6 explores the debt dynamics of firms with different levels of exposure across time. This exercise is an extension of figure 3.5 to the firm-level setting. The left-hand side panel shows the evolution of total credit for firms in the top and bottom quartiles of exposure. The right-hand side shows the evolution of dollar debt. Highly exposed firms outperformed their low exposure counterparts in terms of total debt growth and, particularly, dollar debt growth. Figure 3.7 shows the comparison between firms below and above median exposure to verify that the effect of exposure holds more generally across the distribution of firm exposure. Importantly, we find no substantial evidence of pre-trends across different groups of firm exposure.

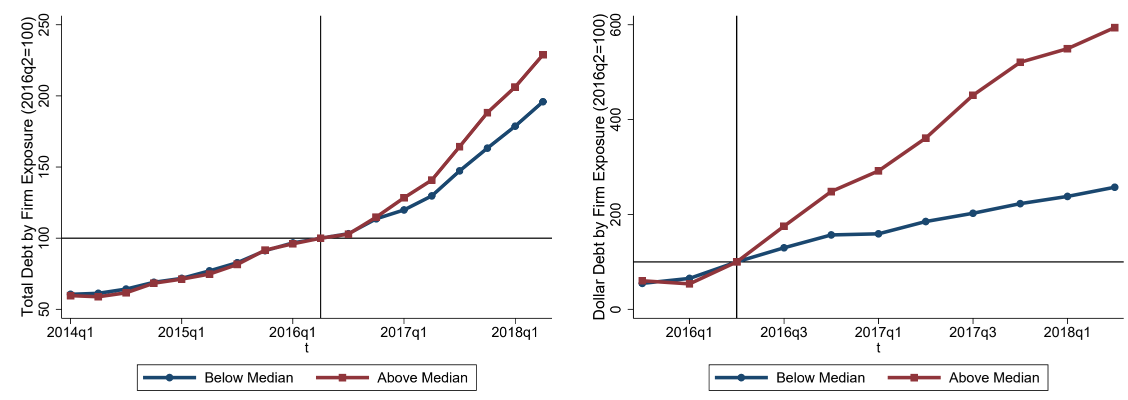
Figure 3.6: Top *vs.* Bottom Firm Exposure



(a) Total Debt (Dec-2016 Pesos) (b) Dollar Debt (in US Dollars)

Panel (a) shows the evolution of total debt, in constant 2016 pesos, for firms in the bottom and top quantiles of exposure. The period covered is $2014Q1 - 2018Q2$. Panel (b) plots the evolution of dollar debt, expressed in current US dollars, for each group of firms. We cover the period $2015Q4 - 2018Q2$ for which dis-aggregated data at the firm-currency level is available.

Figure 3.7: Below *vs.* Above Median Firm Exposure



(a) Total Debt (Dec-2016 Pesos) (b) Dollar Debt (in US Dollars)

Panel (a) shows the evolution of total debt, in constant 2016 pesos, for firms below and above median exposure. The period covered is $2014Q1 - 2018Q2$. Panel (b) plots the evolution of dollar debt, expressed in current US dollars, for each group of firms. We cover the period $2015Q4 - 2018Q2$ for which dis-aggregated data by firm-currency is available.

3.4.2 Bank Lending Channel

The first step of our empirical analysis explores the existence of a bank lending channel in response to a change in banks funding conditions. We want to know whether, after the liquidity shock, firms borrowed relatively more from those banks that were more exposed to it. In order to answer this question we need to observe borrowing outcomes for firms that borrow from banks with different levels of exposure. The way in which the literature tackles this question is by following the *within-firm* approach put forward by the seminal work of Khwaja and Mian (2008). We can summarize the identification strategy as follows. First, let's assume there are only two time periods $t = 0, 1$, before and after the tax amnesty shock. Then, we can think of the level of debt of firm i with bank b in period t as:

$$Y_{ib0} = \alpha_{i0} + \nu_{ib0} + \Gamma \mathbb{X}_{b0} + \epsilon_{ib0} \tag{3.4.2}$$

$$Y_{ib1} = \alpha_{i1} + \nu_{ib1} + \Gamma \mathbb{X}_{b1} + \beta S_b + \epsilon_{ib1} \tag{3.4.3}$$

The realization of Y_{ibt} depends on a number of objects. First, α_{it} captures firm-time credit demand shocks that a firm spreads homogeneously across all its lenders. Second, ν_{ibt} are firm credit demand shocks specific to a certain bank relationship. For example, think of a firm that needs a type of credit line which is offered only by a bank or subset of banks. We will think of $\mathbb{X}_{bt}$ as capturing all other bank liquidity conditions except for the tax amnesty shock. Finally, S_b is our measure of bank-level exposure to the shock and ϵ_{ibt} is an idiosyncratic shock. First differencing yields:

$$\Delta Y_{ib} = \Delta \alpha_i + \Delta \nu_{ib} + \Gamma \Delta \mathbb{X}_b + \beta S_b + \tilde{e}_{ib} \tag{3.4.4}$$

β is our object of interest. It captures the marginal impact of an increase in the exposure of bank b on lending to firm i. β has a causal interpretation under the condition that bank exposure is uncorrelated with other factors affecting credit demand and bank liquidity. We take equation 3.4.4 to the data as follows:

$$\log L_{ibt} = \alpha_{it} + \nu_{ib} + \beta\ S_b \times Post + \Gamma \mathbb{X}_{b,pre} \times Post + e_{ibt} \tag{3.4.5}$$

In order to make *within-firm* comparisons we restrict the analysis to multi-bank firms. This allows us to incorporate firm-time fixed effects, α_{it}, which absorb time-varying firm-specific credit demand shocks that firms spread equally across all their lenders. We also include *firm-bank* fixed effects to control for aspects related to each specific firm-bank match. *Post* is a dummy equal to one after the start of the tax amnesty. Lastly, we incorporate as bank-level controls a set of bank characteristics, measured at the quarter prior to the shock, and we interact them with our *Post* dummy. We include bank ownership status (private vs. public) and bank size as controls in our baseline specification. Our parameter of interest, β, is identified under two assumptions. First, it must be that firm-bank credit demand shocks that vary over time aren't systematically correlated with bank exposure. Formally, $E[S_b \nu_{ibt}] = 0$. Second, any remaining bank-level credit supply shocks not accounted for by our bank controls should be uncorrelated with bank exposure to the tax amnesty funding shock. Under these two assumptions, β measures the marginal effect of bank exposure on credit supply to firm i.

Table 3.1 presents our results. Points estimates measure the percent increase in lending to firm i by bank b for every p.p. increase in bank exposure. Results in Column (1) include only firm-time fixed effects. Column (2) presents our preferred specification which includes both firm-time and firm-bank fixed effects, as well as, bank controls. Comparing between banks in the 75^{th} *versus* 25^{th} percentile of exposure, we find an increase of 8% in lending to firms. There are two things we want to highlight about these results. First, they are evidence of pre-existing firm-bank relations being good predictors of firm exposure to bank funding shocks. Second, we find positive and significant effects even after controlling for *firm-time* fixed effects. These within-firm results will alleviate concerns about firm-driven effects when we study firm level outcomes, as will become clear next.

Table 3.1: Bank Lending Channel - Difference in Difference

	(1)	(2)
Bank Exposure × Post	1.0***	0.8***
	(0.1)	(0.1)
N	2229313	2186016
Firm-Time FE	Yes	Yes
Bank-Firm FE	No	Yes
Bank Size Control	No	Yes
Public Bank Control	No	Yes
R-squared	0.58	0.87

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Standard errors in parentheses and clustered at the bank-firm level. Point estimates measure the percent increase in L_{ibt} for every $1p.p.$ increase in bank exposure, S_b. *Post* is equal to one between $(2016Q3, 2018Q2)$. The sample is comprised by all firms that had at least two bank relations during the last two quarters before the tax amnesty. We winsorize the top and bottom 1% of observations to limit the influence of outliers. The control for bank size is measured as the participation of each bank in total deposits at baseline while the public bank control is simply an indicator for a bank being publicly owned.

3.4.3 Firm-level Outcomes

In the previous section we established that firms responded to the credit supply shock by borrowing relatively more from banks that were more exposed to the tax amnesty shock. But, did this relative shift towards more exposed banks result in more total borrowing by firms? Or did firms simply reallocate their debt portfolio towards more exposed banks? This section tackles this question which is in turn key to understanding the potential effects of the tax amnesty shock on firms real performance. We begin by outlining our estimation strategy.

For the remainder of this section, we will be interested in measuring the effect that firm-level exposure, S_i, had on a series of firm-level outcomes, Y_{it} (e.g. total debt, imports, etc.). For simplicity, suppose there were only two periods $t = 0, 1$ which correspond to before and after the tax amnesty, respectively. We can think of outcome Y_{it} as follows:

$$Y_{i0} = \alpha_i + \eta_{i0} + \Gamma \mathbb{X}_{b(i)0} + \epsilon_{i0}$$
$$Y_{i1} = \alpha_i + \eta_{i1} + \Gamma \mathbb{X}_{b(i)1} + \beta S_i + \epsilon_{i1}$$

The realization of outcome Y_i in period $t = 0$ is the result of (i) a time-invariant firm shifter, α_i; (ii) a time-varying firm-level shifter, η_{i0}; (iii) a credit supply shifter, $\mathbb{X}_{b(i)0}$, coming from the banks from which firm i sources its debt; plus, (iv) an idiosyncratic component ϵ_{i0}. In period $t = 1$, we add the credit supply shock stemming from the tax amnesty, S_i. Taking first differences yields:

$$\Delta Y_i = \Delta \eta_i + \beta S_i + \Gamma \Delta \mathbb{X}_{b(i)} + \tilde{e} \tag{3.4.6}$$

β is our object of interest. It captures the effect of firm exposure on outcome Y_i. To identify β two conditions need to be satisfied. First, there should be no systematic correlation between changes in firm-level shifters and firm exposure to the shock. Formally, we need $E[\alpha_{it} S_i] = 0$. For example, if Y_{it} is firm-level credit, then credit demand shocks hitting specific firms over time should be unrelated to their exposure to the shock. The second condition speaks to the correlation between firm exposure and, what can be thought of as, all other liquidity shocks hitting the banks from which firm i borrows. Formally, we need $E[\mathbb{X}_{b(i),t} S_i] = 0$. This would be challenged if more exposed banks were also more likely to be hit by other funding shocks than less exposed banks over time.

We take the simple intuition of Equation 3.4.6 to the data using the following difference-in-difference specification:

$$\log Y_{it} = \beta\ S_i \times Post + \Gamma \mathbb{X}_{b(i)} \times Post + \gamma_i + \gamma_{jt} + e_t \tag{3.4.7}$$

where the dependent variable is the logarithm of the outcome of interest (unless otherwise noted) in period t, $Post$ is a dummy equal to 1 after the start of the tax amnesty, $\mathbb{X}_{b(i)}$ is a vector of firm-level weighted average bank controls, γ_i are firm fixed effects and γ_{jt} capture industry-time fixed effects. Firm-level bank controls are computed weighted averages of baseline bank characteristics, where the weight is the share of each bank b in firms i debt at baseline. We study the time period between 2014-2018. The frequency of analysis is either quarterly or annual, depending on the outcome.

We tackle the concern that firm exposure could potentially be correlated with positive firm-level shifters by adding time-industry fixed effects. These take care of any trends in firm-level shifters that are shared within narrowly defined industries. While our balance tests show no substantial differences in observable characteristics across banks with different levels of exposure, we take a conservative stance and include the same two bank controls as in our *within-firm* regressions and interact them with the $Post$ dummy. These bank controls are ownership status (privately or publicly owned bank) and bank size which we measure as a bank's participation in total deposits.

Lastly, we estimate the event-study analogue of Equation 3.4.7 to check for pre-trends. Our baseline dynamic difference-in-difference specification is:

$$\log Y_{it} = \sum_{s \in (\pm h)} \Big(\beta_s S_i + \Gamma_s \mathbb{X}_{b(i)}\Big) \times \mathbb{1}(t = s) + \gamma_i + \gamma_{jt} + e_{it} \tag{3.4.8}$$

where $\mathbb{1}(t = s)$ are quarterly or yearly time dummies and h is the horizon of analysis (e.g. eight quarters before and after the shock). The coefficient β_s measures the period-s effect of firm exposure, S_i, on outcome Y relative to the base period. Absence of pre-trends requires $\hat{\beta}_s = 0\ \forall\ s \leq 0$.

Below we present our main findings on firm debt outcomes, importing behavior and labor demand.

3.4.3.1 Firm Borrowing

We examine the impact of increased credit access on a number of firm borrowing outcomes. We begin by looking at whether the positive effects we found in the *within-firm* regression carry onto firms' total borrowing. Our first outcome of interest at this point is firm total borrowing from domestic banks, which we denote with L_{it}. We then evaluate the effects on dollar denominated borrowing which is the most *direct* channel through which the increase in bank liquidity could materialize into increased firm borrowing. We first look at the intensive margin of dollar borrowing. We want to know how the credit supply shock affected dollar borrowing by firms that already had access to dollar loans. As outlined in Section 3.3, the regulatory framework of the financial system grants access to domestic dollar credit only to a restricted subset of firms. These are for the most part exporters. Therefore, we study the impact of the credit supply shock on the intensive margin of dollar borrowing by exporters[4]. Since in some cases, importing firms are allowed to access dollar credit even if they do not export, we also present results for the bigger sample of exporters and importers that had dollar loans before the tax amnesty. We refer to this group of firms as *foreign-trade firms* from now on. Lastly, we study the impact of the credit supply shock on the extensive margin of dollar borrowing. We want to know whether being related to banks that received more dollars during the tax amnesty increased a firm's probability of gaining access to dollar credit. As in our intensive margin analysis, we restrict the analysis to foreign-trade firms.

Table 3.2 shows our results for total firm borrowing for the period $2014Q2 - 2018Q2$. We present results for all firms in column (1); foreign-trade firms in column (2) and, non foreign-trade firms in column (3). All specifications include firm-level bank controls, firm and industry-time fixed effects. Reported coefficients measure the percent increase in L_{it} for every additional *p.p.* of firm exposure. We find positive and significant effects of firm exposure on total firm borrowing across all three groups of firms but with substantial heterogeneity in their magnitudes. It is useful to compare between firms in the 75^{th} *versus* 25^{th} percentile of firm exposure to interpret of our findings. Such comparison implies an increase in total firm borrowing of *i*) 7% for the sample of all firms, *ii*) 22.5% for firms that participate in foreign-trade, and *iii*) 4.6% for firms that don't. Foreign trade firms, related to very exposed banks, emerge as the main beneficiaries of the credit supply shock. However, non foreign trade firms, with virtually no access to dollar credit, also benefit from being related to more exposed banks. This result suggests that the increase in dollar bank funding could spillover to the market for pesos loans. One possible explanation is that as foreign trade firms move towards dollar loans, they release pesos loanable funds which are crowded-in by non-foreign trade firms. Alternatively, spillovers could be the result of banks' strategy to maintain a diversified loan portfolio in terms of currency composition.

[4]We want a representative sample of firms that use dollar debt for productive purposes. If we take the whole sample of firms with positive dollar debt we will be looking at dollar debt by firms not covered under the dollar-borrowing policy of the Central Bank. This would amount to be looking at corporate credit card expenditures abroad during a business trip and putting them at the same level as dollar credit to finance exporting or importing activities. In order to avoid this, we restrict the analysis to firms that fall under the Central Bank's requirements to borrow in dollars.

Table 3.2: Total Credit - Difference in Difference

	(1) All Firms	(2) Foreign Trade	(3) Non Foreign Trade
Firm Exposure × Post	0.67***	2.05***	0.46***
	(0.114)	(0.595)	(0.120)
N	770478	38526	651423
Firm FE	Yes	Yes	Yes
Time-Industry FE	Yes	Yes	Yes
Bank Size Time	Yes	Yes	Yes
Public Bank-Time	Yes	Yes	Yes
Number of Firms	70465	3117	63298
R-squared	0.86	0.88	0.85

Standard errors in parentheses and clustered at the firm level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. We restrict the analysis to firms that had debt at the start of the analysis so our results can be interpreted as intensive margin results. The time period spans between $2014Q2 - 2018Q2$. *Post* indicates the period $(2016q3, 2018q2)$. Point estimates measure the percent increase in total credit for every $1p.p.$ of firm exposure. The samples in each column correspond to all firms, foreign trade firms and non-foreign trade firms, respectively.

Foreign trade firms experienced larger debt growth which is consistent with the fact that the most *direct* use that banks can give to the increase in dollar funding is to lend it in dollars to foreign trade firms. Table 3.3 provides evidence that this was indeed the case. These regressions cover only the period $2015Q4 - 2018Q2$[5] and study the sample of foreign trade firms. Column (1) reports the estimated impact on total debt for this shorter horizon. Column (2) reports results on the intensive margin of dollar borrowing while column (3) shows the extensive margin results. We find a positive and significant (at the 10% level) effect of firm exposure on the intensive margin of dollar borrowing. The magnitude of the point estimate is slightly larger than that for total debt which is indicative of the strong role of dollar debt growth in driving overall debt dynamics. In addition, our extensive margin results strongly support the idea that firms with more tights to exposed banks were more likely to start borrowing in dollars. To get a sense of the magnitude of these results

[5] As described in Section 3.3, information on firm credit by currency is only available since $2015Q4$.

let us compare across firms in the opposite ends of the inter-quantile exposure distribution. Comparing between firms in the 75^{th} *versus* 25^{th} percentile of firm exposure, we find: *i*) a 24.6% increase in dollar debt and, *ii*) a 5.24 p.p. increase in the probability of holding dollar-denominated debt.

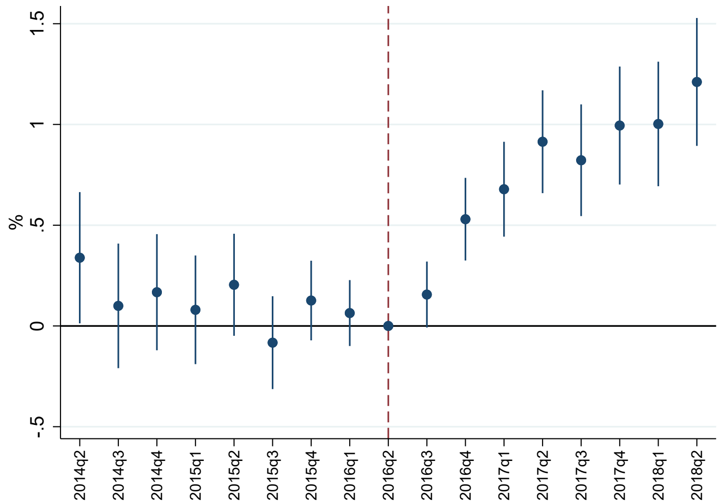
Table 3.3: Dollar Credit - Difference in Difference
Foreign Trade Firms

	(1)	(2)	(3)
	Total Debt	USD Debt*	USD - Extensive
Firm Exposure × Post	2.25^{***}	2.46^{*}	0.52^{***}
	(0.505)	(1.330)	(0.158)
N	25652	22748	25652
Firm FE	Yes	Yes	Yes
Time-Industry FE	Yes	Yes	Yes
Bank Size-Time	Yes	Yes	Yes
Public Bank-Time	Yes	Yes	Yes
Number of Firms	2928	2775	2928
R-squared	0.91	0.76	0.50

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Standard errors in parentheses and clustered at the firm level. The sample includes only firms participating in foreign trade. We cover the period $2015Q4 - 2018Q2$ for which there is credit data dis-aggregated by currency. We report in column (1) the effects on total debt over this reduced time period to make it comparable with our dollar debt findings in column (2). Point estimates in $(1) - (2)$ measure the percent increase in the dependent variable for every $1p.p.$ of firm exposure. Results in column (3) are expressed as $p.p.$ increases.

Finally, we complement the above results by estimating the dynamic difference-in-difference specification

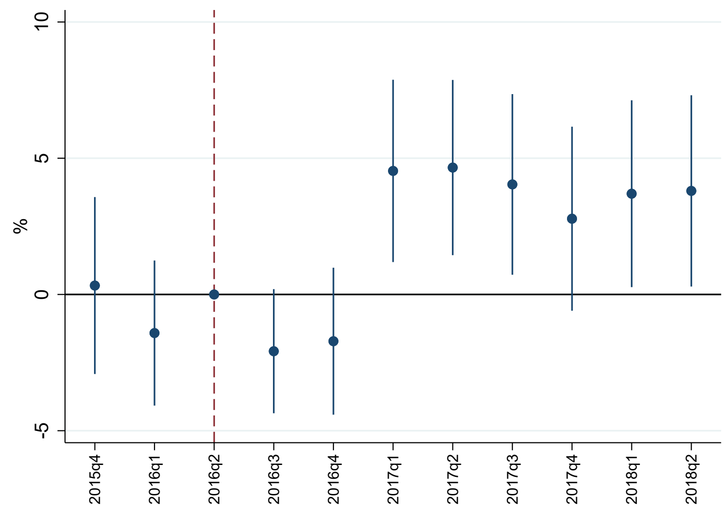
Figure 3.8: Total Debt
All Firms



We report 95% confidence intervals. Standard errors are clustered at the firm level. The plot shows the estimated coefficients on firm exposure for each quarter. Point estimates measure the percentage increase in total debt for every 1*p.p.* increase in firm exposure

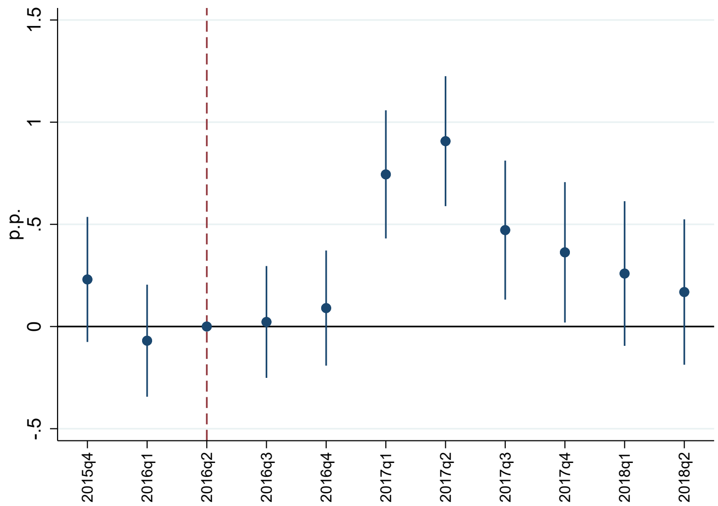
as outlined in Equation 3.4.8. Reassuringly the event study plots show no significant evidence of pre-trends over the period we analyze. To summarize, in this section, we have established that firms that were more exposed to the liquidity shock, due to their pre-existing bank relations, experienced higher credit growth. Estimated effects are particularly large for firms that have access to the market for domestic dollar loans but we also find smaller effects for the rest of the firms in the economy.

Figure 3.9: Dollar Debt - Intensive Margin
Foreign Trade Firms



We report 95% confidence intervals. Standard errors are clustered at the firm level. The plot shows the estimated coefficients on firm exposure for foreign trade firms that had dollar debt in the period before the tax amnesty. Point estimates measure the percentage increase in dollar debt for every 1 p.p. increase in firm exposure. The time period is restricted to $2015Q4 - 2018Q2$ due to data availability.

Figure 3.10: Dollar Debt - Extensive Margin
Foreign Trade Firms



We report 95% confidence intervals. Standard errors are clustered at the firm level. The plot shows the estimated coefficients on firm exposure for foreign trade firms. Point estimates measure the percentage point increase in the probability of having dollar debt for every 1 p.p. increase in firm exposure. The time period is restricted to $2015Q4 - 2018Q2$ due to data availability.

3.4.3.2 Imports

We examine the impact of increased access to bank credit on total imports. We hypothesize that access to credit, in particular, to dollar-denominated bank loans, may affect firms' import decisions by reducing borrowing costs and increasing the availability of funds for importing goods. In particular, the bank's liquidity boom can reduce the firm's constraints to access foreign currency, allowing them to reduce their costs by importing intermediate goods and investing in capital goods from abroad. Additionally, access to credit can allow firms to overcome the sunk costs of discovering suppliers in new markets.

To comprehensively understand the impact of access to dollar-denominated loans on a firm's import behavior, we need to explore several different aspects. First, we examine the intensive margin of imports, also distinguishing between the types of goods that are being imported. Secondly, we study the extensive margin, which focuses on the number of products and origins from which the firm imports, as well as, on the probability of importing.

The results of our analysis are presented in Table 3.4. Just as in the analysis of firm credit outcomes we include firm fixed effects, industry-time fixed effects and the same set of firm-level weighted average bank controls. We construct our dependent variables as yearly averages for all import values. We measure the number of imported products as the number of distinct products imported by a firm during each year. The number of origins is computed analogously. Lastly, we label firm i as an importer in year t if it ever imported during that year.

We find that higher firm exposure to the shock resulted in an increase in their total imports relative to less exposed firms. Importantly, this increase covers both for capital goods and intermediate goods. The raise in imported capital goods suggests that firms utilize newly available dollar-denominated loans to increase their investments in foreign machinery. Furthermore, we observe that more exposed firms expanded their market reach and increased the variety of products that they import. Lastly, on the extensive margin, we find that firms that were more exposed to the shock had greater chances of accessing import markets during the aftermath of the tax amnesty. More concretely, if we compare between firms in the 75^{th} *versus* 25^{th} percentile of exposure, we find: *i*) an increase of 9% in total imports, which holds true for both imported capital goods and imported intermediate inputs; *ii*) a 3% increase in the number of imported products; *iii*) a 3% increase in the number of sourcing countries; and, lastly, *iv*) a .4 p.p. increase in the likelihood of importing.

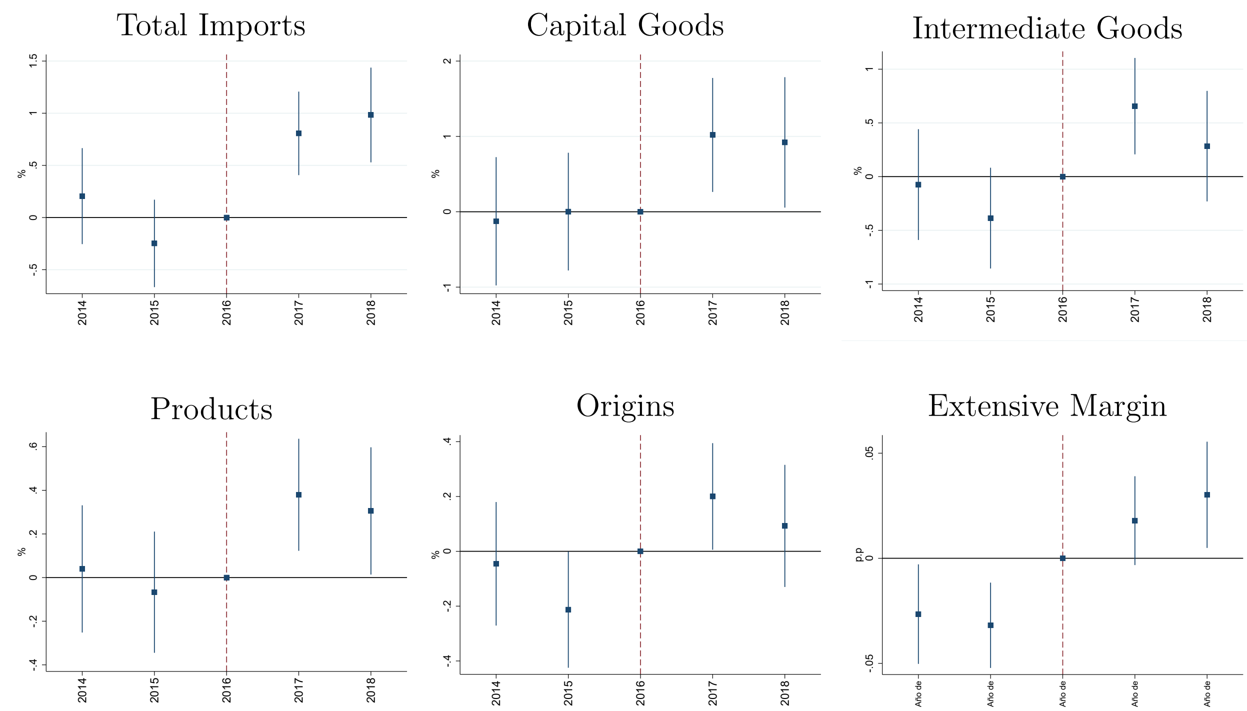
Table 3.4: Effect on Imports

	(1) Total Imports	(2) Capital Goods	(3) Intermediates	(4) Products	(5) Origins
Firm Exposure × Post	0.87***	0.91**	0.78***	0.34**	0.31***
	(0.23)	(0.41)	(0.27)	(0.15)	(0.11)
N	53412	28767	44809	52985	53023
Firm FE	Yes	Yes	Yes	Yes	Yes
Time-Industry FE	Yes	Yes	Yes	Yes	Yes
Bank Size-Time FE	Yes	Yes	Yes	Yes	Yes
Public Bank-Time FE	Yes	Yes	Yes	Yes	Yes
Number of Firms	12246	7042	10374	12184	12200
R-squared	0.84	0.76	0.86	0.84	0.84

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Standard errors in parentheses and clustered at the firm level. Point estimates measure the percent increase in the outcome of interest for every 1 p.p. increase in firm exposure for columns (1)-(3). For columns, (4)-(6) the effects are in p.p.. The sample for the intensive margin analysis, (1)-(5), are all firms that were importing at the start of the tax amnesty. For (6) we include all firms with positive debt levels. We winsorize the top and bottom 1% of observations to limit the influence of outliers.

We complement our previous results with Figure 3.11 that presents results from a dynamic difference-in-difference specification. We find no evidence of substantial pre-trends except for the extensive margin regression. Since this regression includes all firms in the economy, it makes sense to narrow down the sample of firms that could potentially become importers at any point of time and re-assess this outcome on this sample.

Figure 3.11: Total Imports



We report 95% confidence intervals. Standard errors are clustered at the firm level. The plot shows the estimated coefficients on firm exposure for each year. Point estimates measure the percentage increase in the outcome variable for every 1 p.p. increase in firm exposure, with the exception of the extensive margin results which are expressed in p.p..

3.4.3.3 Labor Outcomes

Tax amnesties and inflows of capital have been studied for their potential effects on government revenue and capital flows, but a lesser-known potential outcome is the indirect benefits they may offer to employers and workers of firms connected with banks exposed to these capitals. Through overcoming liquidity constraints, firms are able to increase investment and productivity, which can lead to an increase in the number of employees or wages paid. In other words, the benefits of liquidity shocks stemming from tax amnesties can trickle down to workers. While this effect is often overlooked, we shed light on this potential outcome and provide an analysis of the impact of tax amnesties on labor outcomes.

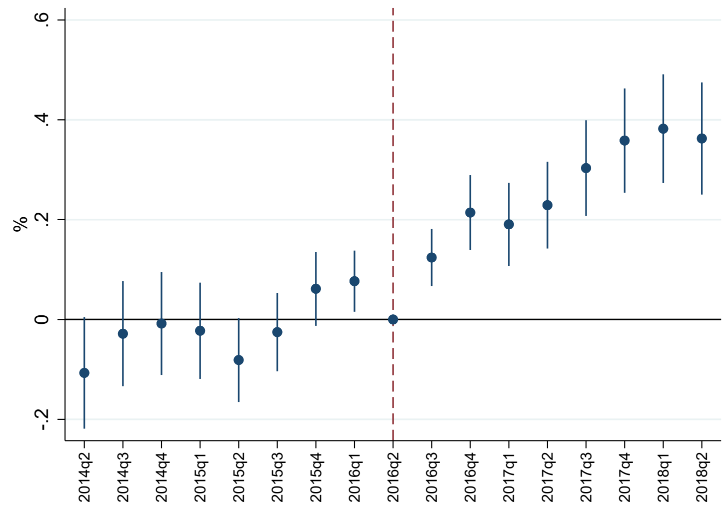
Table 3.5: Employment and wages - Preliminary

	(1) Employment	(2) Employment	(3) Wages	(4) Wages
Firm Exposure × Post	0.21***	0.28***	-0.01	0.03
	(0.03)	(0.04)	(0.02)	(0.03)
N	770257	770257	769616	769616
Firm FE	Yes	Yes	Yes	Yes
Time-Industry FE	Yes	Yes	Yes	Yes
Bank Controls	No	Yes	No	Yes
Number of Firms	54235	54235	54207	54207
R-squared	0.96	0.96	0.83	0.83

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$ Standard errors in parentheses and clustered at the firm level. Point estimates measure the percent increase in the outcome of interest for every 1 p.p. increase in firm exposure. Employment refers to the total number of formal employees in each quarter t. Wages refers to the average nominal wage paid by each firm in quarter t. Bank controls include bank size and bank ownership status interacted with the *Post* indicators as in previous regressions.

Table 3.5 reports the results for our difference-in-difference specification. The first two columns show results on employment without and with bank controls, respectively. Columns (3)-(4) show results for firm-level average wages. We find positive and significant effects of firm exposure on employment but no clear effects on average wages. Lastly, Figure 3.12 shows the event study for firms' employment as an outcome. Reassuringly, we observe no pre-trends for these firms in the years before the event and a substantial and persistence increase in employment after the tax amnesty. Our findings imply that an average firm in the 75^{th} percentile of exposure experienced an average increase of 2.8% in employment relative to the average firm in the 25^{th} percentile, during the aftermath of the tax amnesty.

Figure 3.12: Employment



We report 95% confidence intervals. Standard errors are clustered at the firm level. The plot shows the estimated coefficients on firm exposure. Point estimates measure the percent increase in employment for every 1 p.p. increase in firm exposure. Employment refers to the total number of formal employees in each quarter t.

3.5. Conclusion

We study how firms' performance was affected by a large and unprecedented inflow of dollar deposits to domestic banks. We find that the dollar funding shock, which was the result of a tax amnesty, had sizable effects on firm outcomes. Exploiting variation across banks to the shock and across firms to different banks, we construct firm-level variation in credit supply. Our results indicate that higher firm exposure to the liquidity shock improved credit access. Due to financial regulations, only exporters, and a few other firms, are allowed to get domestic dollar credit. In spite of this, our results indicate that both exporters and non-exporters connected to high-exposure banks benefited from the liquidity shock. While for the former the increase in credit was concentrated in dollar loans, the latter experienced a smaller but significant increase in pesos borrowing. We think that disentangling the mechanisms through which a shock to dollar banks' funding spillovers to the pesos credit market is the next step in this paper's contribution.

We also document that the effects of the liquidity shock go beyond firms' financial performance. Concretely, we show that firm exposure to the funding shock had a strong and positive effect on imports in both the intensive and extensive margins, as well as on employment. We find no significant effects of firm exposure on average wages. Overall, our findings highlight that foreign currency credit supply shocks can have a sizable impact on the corporate sector. This impact is stronger for firms that engage in foreign trade but is not limited to them.

We provide evidence on the importance of foreign currency funding shocks for the real economy by studying how they propagate through bank lending decisions. This suggests that policies aimed at managing these shocks may have important implications for firms and workers in developing countries which are often subject to sudden outflows of foreign capitals. Additionally, we shed light on a new channel through which tax amnesties can affect welfare: the role that banks play in allocating the inflow of funds across firms.

APPENDICES

APPENDIX A

Appendix to Chapter 1

A.0.1 Appendix: Theoretical Model

A.0.1.1 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.

A.0.1.2 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 $\rho_{b'j'} \leq \frac{p_{sb}}{p_{b'j'}}\rho_{sb} = \frac{p_{sb}}{p_{b'j'}}\rho$.[1] Then[2]

$$\lambda_{bj} = P(\rho_{b'j'} \leq \frac{p_{bj}}{p_{b'j'}}\rho_{bj})$$

$$= \underbrace{\int_0^\infty \exp\left(-\left(\sum_{j'} B_{j'}\left(\sum_{b'\in J'} B_{b'j'}\left(\frac{p_{bj}}{p_{b'j'}}\right)^{-\eta}\rho^{-\eta}\right)^{\frac{\theta}{\eta}}\right)\right)}_{\Pr\left(\rho_{b'j'}\leq\frac{p_{bj}}{p_{b'j'}}\right)} \underbrace{dH_{bj}(\rho)}_{density\ \ of\ \ \rho_{bj}}$$

$$= \int_0^\infty \rho^{-\eta-1}\theta B_j B_{bj}\left(\sum_{b'\in S} B_{b'j'}\left(\frac{p_{sb}}{p_{b'j'}}\right)^{-\eta}\rho^{-\eta}\right)^{\frac{\theta-\eta}{\eta}} \exp\left(-\left(\sum_{s'} B_{s'}\left(\sum_{a'\in J'} B_{b'j'}\left(\frac{p_{bj}}{p_{b'j'}}\right)^{-\eta}\rho^{-\eta}\right)^{\frac{\theta}{\eta}}\right)\right) d\rho$$

$$= \int_0^\infty \rho^{-\eta-1}\theta B_j B_{bj} p_{bj}^{\eta-\theta}\left(\sum_{b'\in M} B_{b'j'}p_{b'j'}^{\eta}\rho^{-\eta}\right)^{\frac{\theta-\eta}{\eta}} \exp\left(-\rho^{-\theta}p_{bj}^{-\theta}\left(\sum_{j'} B_{j'}\left(\sum_{b'\in j'} B_{b'j'}p_{b'j'}^{\eta}\right)^{\frac{\theta}{\eta}}\right)\right) d\rho$$

$$= \int_0^\infty \theta P_j^{\theta-\eta} B_{bj} p_{bj}^{\eta-\theta}\rho^{-\theta-1}\exp\left(-\rho^{-\theta}p_{bj}^{-\theta}\left(\sum_{j'} P_{j'}^{\theta}\right)\right) d\rho$$

$$= \underbrace{\frac{P_j^{\theta}}{\sum_{j'} P_{j'}^{\theta}}}_{\Pr(f\ chooses\ product\ j)} \underbrace{\frac{B_{bj}p_{bj}^{\eta}}{P_j^{\eta}}}_{\Pr(seller\ chooses\ buyer\ b|j)} \underbrace{\int_0^\infty -\exp(-u)du}_{=1}$$

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

A.0.1.3 Supply Curve: Choice of Quantity

Aggregating across sellers yields a nested CES supply curve for Buyer b in Product j. We know that

[1]This means that the revenue is higher in Buyer b and Product j.

[2]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, $\lambda = \int_0^\infty H_{sb}(\rho, \frac{p_{sb}}{p_{b'j'}}\rho, ...)$.

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

The expected quantity supplied by Seller w to Buyer a in Sector s is

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

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:

$$q_{bjk} = \left(\frac{p_{bj}^{\eta}}{P_j^{\eta}}\right)\left(\frac{P_j^{\theta}}{P^{\theta}}\right) Y \tag{A.1}$$

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

A.0.1.4 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[3] of Product j to Buyer b, is then determined by their productivity and the idiosyncratic shocks:

$$q_{sbjk} = \rho_{sbjk}^{\frac{1}{\eta}} \rho_{sjk}^{\frac{1}{\theta}} q_s \tag{A.2}$$

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 can be shown in Appendix A.0.1.2, 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.

[3]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.

A.0.1.5 Demand Curve: Choice of Price

Bertrand Competition

$$\pi_{bj} = p_{finalg} Q_{finalg} - \sum_j \frac{1}{e} p_{bj} q_{bj} \quad \text{s.t. } Q_{finalg} = \left(\int_s q_{bj}^{\frac{1-\gamma}{\gamma}} ds \right)^{\frac{\gamma}{\gamma-1}} \quad and \quad q_{bj} = \frac{p_{bj}{}^{\eta-1}}{P_j{}^{\eta-1}} \frac{P_j{}^{\theta-1}}{P^{\theta-1}} Y \tag{A.3}$$

The FOC imply that:

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

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

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

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

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

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

$$p_{bj} = \frac{\epsilon_{bj}}{1 + \epsilon_{bj}} e MRP_{bj} \tag{A.4}$$

Cournot Competition

$$\pi_{bj} = p_{finalg} Q_{finalg} - \sum_s \frac{1}{e} p_{bj} q_{bj} \quad \text{s.t. } Q_{finalg} = \left(\int_j q_{bj}^{\frac{1-\gamma}{\gamma}} dj \right)^{\frac{\gamma}{\gamma-1}} \quad and \quad q_{bj} = \frac{p_{bj}{}^{\eta-1}}{P_j{}^{\eta-1}} \frac{P_j{}^{\theta-1}}{P^{\theta-1}} Y \tag{A.5}$$

The FOC imply that:

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

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

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

$$p_{bj} = \frac{\epsilon}{1 + \epsilon} e MRP_{bj}$$

A.0.1.6 Buyer Size and Level Price

In this section I explore the relationship in the data between the size of the buyer and the price. For doing so, I run the following regression:

$$\ln\big(price_{sbjkt}\big) = \xi BS_{bjkt} + FE_{sjkt} + X_{kt} + \epsilon_{sbjkt} \tag{A.6}$$

where $\ln\big(price_{sbjkt}\big)$ 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 A.1 Panel A shows that the price of the same product, sold to the same destination in a given year is increasing in the buyer's size. This is true, even controlling for destination and time specific variables. The reason for this is that even though the markdowns for firms with higher market shares are larger, the marginal-revenue product for larger firms is also larger. Therefore, large firms are willing to pay larger prices.[4]

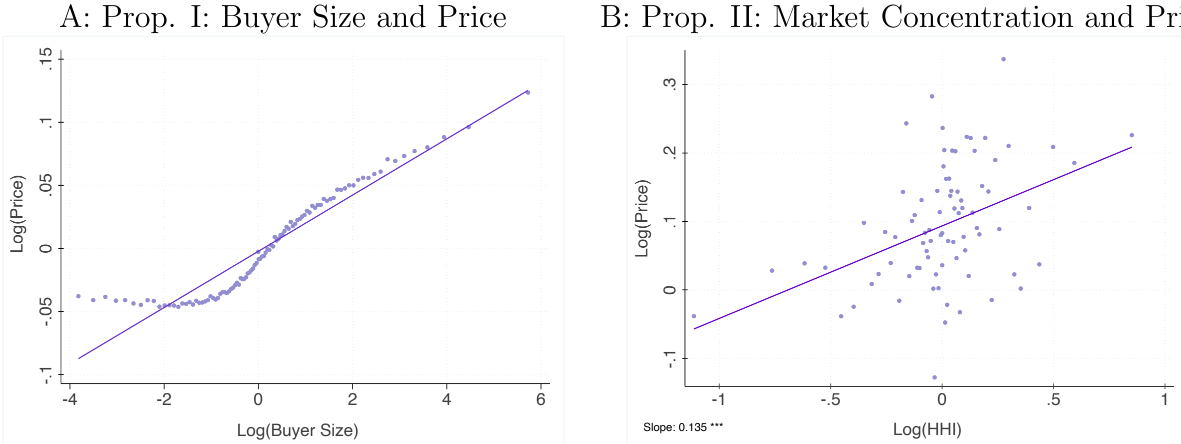
Then, I turn to the market-level predictions of the model. I aggregate equation A.6 at the market level such that price in a market can be expressed as a weighted average of prices for a given product in a given destination where the weights correspond to the buyers' market share. I obtain the average 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 HHI, $HHI_kt = \sum_{b=1}^{B} S_{bjkt}^2$:[5]

$$\ln\big(price_{jkt}\big) = \xi HHI_{jkt} + FE_{jkt} + X_{kt} + \epsilon_{jkt} \tag{A.7}$$

Figure A.1 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.[6]

Figure A.1

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



[4]Note that this results is analogous to Berger et al. (2022) where large firms pay higher wages.

[5]See the Appendix for proof.

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

A.0.1.7 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:

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

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

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

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

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

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

$$p_{bj} = \frac{1}{\frac{1}{\epsilon_{bj}}+1} eMVP_j$$

A.0.1.8 Pass-through

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

$$p_{ask} = \frac{\epsilon_{ask}}{1+\epsilon_{ask}} eMVP_{ask}$$

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:

$$\ln p_{asd} = \ln \mu_{asd} + \ln MVP_{asd} + \ln e_d$$

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

$$\triangle \ln p_{asd} = \triangle \ln \mu_{asd} + \triangle \ln MVP_{asd} + \triangle \ln e_d \tag{A.8}$$

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 (A.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.

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

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

and

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

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

$$\text{dln}S_{bjk} = 1 - \eta\frac{dp_{bjk}}{dp_{bjk}} - 1 - \eta\frac{1}{\sum_s p_{bjk}^{\eta-1}}\frac{p_{bjk}^{\eta-1}}{p_{bjk}}dp_{bjk}$$

$$\text{dln}(S_{bjk}) = 1 - \eta\,\text{dln}p_{bjk} - 1 - \eta)S_{bjk}\,\text{dln}p_{bjk}$$

$$\text{dln}S_{bjk} = \left[1 - \eta - 1 - \eta)S\right] \text{dln}p_{bjk}$$

$$\text{dln}S_{bjk} = 1 - \eta(1 - S_{bjk}) \, \text{dln}p_{bjk}$$

$$\text{dln}S_{bjk} = 1 - \eta \, \text{dln}(p_{bjk}) - 1 - \eta$$

$$\text{dln}\mu = \Upsilon_{sbjk}(\eta + 1)(1 - S_{bjk}) \, \text{dln}p_{bjk} \tag{A.9}$$

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

where

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

- Consider the second term:

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

$$\frac{\text{dln}MVP_{bjk}}{\text{dln}p_{bjk}} = \frac{\text{dln}MVP_{bjk}}{\text{dln}q_{bjk}} \frac{\text{dln}q_{bjk}}{\text{dln}p_{bjk}}$$

$$\frac{\text{dln}MVP_{bjk}}{\text{dln}p_{bjk}} = \frac{dMVP}{dq_{bjk}} \frac{q_{bjk}}{MVP_{bjk}} \epsilon_{bjk}$$

$$\frac{\text{dln}MVP_{bjk}}{\text{dln}p_{bjk}} = (\alpha_j - 1)\frac{MVP_{bjk}}{q_{bjk}} \frac{q_{bjk}}{MVP_{bjk}} \epsilon_{bjk}$$

$$\frac{\text{dln}MVP_{bjk}}{\text{dln}p_{bjk}} = (\alpha_j - 1)\epsilon_{bjk}$$

So, given a change in bilateral exchange rate $\text{dln}e_d$, as in Burstein and Gopinath (2014) there is a direct and indirect effect.

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

$$\frac{\text{dln}p_{sbj}}{\text{dln}e_d} = \frac{1}{1 \underbrace{-\Upsilon_{bjk}(1 - \eta_{bjk})(1 - S_{bjk})}_{Markdownchannel} - \underbrace{(\alpha_j - 1)\epsilon_{bjk}}_{ValueChannel}}$$

Taking into account that $\text{d}; np_{sbj}$ is in USD we can change this equation into COP using the following:

$$\text{dln}p_{sbj}^{dolars} = \text{dln}p_{asd}^{pesos} - \text{dln}e$$

And so we get:

$$\frac{\text{dln}p_{sbjk}}{\text{dln}e_d} = 1 - \frac{1}{1 \underbrace{-\Upsilon_{bjk}(1-\eta)(1-S_{bjk})}_{Markdownchannel} - \underbrace{(\alpha_j - 1)\epsilon_{bjk}}_{ValueChannel}}$$

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

A.0.1.9 Path Through: General Case

Log-differentiating equation 2.4.8, I get that the log change in price, $\text{dln}p_{sbj}$, can be written as:

$$\text{dln}p_{sbjk} = \text{dln}\mu_{bjk} + \text{dln}MVP_{sbjk} + \text{dln}e_k \tag{A.10}$$

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}.

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

Solving for the first term: $\frac{\text{dln}\mu_{bjk}}{\text{dln}S_{bjk}}$

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

Solving for the second term:

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

$$\ln S_{bjk} = lnp_{bjk}^{1+\eta} + \ln\left(\sum_s p_{bjk}^{1+\eta}\right)$$

$$\text{dln}S_{bjk} = (1+\eta)\frac{dp_{bjk}}{p_{bjk}} - (1+\eta)\frac{1}{\sum_s p_{bjk}^{\eta+1}}\frac{p_{bjk}^{\eta+1}}{p_{bjk}}dp_{bjk} - \sum_{z\neq b}(1+\eta)\frac{p_{zjk}}{\sum_b p_{bjk}^{1+\eta}}\frac{{p_{zjk}}^{1+\eta}}{p_{zjk}}\frac{dp_{zjk}}{dp_{bjk}}dp_{bjk}\frac{p_{bjk}}{p_{bjk}}$$

$$\text{dln}S_{bjk} = (1+\eta)\,\text{dln}p_{bjk} - (1+\eta)S_{bjk}\,\text{dln}p_{bjk} - (1+\eta)\sum_z S_{zjk}\frac{p_{bjk}}{p_{zjk}}\frac{dp_{zjk}}{dp_{bjk}}\,\text{dln}p_{bjk}$$

$$\text{dln}S_{bjk} = (1+\eta)(1 - S_{bjk} - \sum_z S_{zjk}\frac{\text{dln}p_{zjk}}{\text{dln}p_{bjk}})\,\text{dln}p_{bjk}$$

Finally,

$$\text{dln}\mu_{bjk} = \Upsilon_{sbjk}(\eta_{bjk}+1)(1 - S_{bjk} - \underbrace{\sum_z S_{zjk}\frac{\text{dln}p_{zjk}}{\text{dln}p_{bjk}}}_{Indirect})\,\text{dln}p_{bjk} \tag{A.11}$$

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

A.0.1.10 Proof of Proposition 3: Log Linearization and First-Order Approximation

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

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

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

Starting from the pass-through equation:

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

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

Doing a first-order approximation in S_{sbjk} and dividing by dlne_d:

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

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

$$\frac{\text{dln}p_{\text{axsd}}}{\text{dln}e_d} \approx \left[\frac{1}{1+\bar{\Upsilon}_{bjk}(1-\eta)\left(1-\bar{S}_{\text{bjk}}\right)+(1-\alpha_j)\bar{\varepsilon}} - \frac{\frac{\partial \Upsilon_d}{\partial S_{sbjk}}\Big|_{\bar{S}_{sbjk}} \cdot (1+\eta)(1-\bar{S}_{bjk}) - \bar{\Upsilon}_d(1+\eta)\cdot \frac{\partial \epsilon_{bjk}}{\partial S_{bjk}}\Big|_{\bar{S}_{bjk}} (1-\alpha_j)}{\left[1+\bar{\Upsilon}_{bjk}(1-\eta)\left(1-\bar{S}_{\text{bjk}}\right)+(1-\alpha_j)\bar{\varepsilon}\right]^2} \right] \cdot \bar{S}_{bjk}$$
$$+ \left[\frac{\frac{\partial \Upsilon_d}{\partial S_{sbjk}}\Big|_{\bar{S}_{sbjk}} \cdot (1+\eta)(1-\bar{S}_{bjk}) - \bar{\Upsilon}_d(1+\eta)\cdot \frac{\partial \epsilon_{bjk}}{\partial S_{bjk}}\Big|_{\bar{S}_{bjk}} (1-\alpha_j)}{\left[1+\bar{\Upsilon}_{bjk}(1-\eta)\left(1-\bar{S}_{\text{bjk}}\right)+(1-\alpha_j)\bar{\varepsilon}\right]^2} \right] \cdot S_{bjk}$$

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

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

where:

$$\alpha_{bjk} = \left[\frac{1}{1+\bar{\Upsilon}_{bjk}(1-\eta)\left(1-\bar{S}_{\text{bjk}}\right)+(1-\alpha_j)\bar{\varepsilon}} + \frac{\frac{\partial \Upsilon_d}{\partial S_{bjk}}\Big|_{\bar{S}_{bjk}} \cdot (1+\eta)(1-\bar{S}_{bjk}) - \bar{\Upsilon}_d(1+\eta)\cdot \frac{\partial \epsilon_{bjk}}{\partial S_{bjk}}\Big|_{\bar{S}_{bjk}} (1-\alpha_j)}{\left[1+\bar{\Upsilon}_{bjk}(1-\eta)\left(1-\bar{S}_{\text{bjk}}\right)+(1-\alpha_j)\bar{\varepsilon}\right]^2} \right]$$

$$\beta_{bjk} = \left[\frac{\frac{\partial \Upsilon_d}{\partial S_{bjk}}\Big|_{\bar{S}_{bjk}} \cdot (1+\eta)(1-\bar{S}_{bjk}) - \bar{\Upsilon}_d(1+\eta)\cdot \frac{\partial \epsilon_{bjk}}{\partial S_{bjk}}\Big|_{\bar{S}_{bjk}} (1-\alpha_j)}{\left[1+\bar{\Upsilon}_{bjk}(1-\eta)\left(1-\bar{S}_{\text{bjk}}\right)+(1-\alpha_j)\bar{\varepsilon}\right]^2} \right]$$

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

A.0.1.11 Monopolistic Competition for Final Good

Adding a demand function assuming that the aggregate income of the final consumers is given. In particular, assume that the demand for the buyers take the following form:

$$x = X(r/R)^{-\sigma}$$
$$r = Bx^{\frac{-1}{\sigma}}$$

where x is quantity and r is price to final consumers and XR is the total income of final consumers. We are going to take these variables as given. Then, the total revenue of the firm is given by:

$$TR = px = Bx^{\frac{-1}{\sigma}}x = Bx^{\frac{\sigma-1}{\sigma}},$$

where B is a constant that is given, just assume that it is equal to 1. Using the production function we get:

$$TR_{bk} = B\left(q_{bjk}^{\alpha}\right)^{\frac{\sigma-1}{\sigma}}$$

Then the marginal revenue is given by:

$$MR_{bjk} = \alpha\left(\frac{\sigma-1}{\sigma}\right)q_{bjk}^{\frac{-\alpha}{\sigma}}$$

The only difference with our previous expression is that it is multiplied by the markup assuming some value for σ and adjust the exponent.

A.0.1.12 Demand Curve: Choice of Price

Bertrand Competition—One Product Only

$$\pi_{bj} = p_{finalg}Q_{finalg} - \frac{1}{e}p_{bj}q_{bj} \quad \text{s.t.} \quad Q_{finalg} = q_{bjk}^{\sigma} \;\; and \;\; q_{bj} = \frac{{p_{bj}}^{\eta}}{{P_s}^{\eta-1}}\frac{{P_s}^{\theta-1}}{P^{\theta-1}}Y \tag{A.12}$$

The FOC imply that:

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

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

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

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

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

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

$$p_{sbj} = \frac{\epsilon_{bj}}{1+\epsilon_{bj}}eMRP_s \tag{A.13}$$

Bertrand Competition—Only Colombia

$$\pi_{bj} = p_{finalg}Q_{finalg} - \sum_j \frac{1}{e_k}p_{bjk}q_{bjk} \quad \text{s.t.} \quad Q_{finalg} = \prod_j z_b q_{bjk}^{\sigma_j} \;\; and \;\; q_{bjk} = \frac{{p_{bjk}}^{\eta}}{{P_{jk}}^{\eta}}\frac{{P_{jk}}^{\theta}}{P^{\theta}}Y \tag{A.14}$$

The FOC imply that:

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

$$p_{sbj} = \frac{1}{1+\epsilon_{bjk}^{-1}}e_k MRP_s \tag{A.15}$$

Bertrand Competition—Only One Input per Country

$$\pi_{bj} = p_{finalg}Q_{finalg} - \sum_{origin} \frac{1}{e_k^{origin}} p_{bjk}q_{bjk} \quad \text{s.t.} \quad Q_{finalg} = \prod_j z_b q_{bjk}^{\sigma_{origin}} \quad and \quad q_{bjk} = \frac{p_{bjk}{}^{\eta}}{P_{jk}{}^{\eta}} \frac{P_{jk}{}^{\theta}}{P^{\theta}} Y \tag{A.16}$$

Origin= Colombia, Ecuador, France

The FOC imply that:

$$[p_{bj}] : \frac{\partial(revenue)}{\partial q_{bj}} \frac{\partial q_{bjk}}{\partial p_{bjk}} - \frac{1}{e_k^{Colombia}} \left[q_{bj} + p_{bjk} \frac{\partial q_{bj}}{\partial p_{bj}} \right] + \frac{1}{e_k^{France}} \left[\underbrace{\frac{\partial p_{bak}}{\partial p_{bjk}} q_{bak}}_{0} + \underbrace{p_{bak} \frac{\partial q_{bak}}{\partial p_{bjk}}}_{} \right]_0 = 0$$

$$p_{sbj} = \frac{1}{1 + \epsilon_{bjk}^{-1}} e_k^{Colombia} MRP_s \tag{A.17}$$

A.0.1.13 Marginal Revenue Effect

One Good

$$Q_{finalgood} = \left(\frac{q_{bjk}}{\sigma_j} \right)^{\sigma_j}$$

If the price charge by the buyer does not change:

$$MRP = \frac{\partial revenues}{\partial q_{bjk}} = \sigma \frac{Q_{finalgood}}{q_{bjk}}$$

$$\frac{\text{dln} MRP_{bjk}}{\text{dln} p_{bjk}} = \frac{\text{dln} MRP_{bjk}}{\text{dln} q_{bjk}} \frac{\text{dln} q_{bjk}}{\text{dln} p_{bjk}}$$

$$\frac{\text{dln} MRP_{bjk}}{\text{dln} p_{bjk}} = \frac{dMRP}{dq_{bjk}} \frac{q_{bjk}}{MRP_{bjk}} \epsilon_{bjk}$$

$$\frac{\text{dln} MVP_{bjk}}{\text{dln} p_{bjk}} = (\sigma_j - 1)\epsilon_{bjk}$$

Cobb-Douglas

$$Q_{finalgood} = \prod_j \left(\frac{q_{bjk}}{\sigma_j} \right)^{\sigma_j}$$

If the price charge by the buyer does not change:

$$MRP = \frac{\partial revenues}{\partial q_{bjk}} = \sigma \frac{Q_{finalgood}}{q_{bjk}}$$

$$\frac{\text{dln} MRP_{bjk}}{\text{dln} p_{bjk}} = \frac{\partial MRP}{\partial p_{bjk}} \frac{p_{bjk}}{MRP}$$

$$\frac{\text{dln}MRP_{bjk}}{\text{dln}p_{bjk}} = \left[-\frac{Q_{finalgood}}{q_{bjk}^2} \frac{\partial q_{bjk}}{\partial p_{bjk}} + \frac{\partial Q_{finalgood}}{\partial q_{bjk}} \frac{\partial q_{bjk}}{\partial p_{bjk}} \frac{1}{q_{bjk}} + \sum_{j' \neq j} \frac{\partial Q_{finalgood}}{\partial q_{bj'k}} \frac{\partial q_{bj'k}}{\partial p_{bjk}} \frac{1}{q_{bjk}} \right] \frac{p_{bjk}}{MRP}$$

$$\frac{\text{dln}MRP_{bjk}}{\text{dln}p_{bjk}} = -\frac{\sigma}{\sigma}\epsilon_{bjk} + \sigma\epsilon_{bjk} + \sum_{j' \neq j} \frac{\partial Q_{finalgood}}{\partial q_{bj'k}} \frac{\partial q_{bj'k}}{\partial p_{bjk}} \frac{1}{q_{bjk}} \frac{p_{bjk}}{MRP}$$

$$\frac{\text{dln}MRP_{bjk}}{\text{dln}p_{bjk}} = \epsilon_{bjk}(\sigma - 1) + \sum_{j' \neq j} \frac{\partial Q_{finalgood}}{\partial q_{bj'k}} \frac{\partial q_{bj'k}}{\partial p_{bjk}} \frac{1}{q_{bjk}} \frac{p_{bjk}}{MRP} < 0$$

CES With a CES production function we have that:

$$Q_b = \left(\sum_j q_{bs}^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}}$$

Then we get that:

$$MVP_{bs} \propto \left(\frac{Q_b}{q_{bs}} \right) \left(\frac{q_{bs}^{\frac{\sigma-1}{\sigma}}}{\left(\sum_s q_{bs}^{\frac{\sigma-1}{\sigma}} \right)} \right) = x_{bs} \frac{Q_b}{q_{bs}}$$

where x_{bs} is the expenditure share of Buyer b on Seller s.[7] Totally differentiating in logs we get:

$$\text{dln}MVP_{bs} = \text{dln}x_{bs} + \text{dln}Q_b - \frac{\text{dln}q_{bs}}{\text{dln}p_{bs}}$$

We get that

$$\text{dln}x_{bs} = \frac{\sigma - 1}{\sigma} \text{dln}q_{bs} - \frac{\sigma - 1}{\sigma} x_{bs} \text{dln}q_{bs} = \frac{\sigma - 1}{\sigma}(1 - x_{bs}) \frac{\text{dln}q_{bs}}{\text{dln}p_{bs}}$$

Similarly:

$$\text{dln}Q_b = x_{bs} \frac{\text{dln}q_{bs}}{\text{dln}p_{bs}}$$

Replacing this in the previous equation we get:

$$\text{dln}MVP_{bs} = \left(\frac{\sigma - 1}{\sigma} - 1 \right) (1 - x_{bs}) \frac{\text{dln}q_{bs}}{\text{dln}p_{bs}} = \frac{-1}{\sigma}(1 - x_{bs}) \frac{\text{dln}q_{bs}}{\text{dln}p_{bs}}$$

$$\frac{\text{dln}MVP_{bs}}{\text{dln}p_{bs}} = \frac{-1}{\sigma}(1 - x_{bs})\epsilon_{bs}$$

A.0.1.14 Increasing Relationship between Markdown Channel and Buyer Size

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

[7] Note that this s could be also product.

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

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

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

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

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

A.0.1.15 HHI and Markdowns

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:

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

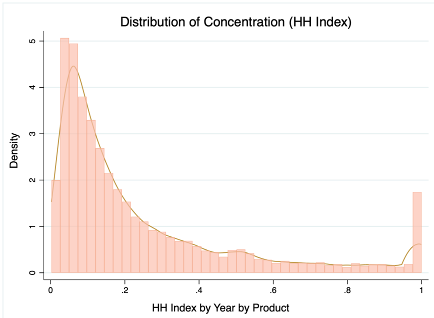
I then compute the standard errors for κ_t under the assumption that the effect on concentration and the input supply parameters are independent. It follows that:

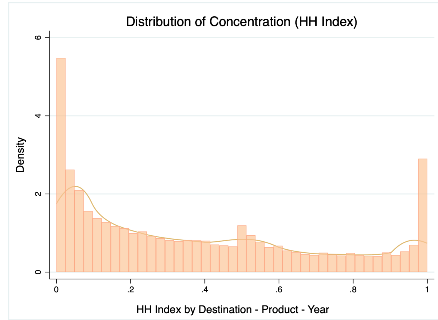
$$\begin{aligned}
\delta(\kappa_t) =& \delta\left[\left(\frac{1}{\theta} - \frac{1}{\eta}\right) .\kappa_t\right] \\
=& \delta\left[\left(\frac{1}{\theta} - \frac{1}{\eta}\right)^2\right][\kappa_t^2] - \left[\left(\frac{1}{\theta} - \frac{1}{\eta}\right)\right]^2 [(\kappa_t)]^2 \\
=& \delta\left[\left(\frac{1}{\theta}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

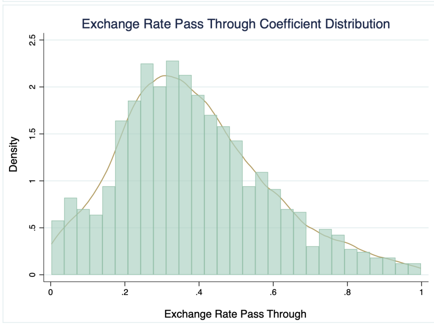
whose components can all be plugged-in using sample estimates.

A.0.2 Appendix: Empirical Part

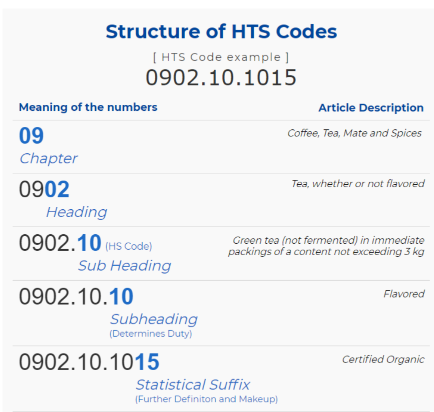
A.0.2.1 Variables Distribution







A.0.2.2 HS10 examples

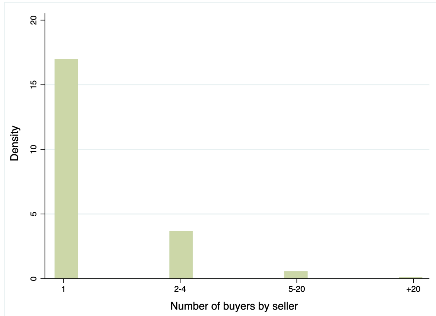


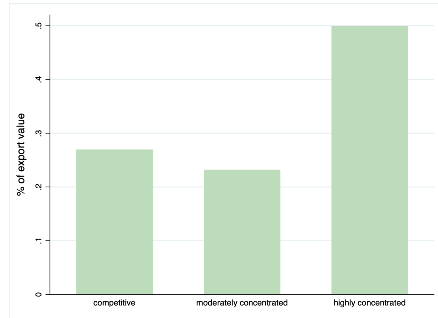
Commodity Code	Description
2204 10	Sparkling wine
2204 1011	With a protected designation of origin (PDO)
2204 1011 00	Champagne
2204 1013 00	Cava
2204 1015 00	Prosecco
2204 1091 00	Asti spumante
2204 1093 00	Other
2204 1094 00	With a protected geographical indication (PGI)
2204 1096 00	Other varietal wines
2204 1098 00	Other

A.0.2.3 Buyers and Sales Concentration

The two figures below show characteristics of the export markets in Colombia. Figure A.0.2.3 shows that in the majority of the cases a sellers only supplies to one buyer. Figure A.0.2.3 shows that for the biggest part of the export value, markets are highly concentrated.

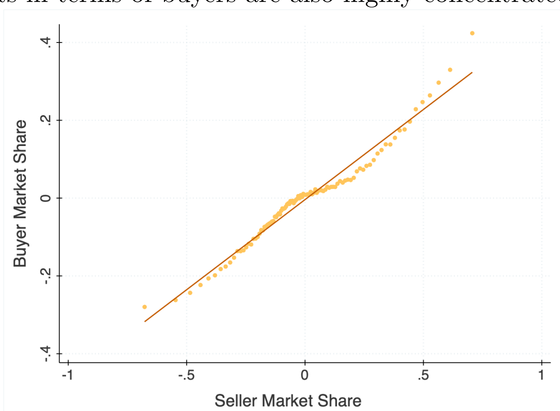
Export value explained by multi-buyers

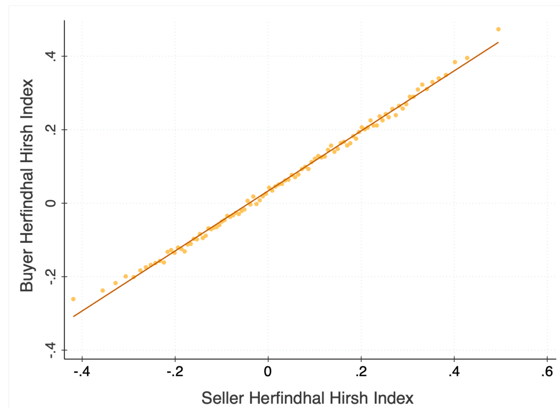




A.0.2.4 Assortative Matching

The figures below show that is more likely large buyers buy from larger sellers and that highly concentrated markets in terms of buyers are also highly concentrated in terms of sellers.





A.0.2.5 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.

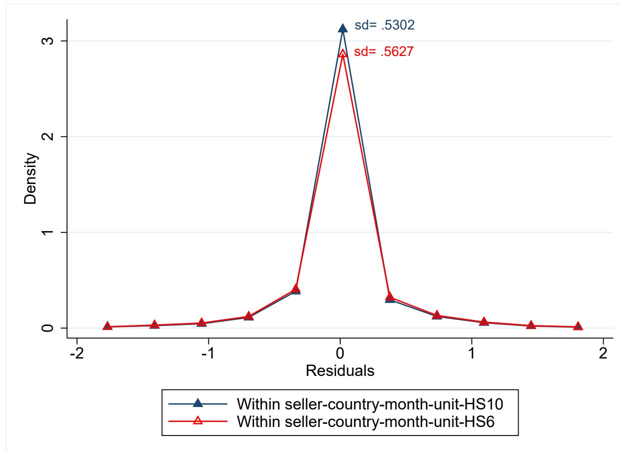


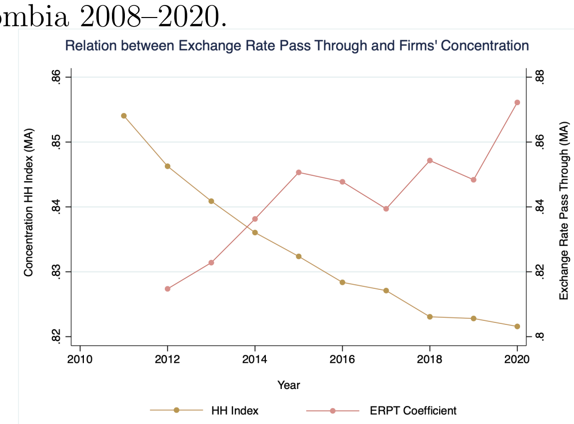
Table A.1: Number of Products

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

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

A.0.2.6 Colombia Time Series

I find a relationship between the concentration of sales in buyers and the exchange rate pass-through. The figures below show how this correlation holds in the time series for Colombia 2008–2020.



A.0.2.7 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

	(1) $\triangle\ln(Prices)$	(2) $\triangle\ln(Prices)$	(3) $\triangle ln(Prices)$
L(△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(△ER) × 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(△ER) × $Seller\ Size_{t-1}$		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
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

exchange rate shock would work in the same way), firms with higher market share internalize this shock (Atkeson and Burstein, 2008a; Amiti et al., 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.

A.0.2.8 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.

A.0.2.9 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 A.2 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 buyer–seller relationship. 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 A.2

	(1)	(2)	(3)
	△ Log(Prices)	△ Log(Prices)	△ 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 × lagbuyersize1	0.00648	-0.324**	-0.312**
	(0.186)	(0.127)	(0.128)
ltenureany		0.0222**	
		(0.0101)	
lERchange × ltenureany		-0.000628	
		(0.0674)	
ltenurehs			0.00627
			(0.0123)
lERchange × 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.

A.0.2.10 Robustness: Prices in USD

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

	(1) △ Log(Prices)	(2) △ Log(Prices)	(3) △ Log(Prices)	(4) △ Log(Prices)	(5) △ 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. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

A.0.2.11 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 USD-to-COP 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) △ Log(Price)	(2) △ Log(Price)	(3) △ Log(Price)
L(△ 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(△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 * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

A.0.2.12 Robustness: Devaluations versus Appreciation

In this section I estimate the different effects for the case where there is a devaluation vs appreciation. As shown in Table A.3, I find the effects are stronger for devaluations. One caveat about this effect, is that my sample does not contain a lot of appreciation events of a relevant magnitude for COP. Potentially the reason why I find almost no effect for appreciation is the appreciation events are insignificant and reverted shortly after they occur.

A.0.3 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 et al., 2020; Eggertsson et al., 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, 2019) but also high entry costs that create barriers to competition (Antras et al., 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:

$$\frac{\text{dln}p_{sbjk}}{\text{dln}e_k} = \alpha + \beta S_{jbk}$$

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

$$\sum_{b'} w_{b'} \frac{\text{dln}p_{sbjk}}{\text{dln}e_k} = \hat{\alpha} + \hat{\beta} \sum_{b'} w_{b'} S_{jk}$$

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

$$\sum_{b'} S_{jb'k} \frac{\text{dln}p_{sbjk}}{\text{dln}e_k} = \hat{\alpha} + \hat{\beta} HHI_{jk}$$

Table A.4 shows the exchange rate pass-through for scenarios with different concentrations compared to the actual concentration in Colombia, Column (2). Comparing to these benchmark values, I propose three other scenarios: a) A merge between the two biggest firm (in terms of buyer share) in every market. So this means an increase in concentration, Column (1), b) leaving fixed the number of buyers in each market and assigning a symmetric share of sales to each buyer, Column (3), and c) assigning the same number of buyers to each market (the median number of buyers across all markets with a symmetric distribution of

Table A.3: Positive or negative Δ ER

	(1) $\triangle \ln(Prices)$ *Devaluation*	(2) $\triangle \ln(Prices)$ *Appreciation*
L($\triangle$ER)	0.493***	0.260
	(0.153)	(0.162)
S_{t-1}	-0.0832***	-0.0160
	(0.0226)	(0.0191)
$L(\triangle ER) \times S_{t-1}$	-0.686***	0.129
	(0.237)	(0.187)
HS–period FE	x	x
Dest–HS–Seller FE	x	x
N	274927	179037

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

sales among them, column(4).

For each case, I present two sets of results corresponding to different weight matrices. 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 A.4: Average Exchange Rate Pass-through

ω	Merger	Benchmark	Symmetric shares Different #
Buyer share	0.04%	**20.50%**	24.10%
Trade flow	0.02%	**15.20%**	22.30%

Results show that for cases with mergers, that is, when the market concentration increases, the exchange rate pass-through decreases. For all other cases, when concentration is decreased the exchange rate pass-through increases.

A.0.3.1 Estimation

Set Up the Model Let's simulate the economy in the baseline equilibrium assuming that you know μ_A, and σ_A from the log normal distribution and an initial vector Y.

- Simulate a random vector of productivities z from the log normal distribution.
- Start the algorithm with an initial vector of $p's$. For example $p = 1$

- Solve for the quantities using the supply function:

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

- Solve for the markdown using the elasticity function.
- Solve for the new vector of p'
- Update the vector of $p's$ and Y:

$$p^r = \nu p^{r-1} + (1-\nu)p'$$
$$Y^r = \sum_{b'j'k'} p_{b'j'k'}^{r-1} q_{b'j'k'}^{r-1}$$

- Repeat the algorithm until the maximum difference between p^r and p^{r-1} and Y^r and Y^{r-1} is lower than a tolerance factor.

APPENDIX B

Appendix to Chapter 2

B.0.1 Solving the Importer's Problem

Now we can write the importer's maximization problem as:

$$\max_{\{Q_i(k)\}_{k\in J_i}} \left[\int_{k\in J_i} Q_i(k)^{\frac{\epsilon-1}{\epsilon}} dk\right]^{\frac{\epsilon}{\epsilon-1}} - \int_{k\in J_i} p_i^*(k)Q_i(k)dk - r_i \int_{k\in J_i} \phi(k)p_i^*(k)Q_i(k)dk \quad \text{(B.1)}$$

s.t.

$$\int_{k\in J_i} \phi(k)p_i^*(k)Q_i(k)dk \leq X_i^* \quad \text{(B.2)}$$

where J_i is the mass of inputs available to the importer in country i. $\phi(k)$ is the down payment share and r_i is the bank interest rate in the importer's country. $p_i^*(k)$ is the price of input k denominated in currency of importer's country faced by importer i.

The Lagrangian:

$$L = \left[\int_{k\in J_i} Q_i(k)^{\frac{\epsilon-1}{\epsilon}} dk\right]^{\frac{\epsilon}{\epsilon-1}} - \int_{k\in J_i} p_i^*(k)Q_i(k)dk - r_i \int_{k\in J_i} \phi(k)p_i^*(k)Q_i(k)dk + \lambda[X_i - \int_{k\in J_i} \phi(k)p_i^*(k)Q_i(k) \quad \text{(B.3)}$$

F.O.C. w.r.t. $Q_i(k)$:

$$\frac{\epsilon}{\epsilon-1} \left[\int_{k\in J_i} Q_i(k)^{\frac{\epsilon-1}{\epsilon}} dk\right]^{\frac{1}{\epsilon-1}} \frac{\epsilon-1}{\epsilon} Q_i(k)^{\frac{-1}{\epsilon}} - p_i^*(k) - r\phi(k)p_i^*(k) - \lambda\phi(k)p_i^*(k) = 0 \quad \text{(B.4)}$$

$$\left[\int_{k\in J_i} Q_i(k)^{\frac{\epsilon-1}{\epsilon}}dk\right]^{\frac{1}{\epsilon-1}} Q_i(k)^{\frac{-1}{\epsilon}} - (1+(r+\lambda)\phi(k))p_i^*(k) = 0 \tag{B.5}$$

$$\left[\int_{k\in J_i} Q_i(k)^{\frac{\epsilon-1}{\epsilon}}dk\right]^{\frac{-\epsilon}{\epsilon-1}\times(\frac{-1}{\epsilon})} Q_i(k)^{\frac{-1}{\epsilon}} - (1+(r+\lambda)\phi(k))p_i^*(k) = 0 \tag{B.6}$$

$$\left(\frac{Q_i(k)}{\left[\int_{k\in J_i} Q_i(k)^{\frac{\epsilon-1}{\epsilon}}dk\right]^{\frac{\epsilon}{\epsilon-1}}}\right)^{\frac{-1}{\epsilon}} = (1+(r+\lambda)\phi(k))p_i^*(k) \tag{B.7}$$

$$\left(\frac{Q_i(k)}{\left[\int_{k\in J_i} Q_i(k)^{\frac{\epsilon-1}{\epsilon}}dk\right]^{\frac{\epsilon}{\epsilon-1}}}\right) = (1+(r+\lambda)\phi(k))^{-\epsilon}(p_i^*(k))^{-\epsilon} \tag{B.8}$$

$$Q_i(k) = (1+(r+\lambda)\phi(k))^{-\epsilon}(p_i^*(k))^{-\epsilon} \times \left[\int_{k\in J_i} Q_i(k)^{\frac{\epsilon-1}{\epsilon}}dk\right]^{\frac{\epsilon}{\epsilon-1}} \tag{B.9}$$

Define

$$\tilde{\lambda}_k \equiv 1+(r+\lambda)\phi(k) \tag{B.10}$$

$$y_i \equiv \left[\int_{k\in J_i} Q_i(k)^{\frac{\epsilon-1}{\epsilon}}dk\right]^{\frac{\epsilon}{\epsilon-1}} \tag{B.11}$$

Then

$$Q_i(k) = \tilde{\lambda}_k^{-\epsilon}(p_i^*(k))^{-\epsilon}y_i \tag{B.12}$$

Put Equation B.12 it into Equation B.2, we have

$$\int_k \phi(k)p_i^*(k)[\tilde{\lambda}_k^{-\epsilon}(p_i^*(k))^{-\epsilon}y_i]dk = X_i \tag{B.13}$$

$$\int_k p_i^*(k)^{1-\epsilon}\phi(k)\tilde{\lambda}_k^{-\epsilon}y_i dk = X_i \tag{B.14}$$

Assume $\phi(k)$ is i.i.d. across exporters, then we have

$$(\int_k \phi(k)\tilde{\lambda}_k^{-\epsilon}dk)(\int_k p_i^*(k)^{1-\epsilon}y_i dk) = X_i \tag{B.15}$$

Define the price index

$$P_i^* = [\int_k p_i^*(k)^{1-\epsilon}dk]^{\frac{1}{1-\epsilon}} \tag{B.16}$$

Put Equation B.16 into Equation B.15, we have

$$(\int_k \phi(k)\tilde{\lambda}_k^{-\epsilon}dk)(P_i^{*1-\epsilon}) = X_i/y_i \tag{B.17}$$

which is

$$(\int_k \phi(k)[1+(r_i+\lambda)\phi(k)]^{-\epsilon}dk)(P_i^{*1-\epsilon}) = X_i/y_i \tag{B.18}$$

From Equation B.18, we can implicitly solve for $\bar{\lambda} = \lambda(P_i^*, y_i; \{\phi(k)\}_k, r, X_i)$.

Assume there are a large number of exporters. Then $P_i^* = [\int_k p_i^*(k)^{1-\epsilon}dk]^{\frac{1}{1-\epsilon}}$ and $y_i \equiv \left[\int_{k\in J_i} Q_i(k)^{\frac{\epsilon-1}{\epsilon}}dk\right]^{\frac{\epsilon}{\epsilon-1}}$ are taken as given by the exporters when they choose prices. Thus, $\bar{\lambda} = \lambda(P_i^*, y_i; \{\phi(k)\}_k, r, X_i)$ is also taken as given.

Knowing that

$$Q_i(k) = \tilde{\lambda}_k^{-\epsilon}(p_i^*(k))^{-\epsilon}y_i \tag{B.19}$$

$$= [1+(r_i+\lambda)\phi(k)]^{-\epsilon}(p_i^*(k))^{-\epsilon}y_i \tag{B.20}$$

we have the equilibrium quantity

$$Q_i(k) = [1+(r_i+\bar{\lambda})\phi(k)]^{-\epsilon}(p_i^*(k))^{-\epsilon}y_i \tag{B.21}$$

B.0.2 Solving the Exporter's Problem

A firm producing product k from country j faces the following problem:

$$\max_{p_i^*(k),b(k)} \quad p_i^*(k)eQ_i(k) - a(k)w_jQ_i(k) - fw_j - b(k)r(k) \tag{B.22}$$

s.t.

$$Q_i(k) = [1 + (r_i + \bar{\lambda})\phi(k)]^{-\epsilon}(p_i^*(k))^{-\epsilon} y_i \tag{B.23}$$

$$\phi(k)p_i^*(k)eQ_i(k) + b(k) \geq a(k)w_jQ_i(k) + fw_j \tag{B.24}$$

$$b(k)(1 + R_j) \leq \beta b(k)(1 + r(k)) + (1 - \beta)(b(k) - m_j) \tag{B.25}$$

which is

$$r(k) \geq \frac{R_j}{\beta} + \frac{1-\beta}{\beta}\frac{m_j}{b(k)}$$

where e is the exchange rate (exporter currency/ importer currency), f is the fixed costs, $r(k)$ is the firm-level interest rate in the exporter's country and $b(k)$ is the borrowing from banks.

$$\begin{aligned} L = {} & p_i^*(k)eQ_i(k) - a(k)w_jQ_i(k) - fw_j - b(k)r(k) \\ & + \mu_k[\phi p_i^*(k)eQ_i(k) + b(k) - a(k)w_jQ_i(k) - fw_j] \end{aligned}$$

F.O.C.

$$\frac{\partial L}{\partial p_i^*(k)} = (1 + \mu_k\phi(k))[eQ_i(k) + ep_i^*(k)\frac{\partial Q_i(k)}{\partial p_i^*(k)}] - (1 + \mu_k)a(k)w_j\frac{\partial Q_i(k)}{\partial p_i^*(k)} = 0 \tag{B.26}$$

$$\begin{aligned} L = {} & p_i^*(k)eQ_i(k) - a(k)w_jQ_i(k) - fw_i - b(k)r(k) && \text{(B.27)} \\ & + \mu_k[\phi p_i^*(k)eQ_i(k) + b(k) - a(k)w_jQ_i(k) - fw_j] && \text{(B.28)} \\ & = (1 + \mu_k\phi(k))p_i^*(k)eQ_i(k) - (1 + \mu_k)a(k)w_jQ_j(k) && \text{(B.29)} \\ & - (1 + \mu_k)fw_j - (r(k) - \mu_k)b(k) - \mu_k fw_j && \text{(B.30)} \end{aligned}$$

F.O.C.

$$\frac{\partial L}{\partial p_i^*(k)} = (1+\mu_k\phi(k))[eQ_i(k) + ep_i^*(k)\frac{\partial Q_i(k)}{\partial p_i^*(k)}] - (1+\mu_k)a(k)w_j\frac{\partial Q_i(k)}{\partial p_i^*(k)} = 0 \tag{B.31}$$

$$\frac{\partial L}{\partial b(k)} = \mu_k - r(k) - b(k)\frac{\partial r(k)}{\partial b(k)} = 0 \tag{B.32}$$

Given $Q_i(k) = [1 + (r+\bar{\lambda})\phi(k)]^{-\epsilon}(p_i^*(k))^{-\epsilon}y_i$ and $\frac{\partial Q_i(k)}{\partial p_i^*(k)} = -\epsilon\frac{Q_i(k)}{p_i^*(k)}$

$$e(1+\mu_k\phi(k))[Q_i(k) + p_i^*(k)(-\epsilon\frac{Q_i(k)}{p_i^*(k)})] - (1+\mu_k)a(k)w_j(-\epsilon\frac{Q_i(k)}{p_i^*(k)}) = 0 \tag{B.33}$$

$$e(1+\mu_k\phi(k))(1-\epsilon)Q_i(k) - (1+\mu_k)a(k)w_j(-\epsilon\frac{Q_i(k)}{p_i^*(k)}) = 0 \tag{B.34}$$

$$e(1+\mu_k\phi(k))(1-\epsilon) = (1+\mu_k)a(k)w_j(-\epsilon\frac{1}{p_i^*(k)}) \tag{B.35}$$

$$p_i^*(k) = e^{-1}\frac{1+\mu_k}{1+\mu_k\phi(k)}a(k)w_j\frac{\epsilon}{\epsilon-1} \tag{B.36}$$

The other first order condition (Equation B.32) shows:

$$\mu_k = r(k) + b(k)\frac{\partial r(k)}{\partial b(k)} \tag{B.37}$$

$$= r(k) - \frac{\beta-1}{\beta}\frac{m_j}{b(k)} \tag{B.38}$$

The equilibrium price is:

$$p_i^*(k) = e^{-1}\frac{1 + r(k) - \frac{\beta-1}{\beta}\frac{m_j}{b(k)}}{1 + (r(k) - \frac{\beta-1}{\beta}\frac{m_j}{b(k)})\phi(k)}a(k)w_j\frac{\epsilon}{\epsilon-1} \tag{B.39}$$

Since $p_i = p_i^* \times e$, we have

$$p_i(k) = \frac{1+r_j}{1+r_j\phi(k)}a(k)w_j\frac{\epsilon}{\epsilon-1} \tag{B.40}$$

(B.41)

$$\log p_i(k) = \log\big(1 + r_j\big) - \log\big(1 + r_j\phi(k)\big) + \log[a(k)w_j\frac{\epsilon}{\epsilon - 1}] \tag{B.42}$$

$$\tag{B.43}$$

$$\frac{\partial \log p_i(k)}{\partial \log e} = \frac{1}{1 + r_j}\frac{\partial r_j}{\partial \log e} - \frac{\phi(k)}{1 + r_j\phi(k)}\frac{\partial r_j}{\partial \log e} \tag{B.44}$$

$$= (\frac{1}{1 + r_j} - \frac{\phi(k)}{1 + r_j\phi(k)})\frac{\partial r_j}{\partial loge} \tag{B.45}$$

$$= \frac{1 - \phi(k)}{(1 + r_j)(1 + r_j\phi(k))}\frac{\partial r_j}{\partial \log e} \tag{B.46}$$

B.1. Attributing interest rate changes to borrowing demand

An alternative scenario would be one where the interest rate reacts to changes in the exchange rate through changes in the aggregate borrowing demand. We focus on the financial market in the exporting country j [1]. We drop the country notation in this section. Thus, the interest rate is denoted by r. Assume there is a saving function $S(r)$ which is increasing in r: higher interest rate, more savings[2].

Next, we introduce a borrowing relationship with moral hazard. There is a continuum of exporters who are risk-neutral. Each exporter owns a "machine" with different qualities: a high-quality machine provides high productivity and high net worth for the exporter. The net worth of a machine is denoted by A. A follows a continuous CDF $G(A|\theta)$ with support $[\underline{A}, \bar{A}]$ and PDF $g(A|\theta)$. θ is a parameter governing the quality distribution: an increase in θ indicates a first-order stochastic dominance shift of the distribution, leading to weakly increase in all machines' quality.

Every time an exporter wants to export to a certain import, she must initiate a project requiring a cost of I. The utility function of exporter is $U(c_0, c_1) = c_0 + c_1$. The exporters have limited liability. Thus, $c_1 \geq 0$[3].

An exporting project will succeed at the probability of p generating an income of $R > 0$. The income is verifiable to the investors. If the project fails, there is zero income. What governs the probability of success is the exporter's effort. If the exporter works, $p = p_H$; if she shirks, $p = p_L = p_H - \triangle p$ and she earns a private benefit $B > 0$. The private benefit is not verifiable to the investors and is counted into c_1: $G_\theta(A|\theta) < 0$. The timing is shown in

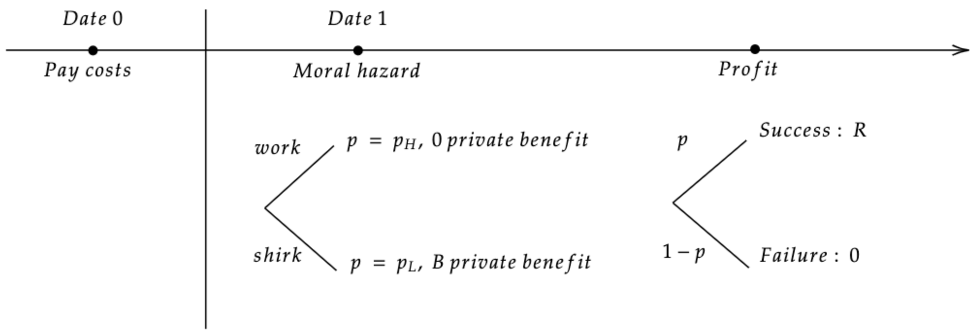
[1] We build this model based on Tirole (2010).

[2] As is shown in (Tirole, 2010), the saving function can be derived from certain investors' preferences. We abstract from that since the investors' behaviors are not our main focus.

[3] As is indicated by (Tirole, 2010), the exporter' utility is not crucial. That said, the exporter should be more patient than the investors so that the lending direction is from the investors to the exporters ($r > 0$).

Figure B.1.

Figure B.1: Model Timing



Notes: This figure provides an illustration of the model timing. In date 0, the exporter pays costs of production. In date 1, the exporter chooses between work and shirk. Working leads to a high success probability with no private benefit. Shirking leads to a low success probability with private benefit B. In the end, profit is realized with a success probability.

We assume the project's NPV is positive if and only if the exporter works:

$$p_H R > (1+r)I > p_L R + B \tag{B.1}$$

On the condition that the exporter get the fund, the optimal financial contract should be:

$$R = R_b + R_l \tag{B.2}$$

which specifies the allocation of the profit in the case of success between the exporter (R_b) and the investors (R_l). In the case of failure, both parties receive zero profit.

The incentive compatibility constraint is

$$(\triangle p)R_b \geq B. \tag{B.3}$$

The pledgeable income is

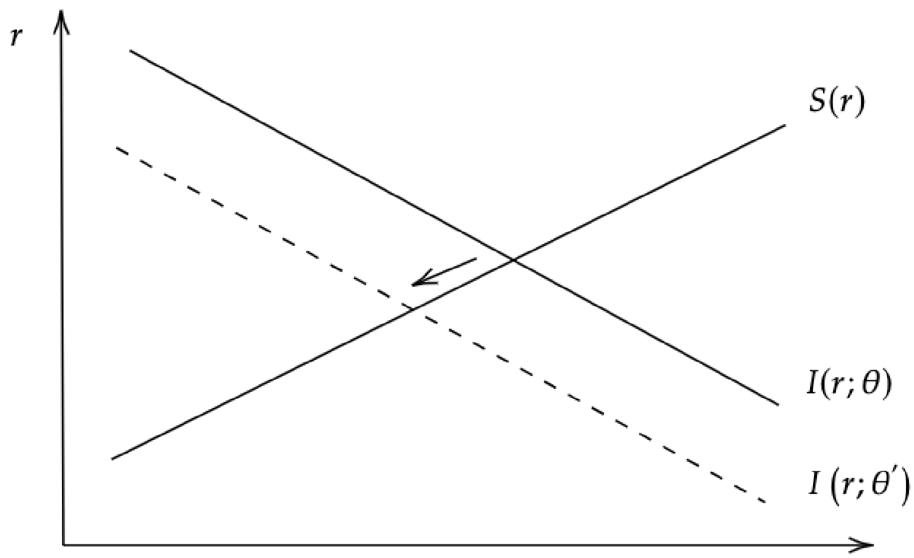
$$p_H(R - \frac{B}{\triangle p}) \tag{B.4}$$

which is the highest level of expected profit that can be pledged to the investors under the IC contriant.

If an exporter with a net worth A gets financing, the necessary and sufficient condition is

$$p_H(R - \frac{B}{\triangle p}) \geq (1+r)(I - A) \tag{B.5}$$

Figure B.2: The Endogenous Interest Rate Change



Notes: This figure illustrates the financial market clear. Saving ($S(r)$) is upward sloping and borrowing ($I(r;\theta)$) is downward sloping. A change in θ could shift $I(r)$ inward, with equilibrium interest rate being lower.

We define the cut-off level of net worth, $A^*(r)$:

$$p_H(R - \frac{B}{\triangle p}) = (1+r)(I - A^*(r)) \tag{B.6}$$

The market clear condition in the financial market is:

$$I(r) = S(r) \tag{B.7}$$

where

$$I(r) \equiv \int_{A^*(r)}^{\bar{A}} (I - A)g(A|\theta)dA - \int_{\underline{A}}^{A^*(r)} Ag(A)dA \tag{B.8}$$

$$= (1 - G(A^*(r)|\theta))I - A^e \tag{B.9}$$

where

$$A^e \equiv \int_{\underline{A}}^{\bar{A}} Ag(A)dA \tag{B.10}$$

which is the average level of net worth of the exporters and also the average level of productivity of them.

Now we can discuss the comparative statics: when the home currency depreciates, how does the interest rate respond? The home currency depreciation leads to an increase in θ because it takes less costs for the exporters to produce in the foreign currency unit. It also means the exporters have higher net worth.

How does an increase in θ affect the total borrowing?

$$\frac{\partial I(A|\theta)}{\partial\theta} = -G_\theta(A^*(r))I - \frac{\partial A^e}{\partial\theta} \tag{B.11}$$

The equation suggests two effects:

First, $-G_\theta(A^*(r))I > 0$ indicates that more exporters are able to borrow. The borrowing curve shifts up. Second, $\frac{\partial A^e}{\partial\theta} > 0$ indicates the average net worth increases. The borrowing curve shifts down. The equilibrium interest rate depends on which effect dominates. When the second effect dominates, the interest rate decreases.

The intuition behind this mechanism is the following: when the home country is depreciated, firms increase their export both on the intensive and extensive margin. Given this increase in production, firms on the one hand need to pay more costs and on the other hand have more cash in hand. The cash effect dominates in this case, and firms with more cash in hand cause a decrease in the aggregate borrowing demand curve, decreasing the interest rate for bank loan. In this way, an increase in the exchange rate causes a decrease in the interest rate, that is, $\frac{\partial r_j}{\partial\log e} < 0$.

APPENDIX C

Appendix to Chapter 3

C.0.1 Data: Cleaning

C.1. Data Cleaning

Our initial dataset consisted of raw data from 85 financial entities, encompassing both banks and other financial companies. To ensure the reliability and relevance of our analysis, we applied a series of filters to narrow down the dataset to a final sample of 59 banks.

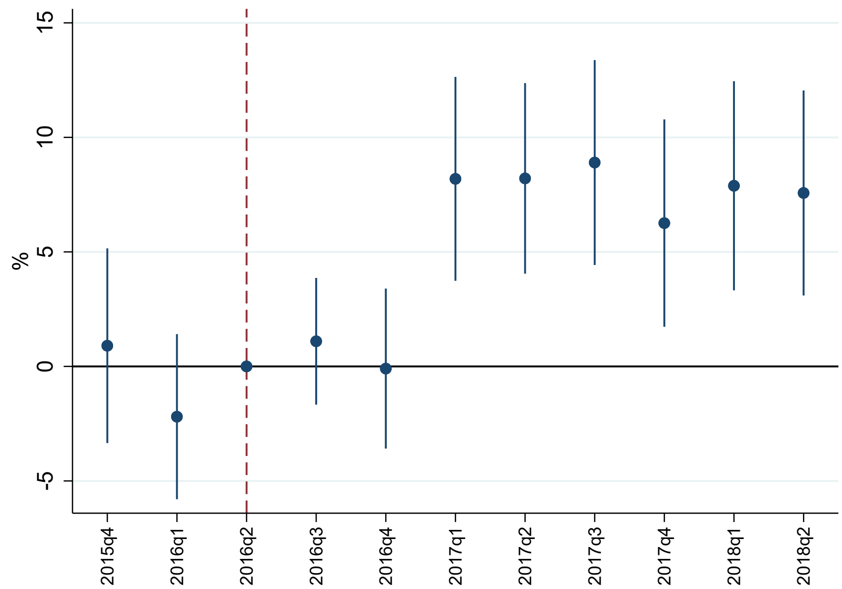
We began by excluding seven banks that were not operational in 2016. We then removed two banks that had no lending activity according to the credit registry data in certain years, as well as three banks that were not present in all years of our sample period to ensure a balanced panel and stable sample. Additionally, we removed five banks that reported zero deposits in all years.

Finally, we excluded 21 financial companies that do not function as banks. These companies are typically the financial services arm of another company and provide financing and insurance services to support their companies' operations in the country.

After applying these filters, our final sample consists of 59 banks, representing 92% of total deposits, 85% of the assets, and 82.3 % of the loans in the financial system.

C.1.1 Robustness - Firm Credit

Figure C.1: Dollar Debt - Exporters
Intensive Margin



We report 95% confidence intervals. Standard errors are clustered at the firm level. The plot shows the estimated coefficients on firm exposure for the set of firms that had dollar debt in the period before the tax amnesty. Point estimates measure the percentage increase in dollar debt for every 1*p.p.* increase in firm exposure. The time period is restricted to $2015Q4 - 2018Q2$ due to data availability.

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