SEARCH, DOLLAR PRICING, AND INFLATION[*]

ANDRES DRENIK

Department of Economics

The University of Texas at Austin

DIEGO J. PEREZ

Department of Economics

New York University and NBER

October 13, 2023

ABSTRACT. We document that a significant fraction of prices in domestic markets of emerging economies are set in dollars, especially those of more expensive goods. This fact is generalized across various countries and holds within goods categories. In addition, more expensive goods take longer to sell and are more likely to be purchased by households with liquid assets in dollars. We develop a search model of currency choice of prices to study how inflation and demand characteristics affect price dollarization. Sellers may set prices in dollars to avoid a rapid erosion of the real value of prices at the expense of experiencing a lower willingness to pay by buyers without dollar assets. We analyze the effects of changes in the inflation rate on the currency denomination of prices.

1. Introduction

In economies with a history of monetary instability, local currencies tend to coexist with a more stable currency (usually the US dollar) that fulfills some of the roles of money. The most common expression of this is the use of dollars as a store of value by denominating assets and liabilities in dollars. We show that dollars also coexist with local currencies when fulfilling the role of unit of account. In particular, we document a new fact by showing that in emerging economies, a significant fraction of prices in domestic markets are set in dollars. We argue that the use of dollars for setting domestic prices is related to the country's inflation rate and the dynamism of the goods market. This has relevant implications for the conduct of monetary and exchange rate policy.

We present new empirical facts regarding the degree of dollarization of prices in domestic markets of various Latin American economies. The data we analyze come from the largest e-trade platform in Latin America, and contain information on all active listings as of August 2017 for 10 Latin American economies, as well as historical information on all listings and transactions made in Argentina and Uruguay during the 2003-2012 period. Importantly, both datasets include information on the currency of denomination of prices. The data show that on average, 19% of goods available for sale are priced in dollars. This figure masks significant heterogeneity across countries and across goods: more expensive goods are more likely to be priced in dollars.

We first study the cross-sectional relationship between unit price values and the likelihood of those prices being set in dollars. We show that this relationship is increasing. While goods in the bottom quartile of the price distribution are almost exclusively priced in the domestic currency, high levels of dollarization are observed for goods in the top quartile of the price distribution. This fact is generalized across countries. We then focus on the cases of Argentina and Uruguay, for which we have better and more data, and show that this fact is robust to grouping the data in various dimensions. In particular, we still observe that more expensive goods are more likely to be posted in dollars when we focus on sellers of similar sizes, when we analyze data from different years, and when we restrict our analysis to goods of the same type.

These new facts can have relevant implications for the conduct of exchange rate policy. The heterogeneous patterns of price dollarization, coupled with the fact that prices tend to be sticky, can give rise to differential degrees of pass-through of exchange rate shocks to prices. Our empirical findings also have implications for theory, by stressing the usefulness of

incorporating prices in multiple currencies in domestic markets into existing open-economy models.

We also present two additional facts regarding the market for goods, which we later use in the quantitative analysis of our theory. First, we document that in the online platform, transactions do not occur immediately; the average time to sell is close to a month. Second, we show that more expensive goods are more likely to be bought by buyers that have easier access to dollars (as defined by having a higher probability of holding liquid assets in dollars). To show this last fact, we make use of two household surveys from Uruguay that contain micro-data on households' consumption patterns and on households' balance sheets broken down by currency denomination of assets and liabilities. We first show that wealthier households tend to purchase more expensive goods. Second, we show that wealthier households have a higher probability of holding liquid assets (cash and/or bank accounts) in dollars.

Motivated by our empirical evidence, we then formulate a model of price setting in multiple currencies that is designed to explain our cross-sectional facts. Our model focuses on how demand-side characteristics and the inflation rate can affect price dollarization. We do not consider supply-side and aggregate risk considerations that might affect the currency choice of prices, since these are already well understood from previous studies (see, for example, Engel, 2006; Gopinath et al., 2010).

A key ingredient of the model is the presence of search frictions, which allows the model to speak meaningfully about markets in which goods remain unsold for a certain period of time. The model is based on the sticker-price model of Diamond (1993) and enhanced by the possibility of setting prices in a domestic or foreign currency. We also extend the model to include heterogeneous buyers that differ in the ease with which they can acquire foreign currency (dollars) to purchase goods. This additional feature helps us to address some of the facts documented in our empirical section.

When choosing the currency in which to set prices, firms face a trade-off. If they price in local currency, the real value of that price decays faster, since inflation in local currency is higher than in foreign currency (a valid assumption in all countries for which we have data). If they price in foreign currency, the buyers' willingness to pay is lower, since some of them do not have foreign currency readily available and will incur a transaction cost associated with exchanging currency before purchasing the good. The relative importance of this trade-off differs for each seller, depending on the characteristics of the market in which they sell.

Pricing in foreign currency is more attractive for sellers in markets in which there are more buyers with easy access to foreign currency. These buyers do not need to pay the transaction cost to acquire goods with foreign currency, and hence have the same willingness to pay for goods in both currencies. If markets trading more valuable goods tend to be markets with a higher share of buyers with easy access to foreign currency, then our model predicts that this is one reason more expensive goods are more likely to be priced in foreign currency. Setting prices in foreign currency is also more attractive for sellers that operate in markets that take more time to sell because the relative value of preventing a fast decay rate in the real value of prices is higher for goods that take longer to sell.

We then quantify our model by calibrating it to match the Uruguayan economy in 2012. This is the economy with the best data availability, with both price and transaction data from the online platform, as well as data from households' consumption patterns and access to dollars from different surveys. An important data input for the model is a significantly higher inflation rate in domestic currency than in dollars: annual inflation in Uruguay in 2012 was four times higher than in the US. The calibration strategy targets the average level of dollarization of prices and other unconditional moments of the joint distribution of prices, time to sell of goods, and buyers' access to dollars (measured as a data estimate of the probability of buyers holding liquid assets in dollars).

The model predicts that more expensive goods are more likely to be priced in dollars. Quantitatively, the model is able to explain a large fraction of the heterogeneity of price dollarization. While the share of prices in dollars is around 10% in the model and 4% in the data for the cheapest quartile of prices, this share is 30% in the model and 41% in the data for the most expensive quartile of prices. Both in the model and in the data, this relationship is exponential. In the model, the prediction that more expensive goods are more likely to be priced in dollars is mostly due to a calibrated positive covariance between the valuation of the good and the share of buyers with easy access to dollars. This moment is, in turn, identified by the observed positive correlation between prices and the probability of buyers holding liquid assets in dollars.

Finally, we perform a counterfactual exercise to analyze the effects of changes in the domestic inflation rate on the share of prices denominated in dollars. We simulate data from a model economy that features a higher domestic inflation rate (consistent with that observed in Uruguay in 2003-04), leaving all remaining parameters from the calibration unchanged, and analyze the patterns of currency choice of prices. Consistent with observed data for

Uruguay in 2003-04, in the high-inflation economy the share of prices in dollars (both in the model and in the data) is higher than in the baseline low-inflation economy. The reason is that certain sellers have more incentives to set their prices in dollars to avoid a rapid erosion of the real value of their posted prices.

Our paper is related to the literature that studies currency choice of prices and the literature that studies price setting in markets with search frictions.

A significant amount of research has analyzed the effects of the currency denomination of prices in international markets (see Burstein and Gopinath, 2014, for a survey of the literature). Theoretical literature has primarily examined the determinants of firms' currency choices in setting international prices and its implications for exchange rate policy (Engel, 2006; Devereux and Engel, 2003; Devereux et al., 2004; Bacchetta and van Wincoop, 2005), while empirical studies have analyzed the determinants of the currency invoicing in international trade and the impact of nominal exchange rate movements on output (Goldberg and Tille, 2008; Gopinath et al., 2010; Cravino, 2014; Gopinath et al., 2020). However, little attention has been given to currency choice when setting prices in domestic markets in emerging economies. Drenik and Perez (2021) provides aggregate facts regarding price dollarization in domestic markets and shows how pass-through of exchange rate movements to domestic prices and quantities depends on currency of invoicing. This paper contributes to the literature by analyzing how demand-side factors can account for the heterogeneous price dollarization in domestic markets. Additionally, our research contributes to the literature on financial dollarization in emerging economies (see Barro and Gordon, 1983; Uribe, 1997; Alesina and Barro, 2002; Gale and Vives, 2002; Ize and Levy Yeyati, 2003; Calvo et al., 2006; Arellano and Heathcote, 2010; Drenik et al., 2022), by examining the endogenous presence of price dollarization, which is an understudied feature of dollarization.

Our paper also contributes to the literature that studies price setting in markets with search frictions. Following the early contributions of Diamond (1971), Burdett and Judd (1983), and Benabou (1988), an important strand of the literature has developed models with search frictions of goods markets to study certain features of price setting that standard models of centralized markets have difficulty accounting for. Some examples include the study of nominal rigidities (Head et al., 2012), price dispersion (Kaplan et al., 2016), shopping behavior and unemployment (Kaplan and Menzio, 2016), and deviations from the law of one price in international prices (Alessandria, 2004). The two papers that are most closely related to ours in terms of the theoretical framework are Diamond (1993) and Burdett and Menzio

(2017). Burdett and Menzio (2017) develop a theory of price setting with search frictions and menu costs and show that even in the presence of menu costs, search frictions are important in accounting for certain features of the data. Diamond (1993) studies price-setting in a context in which the price is attached to individual goods. Our theory builds on Diamond (1993) and extends it to include currency choice of prices and heterogeneous buyers in terms of their access to foreign currency.

The paper proceeds as follows. Section 2 describes the data and documents the main stylized facts regarding the currency choice of prices. Section 3 presents and solves a model of price setting with currency choice and analyzes its quantitative properties, and Section 4 concludes.

2. Empirical Facts about Price Dollarization

2.1. *Data Description and Representativeness*

In our empirical analysis, we use multiple sources of data. The primary dataset is obtained from Mercado Libre (www.mercadolibre.com), the largest e-commerce platform in Latin America, which has been operating since 1999 and currently serves over 190 million users across 18 countries. Mercado Libre's platform provides a diverse array of goods for sale, with a particular focus on durable items, and has recently expanded to include ads for real estate and vehicles.[1] Sellers post listings for goods that include a title, picture, detailed description, selling price, and other relevant features. Buyers can browse listings by searching by name or navigating through a category tree. Most transactions are conducted electronically using credit or debit cards.[2] For a more comprehensive explanation of these data refer to Drenik and Perez (2021).

Data from this platform are divided into two sub-datasets. The first and more complete dataset contains information about all the listings and transactions of goods made in Argentina and Uruguay during the 2003-2012 period. Data regarding listings contain all information available at the moment the seller posted the good on the platform. Some of the observed characteristics of a listing are: a description of the product, its posted price

---

[1]Real estate and vehicles are not actually transacted on the platform. Instead, listings for real estate and vehicles provide information about the property or vehicle and the contact details of the seller.

[2]The platform allows buyers to pay in local currency for goods with prices denominated in dollars. However, the exchange rate that the platform uses to convert the price into local currency includes a bid-ask spread that is the same as the one buyers would obtain if they exchanged currency in financial institutions and then pay for the good in the platform with dollars.

and currency denomination, the product category, the type of product (new or used), the quantities available for sale, a seller identifier, and the start and end date of the listing. Our analysis focuses on the currency of denomination of posted prices, which is chosen by the seller. The platform allows prices to be set in either local currency or US dollars. Data regarding transactions contain information related to each transaction associated with a listing: the date of purchase, buyer and seller identifiers, and the transacted price and quantity. Our main analysis uses this dataset and focuses on listings of new products (i.e., never before used) that had transactions associated with them. The analysis is carried out using transacted prices (although results are virtually the same when using posted prices). We also clean the data in various dimensions to make it suitable for analysis. We provide details of the cleaning procedure in Online Appendix A. Once cleaned, our entire dataset contains more than 13 million listings and around 37 million transactions in both countries during the 2003-2012 period.

The second dataset from this platform contains information on all active listings as of August 2017 for Argentina, Bolivia, Costa Rica, the Dominican Republic, Guatemala, Mexico, Nicaragua, Paraguay, Peru, and Uruguay.[3] This dataset includes information about listings of goods as well as listings of real estate and vehicles. These data allow us to generalize our analysis in terms of coverage of countries and types of goods. This second dataset includes information on approximately 20 million listings. Due to the nature of this dataset, its analysis is based on posted prices.

We also make use of two household surveys from Uruguay to analyze data on buyers' consumption patterns and access to dollars. The first survey is the Uruguayan households consumption survey (*Encuesta Nacional de Gastos e Ingresos de los Hogares*), which is similar to the Consumer Expenditure Survey in the US. This survey was conducted in 2005-2006 and contains detailed information on consumption at the good level for a representative sample of households. We use this dataset to analyze demand and consumption patterns and compare it to the main dataset to assess the representativeness of the latter. The second survey is the Uruguayan households financial survey (*Encuesta Financiera de los Hogares Uruguayos*), which is similar to the Survey of Consumer Finances in the US. This survey was conducted in 2012-2013, and contains information on households' balance sheets. One

---

[3]We also have data for Brazil, Colombia, Chile, Ecuador, El Salvador, Panama, and Venezuela. We do not include these countries in the analysis because: (1) dollar pricing is not available as a choice in the platform for Brazil, Chile, Colombia, and Venezuela, and (2) Ecuador, El Salvador, and Panama are fully dollarized economies.

of the salient features of this survey is that it contains information on households' holdings of assets and liabilities, both in domestic and foreign currencies. From this survey, we obtain measures of households' holdings of liquid assets denominated in dollars and measures of households' income. We merge the information in these two surveys through an imputation procedure based on households' income in order to jointly analyze consumption patterns and households' likelihood of holding of liquid assets denominated in dollars. We provide a detailed description of these datasets and the merging procedure in Online Appendix A.

Representativeness Analysis–In Online Appendix B, we assess how representative the goods listed on the online platform are of the aggregate economy in Uruguay. First, we analyze the relevance of goods that are available for sale on the platform in the representative consumption basket of Uruguayan households. We do this by comparing data from the online platform with representative data from the consumption survey. We find that the online platform has broad and relevant coverage. Goods that are traded on the platform account for 31% of the total consumption basket. However, goods traded on the platform are heavily concentrated in certain categories of the consumption basket such as apparel, furniture, and home appliances. On the other hand, other relevant consumption categories, such as food and services, are not offered on the platform.

Second, we use data from the financial survey to analyze the economic and demographic characteristics of potential users of the online platform in Uruguay (as measured by those who either use the internet or use the internet for shopping purposes). We find that potential users of the platform tend to be wealthier, more educated, and with more liquid assets in dollars than the average population.

2.2. *Price Dollarization in the Data*

Cross-sectional Aspects of Price Dollarization As documented in Drenik and Perez (2021), in a large number of countries, a significant share of prices are set in dollars: The average share of prices in dollars is 19% for goods, 27% for vehicles, and 54% for real estate. However, there is significant heterogeneity in the share of prices set in dollars across goods, which is the novel focus of this paper. We document this using the main dataset of listings and transactions from Uruguay and Argentina for the period 2003-2012. First, we analyze whether the currency of denomination of prices differs with the value of the unit price of goods.[4] For

---

[4]In order for the unit price of a good to have a well-defined meaning, we focus our analysis on those listings that have a good offered for sale that is indivisible. We describe the data-cleaning procedure by which we remove listings of goods that are divisible in Online Appendix A.

this, we compute the real value of unit prices measured in a common currency, order listings from lower to higher prices and then split them into ten bins of equal frequency. While the average price in the lowest price decile is US\$3.5, the average price for goods in the highest decile is US\$480 (see Online Appendix A for more details about the types of goods included in each price decile). Finally, we compute the fraction of goods with a price set in dollars within each price decile.

Results are presented in Figure 1, which shows the share of prices posted in dollars on the vertical axis as a function of the price decile on the horizontal axis. More expensive goods are more likely to be denominated in dollars than cheaper goods. In both countries, the fraction of prices set in dollars is negligible for very cheap goods. On the other side of the price distribution, the share of prices set in dollars is around 38% and 67% in the top two deciles in Argentina and Uruguay, respectively. We also present a regression version of Figure 1 in Online Appendix C, where we also test the null hypothesis of no difference across all price deciles (this type of statistical analysis is also carried out for other figures included in this section). We repeat the previous analysis for the remaining countries with data on active listings of goods on the platform as of August 2017. Results are shown in Figure C.1 in Online Appendix C. Despite the presence of significant cross-country differences in average levels of price dollarization, the same pattern emerges in all eight economies, suggesting that our main finding is generalized across countries.

In Online Appendix C we argue that this fact is robust to grouping listings by broad types of goods, by year, or by type of seller. First, we show that the same pattern emerges if we split the sample according to different category groups and if we consider used goods.[5][6]

---

[5]The platform allows the seller to categorize the good being sold according to a pre-specified set of choices. Each product is placed within a category tree that has five levels, which go from a broader to a more specific classification. We repeat our analysis by grouping goods according to the broadest level, which includes product types such as computers, books, and health/beauty goods.

[6]In Drenik and Perez (2021), we showed that goods that are more tradeable are more likely to be denominated in dollars. One could argue that the reason more expensive goods are more likely to be sold in dollars may be due to the fact that more expensive goods tend to be imported. To test this, we conduct a variance decomposition analysis of the variation in the currency choice of prices by estimating $dollar_{p,tr}^{i} = \alpha_p + \beta_{tr} + \varepsilon_{p,tr}^{i}$, where $dollar_{p,tr}^{i}$ is a dummy that equals one if the price of good i in price decile p and tradeability decile tr is in dollars and zero if it is in local currency, α_p is a price decile fixed effect, β_{tr} is a tradeability decile fixed effect, and $\varepsilon_{p,tr}^{i}$ is an error term. Price decile fixed effects explain 11% (resp. 15%) of the variation in the currency choice of prices in Argentina (resp. Uruguay), compared to 8% (resp. 10%) explained by tradeability deciles fixed effects. Thus, a significant fraction of the observed variation in the currency of

FIGURE 1. Price Dollarization and Transacted Prices
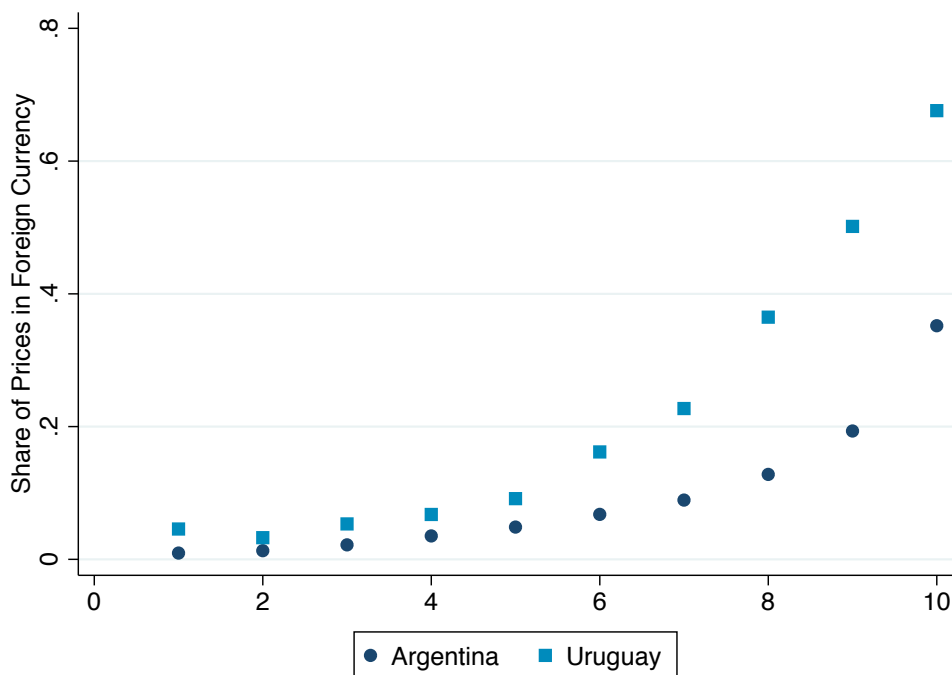
Notes: The figure shows the share of transacted prices (measured in real terms) set in dollars in Argentina and Uruguay, by decile of the transacted price distribution. Data correspond to listings of new goods that ended up being sold.

Second, we show that the same pattern holds for both countries in every year of the sample. Third, we show that the pattern is robust to splitting the sample into listings created by big, small, and one-time sellers.

Finally, we document that the same pattern holds in the real estate market. As we show in Figure C.8 in Online Appendix C, more expensive units are more likely to be priced in dollars. This fact holds for units available for sale and for rent. The highest degree of price dollarization is observed in units for sale, which usually take several months to get sold.[7] We also observe high degrees of price dollarization in expensive units available for vacation rentals. These units are usually catered to international tourists, who have easier access to dollars.

---

prices is correlated with the value of the unit price, even after controlling for the degree of tradeability of goods.

[7]The average time that a unit is available for sale ranges between four and six months in Argentina (see, for example, *Clarin, December 16, 2016*).

Price Stickiness by Currency–Even though we do not directly observe changes in posted prices in our dataset, we can infer them. We do so by comparing the transacted price with the previous reference price, which can be one of the following: (1) the original posted price, in the case of the first transaction associated with the listing, or (2) the price of the previous transaction associated with the same listing, for all subsequent transactions. If the transacted price and the previous reference price differ, we can infer that there was a price change somewhere in between the time of the current and previous transaction.[8] The degree of price stickiness in our dataset is high. The share of listings that had at least one transaction with a price that was different from the previous reference price is 5.2%. We also compute this share for different subsamples: by currency of denomination of prices and by goods categories. We find that prices in local currency are less sticky than prices in dollars. In particular, in 12 of 19 goods categories, the share of listings with at least one price change is higher for listings with prices in local currency than for those with prices in dollars (see Table C2 in Online Appendix C).

2.3. *Additional Market Features*

In this section we analyze two additional market features that will be relevant when we develop a theory to understand the determinants of price dollarization. In particular, we study the relationship between prices of goods and the time it takes to sell them and the relationship between prices of goods and the characteristics of the buyers of these goods in terms of their holdings of dollars.

From the main dataset, we can compute the time it takes to sell a good on the platform. We define time to sell as the number of days that elapse between the day of the original listing and the transaction day for each unit sold. Figure 2 shows the average time to sell of goods for each price decile. The first observation is that it takes between 3 and 5 weeks on average to sell a good. Second, we also observe an increasing pattern between time to sell and the value of unit prices. However, the slope of this relationship is quantitatively small. For example, in Argentina in 2012 it takes 25 days on average for the goods in the cheapest decile to be sold. On the other hand, the average time to sell for prices in the most expensive decile is 31 days. Therefore, the most important take-away is that transactions do not occur immediately; the average time to sell is close to a month.

---

[8]Identifying price changes in this way serves as a lower bound of the actual number of price changes and as an upper bound of the actual elapsed time between price changes.

FIGURE 2. Time to Sell and Transacted Prices
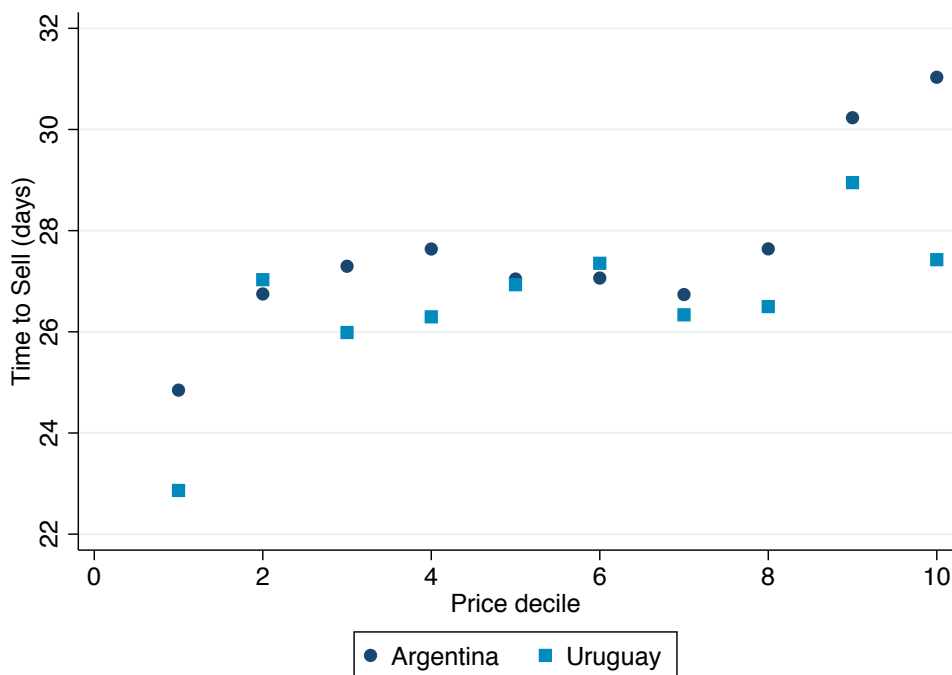
Notes: The figure shows the number of days it takes the average good to be sold in Argentina and Uruguay, by decile of the transacted price distribution. Data correspond to listings of new goods that ended up being sold.

Using micro-data from the two household surveys from Uruguay, we estimate a relationship between prices paid for goods and the probability that the buyers who made those purchases had holdings of liquid assets in dollars. To do this, we construct two datasets and merge them. First, we use the consumption survey to construct a dataset at the transaction level that contains information on prices paid for goods and the monthly income of the household that purchased them. These data show that wealthier households tend to purchase goods with higher unit prices. Second, we use the financial survey to construct another dataset that contains information on households' monthly income and on whether the household has cash in dollars and/or a bank account denominated in dollars. These data show that wealthier people are more likely to have liquid assets denominated in dollars, and hence easier access to dollars when purchasing goods. For example, while the fraction of households with liquid assets in dollars is close to zero among the poorest households, more than 30% of households in the top decile of the income distribution have some type of liquid asset in dollars.

We then merge the datasets to assign to each transacted price in the consumption survey an estimate of the probability of the buyer of that good having liquid assets in dollars. The merging procedure is done through households' income, which is the variable that is common to both datasets. We document these facts and provide a detailed description of the merging procedure in Online Appendix A. We then estimate non parametrically (with a local linear regression) the relationship between the transacted price of a good and the probability of its buyer having liquid assets in dollars. The results, shown in Figure 3, demonstrate that more expensive goods are more likely to be purchased by households that have liquid assets in dollars. The positive relationship is quantitatively important. For example, a good with a price of 5 dollars (which corresponds to the average price in the first decile of prices in the online platform) has an associated probability of its buyer having liquid assets in dollars of 12%, whereas a good priced at 450 dollars (the average price at the top decile in the online platform) has an associated probability of its buyer having liquid assets in dollars of 20%. For the most expensive goods sold on the platform (for example, a laptop with a unit price close to US$1,000), this probability increases to 35%.

Finally, we also show that the dollar, in addition to being used as a unit of account, is also used as a means of payment in Uruguay. In Online Appendix C, we use summary data provided by the Central Bank of Uruguay on the retail payment system, and show that 11% of the volume of transactions with credit cards correspond to dollar transactions. This figure increases to 19% for ATM extractions and 13% for mobile payments. With the caveat that average transacted amounts do not correspond to the value of unit prices of goods, average transaction amounts tend to be larger for transactions made in dollars than for those made in pesos: US$198 in dollars vs US$38 in pesos for credit card transactions, US$228 in dollars vs US$80 in pesos for mobile payments, and US$401 in dollars vs US$171 in pesos for local ATM extractions. This evidence is consistent with the fact that more expensive goods are purchased by households that are more likely to have some liquid asset in dollars (and use those dollars to pay for these more expensive goods).

3. A Search Model of Pricing in Multiple Currencies

In this section, we formulate and quantify a search model of pricing in multiple currencies aimed at describing the trade-offs associated with the currency choice of prices. Our model focuses on demand-side features as determinants of the optimal currency choice and rationalizes why more expensive goods are more likely to be priced in dollars, in a context

FIGURE 3. Transaction Prices and Households' Holdings of Liquid Assets in Dollars
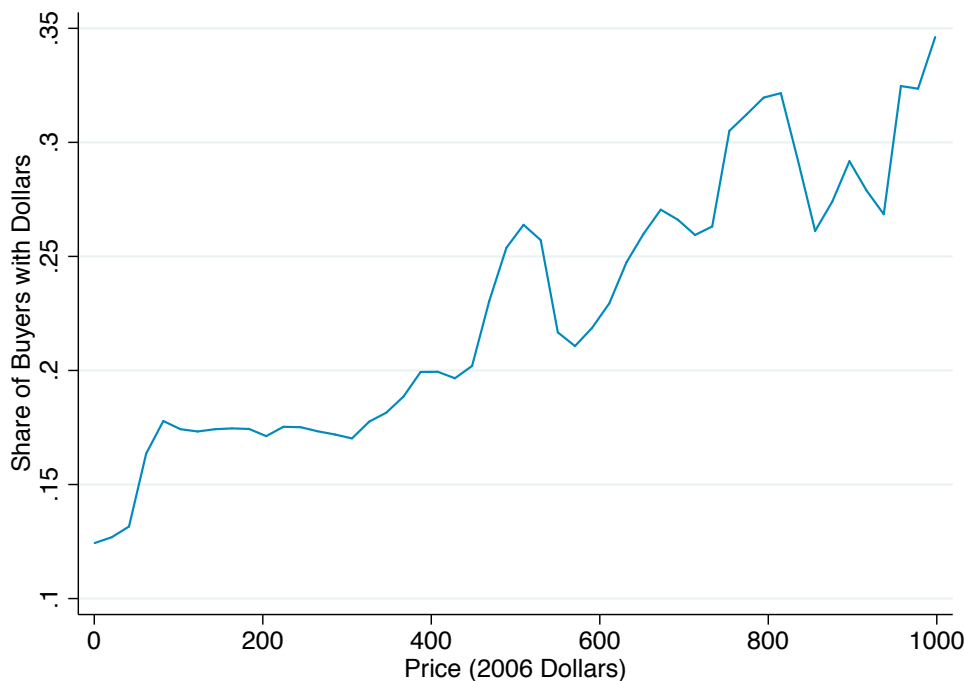
Notes: This figure shows the average probability of buyers having liquid assets denominated in dollars as a function of transaction prices. This relationship has been estimated using data from the consumption and financial surveys in Uruguay. See Online Appendix A for more details on how this relationship was estimated.

in which goods take time to sell and buyers have heterogeneous holdings of liquid assets in foreign currency, as previously documented. For tractability reasons, we do not consider supply-side and aggregate risk considerations that might affect the currency choice of prices. For models that study these channels see, for example, Engel (2006) and Gopinath et al. (2010).

3.1. *Theoretical Framework*

We model a market with search frictions and heterogeneous consumers, in which firms optimally choose the currency of their prices. Our model is based on the 'sticker price model' of Diamond (1993). We introduce search frictions, since they better characterize the market we analyze in our empirical section. In the online platform, sellers post a price and transactions occur only after a consumer searches for the post and agrees to buy, thereby

requiring some time to sell goods.[9] In addition, since we are interested in studying the link between currency choice and demand characteristics, we model heterogeneous consumers that differ in their holdings of foreign currency.

We also depart from the most common ways of modeling price stickiness (e.g. menu costs or Calvo pricing) and assume prices are attached to individual goods.[10] Firms face no cost of setting prices when posting goods for sale. The source of price stickiness comes from the fact that it is costly for firms to change the price once the good is already available for sale.

Buyers–There is a continuum of buyers of endogenous mass B. The utility of buyers is linear in real wealth available to spend on goods and discounted at the real interest rate r. Real wealth grows at the rate r. Buyers receive a utility u whenever they purchase and consume the good. The market features search frictions. Buyers meet sellers randomly, following a Poisson process with arrival rate $p(\theta)$, which we describe later. Once the buyer and the seller meet, the buyer observes the price and the currency of denomination of the price, which can be expressed in local or foreign currency. If a transaction occurs, the buyer must pay the posted price in the currency in which the price is posted.

Buyers differ in their holdings of foreign currency. An endogenous fraction $1 - \Lambda$ of buyers has all their wealth denominated in local currency. We denote these buyers as buyers of type $i = 1$. When these buyers pay for the good in foreign currency they first need to acquire foreign currency. To do so, they need to pay a proportional transaction cost $\kappa > 0$ (expressed in real terms) associated with the exchange of currency. The remaining fraction Λ of buyers has both local and foreign currency ready to use when purchasing the good. These buyers do not have to incur in any transaction cost when buying the good in either currency. We denote these buyers as buyers of type $i = 2$.

We can express the value of searching for a buyer of type $i = \{1, 2\}$ recursively as

$$V_i^w = \mathbb{E}_\tau \left[e^{-r\tau} \left(f \int \max \{u - s(1 + \kappa_i), V_i^w\} \, \mathrm{d}G_F(s) + (1 - f) \int \max \{u - s, V_i^w\} \, \mathrm{d}G_D(s) \right) \right],$$

(1)

---

[9]Searching behavior from buyers in online markets has been documented in De los Santos et al. (2012). Additionally, the use of search-theoretic frameworks to study the dynamics of online markets has been widely used in the industrial organization literature (see, for example, Ellison and Ellison (2009) and Dinerstein et al. (forthcoming)).

[10]This assumption captures well the way the online platform works. In the platform, each listing from a seller has associated a limited number of goods available for sale.

where f is the fraction of goods posted in foreign currency in the market, $\kappa_1 = \kappa > 0 = \kappa_2$, and $G_D(s)$ and $G_F(s)$ denote the distributions of real prices posted in domestic and foreign currency, respectively. We use subscripts $c \in \{F, D\}$ to denote the currency of denomination of prices, which can be foreign currency (F) or domestic currency (D). The expectation is taken with respect to τ, the time until the first meeting with a seller.

Conditional on a meeting, the buyer's optimal choice of which transactions to accept involves reservation prices in foreign currency $p_{i,F}$ and in domestic currency $p_{i,D}$, which are given by

$$p_{i,D} = u - V_i^w, \tag{2}$$

$$p_{i,F} = \frac{u - V_i^w}{1 + \kappa_i}, \tag{3}$$

for $i \in \{1, 2\}$. Thus, buyers of type i buy the good if the observed price in currency c is lower than the corresponding reservation price (i.e., $p \leq p_{i,D}$). We can compare the reservation prices of different buyers. Buyers of type 2 do not have to pay the transaction cost to buy a good that is denominated in foreign currency. Hence, they are willing to pay a higher price in real terms than buyers of type 1. On the other hand, when facing a buying opportunity in domestic currency, buyers of type 1 have a higher willingness to pay, since they know that if they do not buy now the next buying opportunity may be in foreign currency, in which case they will have to pay the transaction cost. We formalize these results in the following proposition. All proofs can be found in Online Appendix D.

PROPOSITION 1. *In any equilibrium, type 2 buyers have higher willingness to pay in foreign currency ($p_{2,F} \geq p_{1,F}$) and lower willingness to pay in domestic currency ($p_{2,D} \leq p_{1,D}$) than type 1 buyers.*

Given this cutoff strategy, we can solve the integrals found in equation (1) using integration by parts and the definition of reservation prices:

$$\int \max \{u - s, V_i^w\} \, \mathrm{d}G_D(s) = V_i^w + \int_0^{p_{i,D}} G_D(p) \mathrm{d}p$$

and

$$\int \max \{u - s(1 + \kappa_i), V_i^w\} \, \mathrm{d}G_F(s) = V_i^w + \int_0^{p_{i,F}} G_F(p) \mathrm{d}p$$

for $i \in \{1, 2\}$. These equations state that the extra surplus for the buyer depends on the curvature of the distribution of prices. If prices decay quickly ($G_c(p)$ is concave), then the buyer faces transaction opportunities with lower prices on average, and hence obtains more

surplus from buying that good. Replacing these expressions into equation (1) and solving for V_i^w we obtain

$$V_i^w = \frac{p(\theta)}{r}\left[f\int_0^{p_{i,F}}G_F(p)\mathrm{d}p + (1-f)\int_0^{p_{i,D}}G_D(p)\mathrm{d}p\right].\tag{4}$$

A continuous flow of exogenous size b of new buyers enter into the market at each instant. Of these new entrants an exogenous fraction λ are of type 2. In a stationary equilibrium the mass of buyers of each type is constant, implying that the entry of buyers equals the exit of buyers of each type. Inflows of buyers for types 1 and 2 are given by $b(1-\lambda)$ and $b\lambda$, respectively. Outflows of buyers of type 1 are given by $B(1-\Lambda)p(\theta)(fG_F(p_{1,F}) + (1-f)G_D(p_{1,D}))$, which is the measure of buyers that meet a good with a real price that is lower than their reservation price in the relevant currency. Similarly, outflows of buyers of type 2 are given by $B\Lambda p(\theta)(fG_F(p_{2,F}) + (1-f)G_D(p_{2,D}))$. As we argue below, sellers will never set real prices above the maximum reservation price in each currency. This implies that $G_F(p_{2,F}) = G_D(p_{1,D}) = 1$. Equating outflows and inflows for each type of buyers yields

$$B\Lambda p(\theta)(f + (1-f)G_D(p_{2,D})) = b\lambda$$

and

$$B(1-\Lambda)p(\theta)(fG_F(p_{1,F}) + (1-f)) = b(1-\lambda).$$

Solving for the measure of buyers and its composition we obtain

$$\Lambda = \frac{\lambda\left(fG_F(p_{1,F}) + (1-f)\right))}{\lambda\left(fG_F(p_{1,F}) + (1-f)\right)) + (1-\lambda)\left(f + (1-f)G_D(p_{2,D})\right)}\tag{5}$$

and

$$B = \frac{b}{p(\theta)\left[(1-\Lambda)\left(fG_F(p_{1,F}) + (1-f)\right)) + \Lambda\left(f + (1-f)G_D(p_{2,D})\right)\right]}.\tag{6}$$

Sellers–The market is also populated by a continuum of sellers of size $S = 1$. Sellers can produce the good at a constant marginal cost which we normalize to zero. This normalization is without loss of generality because at the time the seller chooses the price, the good has already been produced. Sellers post a good for sale and choose its nominal price, which can be denominated either in domestic or foreign currency. We assume this price cannot be changed after it is set. The implicit assumption is that there is a sticker cost of changing

the price that is sufficiently high that dissuades sellers from revising prices.[11] Sellers exit the market after their good is sold and are replaced by new entrants.

Sellers discount real profits at the real interest rate r and meet buyers at an instantaneous rate $q(\theta)$, which is described later. We assume that the real value of nominal prices in domestic currency decreases at the rate $\pi_D > 0$. Similarly, the real value of nominal prices in foreign currency decreases at the rate π_F with $0 < \pi_F < \pi_D$. Our working assumption is that the inflation rate is higher for the domestic economy than for the foreign country (in this case the US).[12] The problem of the seller is given by

$$\max_{c \in \{D,F\}, p_c} \mathbb{E}_t \left[p_c e^{-i_c t} \right],$$

where $i_c = r + \pi_c$ is the nominal interest rate in currency c, and t is the time until the transaction occurs, which follows a Poisson process with time-varying intensity $\gamma_c(p,t)$ given by

$$\gamma_D(p,t) = \begin{cases} q(\theta) & \text{if } pe^{-\pi_D t} \leq p_{2,D} \\ q(\theta)(1-\Lambda) & \text{if } p_{2,D} < pe^{-\pi_D t} \leq p_{1,D} \\ 0 & \text{if } p_{1,D} < pe^{-\pi_D t} \end{cases}, \qquad \gamma_F(p,t) = \begin{cases} q(\theta) & \text{if } pe^{-\pi_F t} \leq p_{1,F} \\ q(\theta)\Lambda & \text{if } p_{1,F} < pe^{-\pi_F t} \leq p_{2,F} \\ 0 & \text{if } p_{2,F} < pe^{-\pi_F t} \end{cases}.$$

Seller's revenues in currency c depend positively on the meeting rate $\gamma_c(p,t)$ and negatively on the rate of inflation π_c. If the meeting rate is high given an inflation rate, then the expected price erosion is lower. Similarly, given a meeting rate, a higher inflation rate translates into higher expected price erosion.

The seller's arrival rate of transaction opportunities depend on the real posted price for the following reason. If the seller's real price is below the lowest reservation price in currency c, the probability of a transaction occurring conditional on a meeting is equal to one. Hence, the transaction rate is equal to the meeting rate. If the seller's real price is in between the reservation prices, then the seller needs to either wait to meet a buyer with a high reservation price in that currency or wait until inflation erodes the real price of the good so much that buyers with a low reservation price are willing to purchase it. Therefore, the transaction rate is equal to the meeting rate times the probability of meeting a buyer with a high reservation price in a given currency. Finally, if the seller's real price is above the highest reservation

---

[11]This is assumption is motivated by the small fraction of price changes observed in our dataset. The main trade-offs would not be affected by the introduction of a low cost that allows for price changes in equilibrium.

[12]We take inflation rates as primitives in our model. These could be micro-founded by analyzing economies with different growth rates of money. See Lagos and Wright (2005) for an example of such micro-foundations based on the presence of decentralized markets.

price, the arrival rate of transaction opportunities for a seller is zero, since no buyer will decide to purchase the good.

When analyzing sellers' pricing decisions we can rule out some choices. First, no seller is willing to set a price in a given currency higher than the maximum reservation price of buyers in that currency. If it does, the seller faces a zero probability of selling for some interval of time, which is costly due to discounting. Similarly, no seller sets a price below the minimum reservation price of buyers. The reason is that the seller setting the lowest price can increase it without losing any transactions. Finally, given our assumption of two types of buyers, sellers will not post any price between the minimum and maximum reservation price. If a seller did set such a price, then it could increase profits either by choosing the high reservation price and without losing customers initially, or by choosing the low reservation price and attracting all customers with the initial posted price. We collect these results in the following proposition.

PROPOSITION **2.** *The optimal posted price of sellers is one of the reservation prices of buyers,* $p_c \in \{p_{1,c}, p_{2,c}\}.$

This results implies that the distribution of initial prices can have at most four prices corresponding to buyers' reservation prices $(p_{1,F}, p_{2,F}, p_{1,D}, p_{2,D})$. Once we narrow down the choices of the seller, we can compute the value associated with pricing at each of these four reservation prices. The seller's values of posting $p_{1,F}$ and $p_{2,D}$ are given by

$$W_{1,F} = p_{1,F} \frac{q(\theta)}{q(\theta) + r + \pi_F} \tag{7}$$

and

$$W_{2,D} = p_{2,D} \frac{q(\theta)}{q(\theta) + r + \pi_D}, \tag{8}$$

respectively. The value of setting the high reservation price in foreign currency $p_{2,F}$ is given by

$$W_{2,F} = p_{2,F} \left(\left(1 - e^{-(i_F + q(\theta)\Lambda)T_F}\right) \frac{q(\theta)\Lambda}{q(\theta)\Lambda + i_F} + e^{-(i_F + q(\theta)\Lambda)T_F} \frac{q(\theta)}{q(\theta) + i_F} \right). \tag{9}$$

By posting the high reservation price in foreign currency $p_{2,F}$, the seller initially sells only to buyers of type 2 and the arrival rate of transactions is $q(\theta)\Lambda$. After a period of time of length $T_F = \log(p_{2,F}/p_{1,F})/\pi_F$, the real value of the price is lower than the reservation price of type 1 buyers and the good will be sold to any type of buyer. Hence, the arrival rate of transactions becomes $q(\theta)$ after T_F units of time. The value of setting the high reservation

price in domestic currency $p_{1,D}$ is given by

$$W_{1,D} = p_{1,D} \left(\left(1 - e^{-(i_D + q(\theta)(1-\Lambda))T_D}\right) \frac{q(\theta)(1-\Lambda)}{q(\theta)(1-\Lambda) + i_D} + e^{-(i_D + q(\theta)(1-\Lambda))T_D} \frac{q(\theta)}{q(\theta) + i_D} \right).$$
(10)

By posting the high reservation price in domestic currency $p_{1,D}$, the seller initially sells only to buyers of type 1. After a period of time of length $T_D = \log(p_{1,D}/p_{2,D})/\pi_D$, the good will be sold to any type of buyer.

Finally, the optimal choice of currency delivers the highest value to the seller:

$$W = \max\{W_{1,D}, W_{2,D}, W_{1,F}, W_{2,F}\}.$$

By setting the price in foreign currency, the seller avoids the quicker erosion of the real price due to lower foreign inflation. The cost of setting prices in foreign currency is that buyers of type 1 have a lower willingness to pay in that currency due to the transaction cost κ, i.e. $p_{1,F} < p_{1,D}$.

Equilibrium Distribution of Prices–Since sellers post goods at the reservation prices $p_{1,c}$ and $p_{2,c}$, with $c \in \{D, F\}$, the distribution of prices of newly posted goods in a given currency has at most two mass points at those two prices. However, the distribution of real posted prices has no mass points. The distribution of prices at any given point in time reflects the dynamics of inflation and transaction rates. We first analyze the distribution of foreign currency prices that prevail in a stationary equilibrium. In any arbitrary interval of time Δt, the mass of prices that enter a certain interval of prices $(0, s)$ (for some s) should equal the mass of prices that exit the same interval. These conditions are given by

$$G_F(se^{\pi_F \Delta t}) - G_F(s) = \left(1 - e^{-q(\theta)\Delta t}\right) G_F(s)$$
(11)

for all $s \in (0, p_{1,F})$, and

$$G_F(se^{\pi_F \Delta t}) - G_F(s) + \left[\left(1 - e^{-q(\theta)\Lambda \Delta t}\right) + \left(1 - e^{-q(\theta)(1-\Lambda)\Delta t}\right) G_F(p_{1,F})\right] x_F$$
$$= \left(1 - e^{-q(\theta)\Lambda \Delta t}\right) G_F(s) + \left(1 - e^{-q(\theta)(1-\Lambda)\Delta t}\right) G_F(p_{1,F})$$
(12)

for all $s \in [p_{1,F}, p_{2,F}]$. The left hand side in equations (11) and (12) corresponds to the flow of prices into the interval $(0, s)$. The inflow in equation (11) is given by the measure of sellers with prices between s and $se^{\pi_F \Delta t}$ that enter the interval $(0, s)$ due to inflation. The inflow in equation (12) includes the measure of sellers that enter the interval due to inflation, plus the measure of all sellers that exit due to a sale times the fraction x_F of new sellers that post the price $p_{1,F}$ (the remaining fraction $1 - x_F$ sets an initial price equal to $p_{2,F}$). The right hand

side in equation (11) is the flow of prices out of the interval $(0, s)$ for $s \in (0, p_{1,F})$, which is given by the measure of all buyers that meet sellers with prices below s during the interval of time Δt and purchase the good. Finally, the right hand side in equation (12) is the flow of prices out of the interval $(0, s)$ for $s \in [p_{1,F}, p_{2,F}]$, which is given by the measure of sellers that meet type 2 buyers and have real price below s, plus the measure of sellers that meet type 1 buyers and have real price below $p_{1,F}$.

Dividing both equations by Δt and taking the limit as $\Delta t \to 0$, yields the following differential equations that characterize the distribution $G_F(s)$:

$$g_F(s)s\pi_F = G_F(s)q(\theta), \qquad\qquad \forall s \in (0, p_{1,F})$$

$$g_F(s)s\pi_F + q(\theta)\left[\Lambda + (1-\Lambda)G_F(p_{1,F})\right]x_F = q(\theta)(1-\Lambda)G_F(p_{1,F}) + q(\theta)\Lambda G_F(s), \forall s \in [p_{1,F}, p_{2,F}].$$

The solutions of these differential equations are pinned down by the boundary conditions $G_F(p_{F,2}) = 1$ (no seller sets a price above the reservation price of buyers of type 2) and $G_F(p_{1,F}^-) = G_F(p_{1,F}^+)$ (the CDF $G_F(\cdot)$ is continuous at the price $p_{1,F}$). The resulting real price distribution is

$$G_F(s) = \begin{cases} s^{\frac{q(\theta)}{\pi_F}}\ell_0^F & \text{for } 0 < s < p_{1,F} \\ q_F - \frac{(1-q_F)(1-\Lambda)}{(1-q_F(1-\Lambda))}\left(q_F + \frac{1-q_F}{(1-q_F(1-\Lambda))(p_{2,F}/p_{1,F})^{q(\theta)\Lambda/\pi_F}-(1-q_F)(1-\Lambda)}\right) + s^{\frac{q(\theta)\Lambda}{\pi_F}}\ell_1^F & \text{for } p_{1,F} \le s \le p_{2,F} \end{cases}, \tag{13}$$

where the constants are given by

$$\ell_1^F = \frac{(1-q_F)}{(1-q_F(1-\Lambda))p_{2,F}^{q(\theta)\Lambda/\pi_F}-(1-q_F)(1-\Lambda)p_{1,F}^{q(\theta)\Lambda/\pi_F}}$$

and

$$\ell_0^F = \frac{\Lambda p_{1,F}^{-q(\theta)/\pi_F}}{(1-q_F(1-\Lambda))}\left(q_F + \frac{1-q_F}{(1-q_F(1-\Lambda))(p_{2,F}/p_{1,F})^{q(\theta)\Lambda/\pi_F}-(1-q_F)(1-\Lambda)}\right).$$

The distribution of real prices in domestic currency is derived using the same arguments, but noting that the low and high reservation prices are $p_{2,D}$ and $p_{1,D}$, respectively. The resulting distribution is given by

$$G_D(s) = \begin{cases} s^{\frac{q(\theta)}{\pi_D}}\ell_0^D & \text{for } 0 < s < p_{2,D} \\ q_D - \frac{(1-q_D)\Lambda}{(1-q_D\Lambda)}\left(q_D + \frac{1-q_D}{(1-q_D\Lambda)(p_{1,D}/p_{2,D})^{q(\theta)(1-\Lambda)/\pi_D}-(1-q_D)\Lambda}\right) + s^{\frac{q(\theta)(1-\Lambda)}{\pi_D}}\ell_1^D & \text{for } p_{2,D} \le s \le p_{1,D} \end{cases}, \tag{14}$$

where the constants are given by

$$\ell_1^D = \frac{(1 - q_D)}{(1 - q_D\Lambda)p_{1,D}^{q(\theta)(1-\Lambda)/\pi_D} - (1 - q_D)\Lambda p_{2,D}^{q(\theta)(1-\Lambda)/\pi_D}}$$

and

$$\ell_0^D = \frac{(1 - \Lambda)p_{2,D}^{-q(\theta)/\pi_D}}{(1 - q_D\Lambda)}\left(q_D + \frac{1 - q_D}{(1 - q_D\Lambda)(p_{1,D}/p_{2,D})^{q(\theta)(1-\Lambda)/\pi_D} - (1 - q_D)\Lambda}\right).$$

Matching Technology–There is a matching technology that determines the flow of matches as a continuously differentiable function of the stock of buyers and sellers, $m(S, B)$. We assume m has constant returns to scale and positive first derivatives. This allows us to characterize the meeting rates of buyers and sellers as functions of the market tightness $\theta = S/B$:

$$p(\theta) = \frac{m(S, B)}{B} = m(\theta, 1), \tag{15}$$

$$q(\theta) = \frac{m(S, B)}{S} = m(1, \theta^{-1}). \tag{16}$$

Having described the setup of the model, we are in a position to define a stationary equilibrium.

DEFINITION **1.** *A stationary equilibrium is given by:*

(1) *reservation prices (2), (3) and values of searching (4),*

(2) *seller's profits (7), (8), (9), and (10),*

(3) *cumulative distributions of prices (13) and (14),*

(4) *fraction of firms selling in foreign currency that post price $p_{1,F}$,*

$$x_F = \begin{cases} 1 & if \quad W_{1,F} > W_{2,F} \\ \in [0,1] & if \quad W_{1,F} = W_{2,F} \\ 0 & if \quad W_{1,F} < W_{2,F} \end{cases}$$

(5) *fraction of firms selling in domestic currency that post price $p_{2,D}$,*

$$x_D = \begin{cases} 1 & if \; W_{2,D} > W_{1,D} \\ \in [0,1] & if \; W_{2,D} = W_{1,D} \\ 0 & if \; W_{2,D} < W_{1,D} \end{cases}$$

(6) fraction of sellers that post price in foreign currency

$$
f = \begin{cases} 1 & \text{if } W_F > W_D \\ \in [0,1] & \text{if } W_F = W_D \\ 0 & \text{if } W_F < W_D \end{cases}
$$

where $W_c = \max\{W_{1,c}, W_{2,c}\}$,

(7) the measure of total buyers (6) and the share of type-2 buyers (5).

Equilibrium Currency Choices–In this subsection, we characterize the equilibrium sellers' choices of the currency of denomination of prices for a particular case of the model with only buyers of type 1, by setting $\lambda = 0$. This particular case allows us to make significant advances in characterizing the equilibrium, while at the same time keeping most of the relevant economic mechanisms.

When $\lambda = 0$, there is no buyer heterogeneity, so sellers will either set prices at $p_{1,F}$ or $p_{1,D}$. This implies that buyers purchase the first good they find. The meeting rate for sellers is given by $q(\theta) = b$. If the entry rate of buyers is higher, sellers will meet buyers more frequently. Using the expressions of reservation prices (2)-(3) and seller's profits (10) and (7), we obtain an expression for the optimal currency choice of the seller,

$$
f = \begin{cases} 0 & \text{if} \quad \frac{b+r+\pi_D}{b+r+\pi_F} < 1 + \kappa \\ x \in [0,1] & \text{if} \quad \frac{b+r+\pi_D}{b+r+\pi_F} = 1 + \kappa \\ 1 & \text{if} \quad \frac{b+r+\pi_D}{b+r+\pi_F} > 1 + \kappa. \end{cases} \tag{17}
$$

The optimal currency choice trades-off differential resilience to inflation of prices in different currencies and differential willingness to pay by buyers. By pricing in foreign currency, sellers can prevent a rapid decay of the real value of their prices, but face a lower initial willingness to pay by buyers due to the presence of the transaction cost.

One advantage of this simplified version of the model is that it allows us to easily characterize the optimal currency choice. First, if transaction costs are higher, then sellers are more likely to post their prices in domestic currency. A higher transaction cost reduces the initial willingness to pay of buyers and, thus, the average price in foreign currency that sellers can charge. Second, if inflation in domestic currency is higher, then sellers are more likely to post their prices in foreign currency. A higher inflation rate erodes more rapidly the real value of prices in domestic currency. This implies that the average price that buyers face is

lower, which makes pricing in foreign currency more attractive for sellers. By a symmetric argument, sellers are more likely to post their prices in domestic currency when inflation in foreign currency is higher. Third, if search frictions are more severe for sellers, then sellers are more likely to set prices in foreign currency. If transaction opportunities for sellers arrive at a lower rate, then more time passes between the price posting decision and the transaction. This implies that real transacted prices are lower, and sellers avoid larger losses by pricing in foreign currency. In the model, less frequent transaction opportunities come from a lower entry rate of buyers. We collect these results in the following proposition.

PROPOSITION **3.** *If* $\lambda = 0$ *and* $\pi^D > \pi^F > 0$, *optimal dollarization* f *is*

(1) *weakly decreasing in* κ,

(2) *weakly increasing in* π^D *and weakly decreasing in* π^F,

(3) *weakly increasing in* r,

(4) *and weakly decreasing in* b.

Finally, although we cannot characterize analytically the comparative statics with respect to λ, we can show that the equilibrium entails full price dollarization when $\lambda = 1$, but not necessarily when $\lambda = 0$. It is expected that the degree of price dollarization is increasing in λ, since the expected willingness to pay for the good in dollars increases, as there are more buyers with foreign currency holdings.

The optimal currency choice is independent of the cost structure in this simplified model. This is due to the fact that in the sticker price model, prices are attached to individual goods and these are already produced at the time of the pricing decision. Hence, there is no need to forecast future costs since these will be associated with different pricing decisions. Additionally, this model isolates from any meaningful degree of optimal exchange rate pass-though, which is a relevant factor in the determination of the currency of denomination of international prices.[13] These considerations are relevant for the determination of the currency of prices. Our analysis tries to shed light into relevant factors that determine the currency choice in domestic markets with search frictions, above and beyond those already highlighted by previous studies.

---

[13]The interaction of differential desired degrees of exchange rate pass-through and optimal currency choice of prices has been studied in Gopinath et al. (2010) and Devereux and Engel (2003), among others.

3.2. *Quantitative Analysis*

In this section, we calibrate the model with heterogeneous buyers to match key aspects of the distribution of prices and time to sell of goods, as well as certain features regarding the buyers' access to dollars for the Uruguayan economy. We then re-visit our main empirical finding using simulated data from our model to assess whether it can account for the patterns observed in the data and perform a counterfactual exercise.

3.2.1. *Calibration*

Our model describes the equilibrium in a market of a single good with certain demand characteristics. On the other hand, our dataset contains various types of goods with different demand characteristics. In order to match the characteristics of our data, we analyze an enhanced economy that is composed of a continuum of replicas of single markets that differ in their deep parameters. We allow markets to vary by the utility value of the good u, the entry rate of buyers b and the composition of entrant buyers given by λ. Hence, each market is indexed by the triplet (u, b, λ). By varying these parameters, our enhanced economy features significant variation in prices (by varying u), time to sell (by varying b) and the share of buyers with dollars (by varying λ).

We assume that the underlying joint distribution of these parameters is parametric. In particular, we assume the following log-normal distribution:

$$
\begin{pmatrix} \log u \\ \log b \\ \log \hat{\lambda} \end{pmatrix} \sim N \left(\begin{bmatrix} \mu_u \\ \mu_b \\ \mu_{\hat{\lambda}} \end{bmatrix}, \begin{bmatrix} \sigma_u^2 & \sigma_{u,b} & \sigma_{u,\hat{\lambda}} \\ \sigma_{u,b} & \sigma_b^2 & 0 \\ \sigma_{u,\hat{\lambda}} & 0 & \sigma_{\hat{\lambda}}^2 \end{bmatrix} \right),
$$

where $\hat{\lambda}$ is a monotone transformation of λ, so that $\lambda = \hat{\lambda}/(\hat{\lambda} + 1)$. This transformation ensures that $\lambda \in [0, 1]$ in all markets. We allow for potential correlation between these parameters, to the extent that these correlations can be identified with our data. As discussed below, all the components of the covariance matrix are well-identified in our calibration strategy, with the exception of $\sigma_{b,\hat{\lambda}}$, which we set to zero.

We use a Cobb-Douglas matching function $m(S, B) = S^\alpha B^{1-\alpha}$, with $\alpha \in (0, 1)$, which yields a meeting rate for sellers of $q(\theta) = \theta^{\alpha-1}$ and a meeting rate for buyers of $p(\theta) = \theta^\alpha$.

We calibrate the model to match the features of the Uruguayan economy in 2012. We focus on Uruguay, since it is the country with the most comprehensive data (both data from the online platform as well as data on households' dollar holdings). We chose the year 2012,

because it is the year with the largest amount of data from the online platform, and close to the year in which the survey of consumer finances was carried out.

The model is calibrated to a monthly frequency. Since time is continuous, this implies that a time interval of length one corresponds to one month. The model is parametrized by 12 parameters: $(r, \pi_D, \pi_F, \kappa, \alpha)$, which are common across markets, and $(\mu_u, \mu_b, \mu_{\hat{\lambda}}, \sigma_u^2, \sigma_b^2, \sigma_{\hat{\lambda}}^2, \sigma_{u,b}, \sigma_{u,\hat{\lambda}})$, which parametrize the underlying distribution of (u, b, λ). The calibrated parameters are summarized in Table 1. We set the real interest rate (which is also the discount rate) to $r = 0.33\%$, which is equivalent to an annual real interest rate of 4%. The monthly inflation rates in domestic and foreign currency are set to $\pi_D = 0.17\%$ and $\pi_D = 0.64\%$. These values are equivalent to annual inflation rates of 2% and 8%, which are consistent with inflation rates in the US and in Uruguay during the period studied.[14] We set the curvature of the matching function to $\alpha = 0.5$, since there are no prior estimates of this parameter in the literature. We set the transaction cost $\kappa = 0.7\%$ to match the unconditional mean of price dollarization of goods in Uruguay in 2012. Given that this value is slightly below the average observed bid-ask spread for exchanging local currency into dollars in Uruguay, we consider this a reasonable parameter value.

The parameters that shape the underlying distribution of (u, b, λ) are jointly calibrated. The only exception is μ_u, which is normalized, since u only scales prices without affecting currency choices. The seven remaining parameters $(\mu_b, \mu_{\hat{\lambda}}, \sigma_u^2, \sigma_b^2, \sigma_{\hat{\lambda}}^2, \sigma_{u,b}, \sigma_{u,\hat{\lambda}})$ are calibrated to match the following seven moments from the data: the standard deviation of log prices, the average and standard deviation of time that takes for a good to be sold, the average and standard deviation of the the probability of buyers having liquid assets in dollars, the correlation of log prices and time to sell, and the correlation of log prices and the probability of buyers having liquid assets in dollars.

The data moments are obtained from our two datasets. The first and second moments regarding log prices and time to sell are obtained from the data from the online platform (focusing on data from Uruguay in 2012). The average and the dispersion of the probability of buyers having liquid assets in dollars are obtained from the merged dataset that estimates this probability for all transactions recorded in the consumption survey. Our working assumption

---

[14]The model features the implicit assumption that the real exchange rate (measured in terms of the numeraire good) is constant, with the nominal exchange rate depreciation given by the difference in the inflation rates ($\Delta e = \pi_D - \pi_F$). This assumption holds in the data in 2012 (the targeted year in the calibration exercise), since the nominal exchange rate depreciated 6%, which is very close to the difference in observed inflation rates.

Table 1. Calibrated Parameters

Parameter	Value	Comments/Targets
Exogenous Parameters		
r	0.33%	Standard value
π_F	0.14%	Average inflation in US
π_D	0.64%	Average inflation in Uruguay 2012
α	0.50	
Calibrated Parameters		
κ	0.73%	Average price dollarization
μ_b	0.03	Average time to sell goods
$\mu_{\hat{\lambda}}$	-2.75	Average buyers with dollar accounts
σ_u^2	2.02	Std Dev. of log prices
σ_b^2	0.23	Std Dev. of time to sell goods
$\sigma_{\hat{\lambda}}^2$	2.75	Variance of buyers with dollar accounts
$\sigma_{u,b}$	-0.23	Correlation log prices - time to sell
$\sigma_{u,\hat{\lambda}}$	0.24	Correlation log prices - dollar buyers

is that buyers with liquid assets in dollars map into buyers of type $i = 2$ in the model, since they do not need to pay the transaction cost to acquire goods with foreign currency.[15] The average and the standard deviation of this probability, as well as its correlation with log prices, is computed at the transaction level. For a detailed description of this dataset and the estimates of the probability of having liquid assets in dollars see Online Appendix A.

To obtain the model-equivalent moments, we simulate data generated by the model. In particular, we first simulate 5,000 different markets -defined by the triplet (u, b, λ)- from the log-normal distribution. Then we compute the equilibrium associated with each market and simulate the experiences of 500 sellers in each of those markets for one year. This requires randomizing the initial price sellers set and the time until they find a buyer that is willing to buy their good. Once we have our simulated data, we process it in the same way we process the empirical data to generate the moments and graphs.

---

[15]We also assume that buyers that have liquid assets in dollars do not need to pay the transaction cost to acquire goods in domestic currency. This assumption is supported by the fact that in our data nearly all buyers that have liquid assets in dollars also have liquid assets in domestic currency.

The calibrated values are $\mu_b = 0.03$, $\mu_{\hat\lambda} = -2.75$, $\sigma_u^2 = 2.02$, $\sigma_b^2 = 0.23$, $\sigma_{\hat\lambda}^2 = 2.75$, $\sigma_{u,b} = -0.23$ and $\sigma_{u,\hat\lambda} = 0.24$. While in the joint calibration each parameter can potentially affect all moments, we find that σ_u^2 mostly affects the dispersion of prices, μ_b and σ_b^2 mostly determine the average and the standard deviation of time to sell, $\mu_{\hat\lambda}$ and $\sigma_{\hat\lambda}^2$ mostly determine the average and the standard deviation of the probability of buyers having liquid assets in dollars, and $\sigma_{u,b}$ and $\sigma_{u,\hat\lambda}$ mostly affect the correlation of log prices with time to sell and the probability of buyers having liquid assets in dollars, respectively. Table E1 in Online Appendix E reports the data moments and their model counterparts used in the joint calibration. All moments are well-approximated, perhaps with the exception of the standard deviation of time to sell. In addition, our model is able to correctly reproduce the global relationship between prices and time to sell (see Figure E.1a), as well as the relationship between prices and the probability of buyers having liquid assets in dollars (see Figure E.1b).

3.2.2. *Model Performance*

With our calibrated model, we then assess the ability of the model to replicate our empirical findings regarding currency choice of prices from section 2. The calibration strategy targets the unconditional share of price dollarization. However, it does not target the cross-sectional pattern of price dollarization. Hence, this information can be used to gauge the model's performance. Figure 4 shows the share of prices in dollars as a function of price deciles in the data and model simulations. The model correctly predicts the fact that more expensive goods are more likely to be priced in dollars. However, it slightly underestimates the quantitative strength of this relationship. While the share of prices in dollars is around 9.6% in the model and 4.5% in the data for the cheapest three deciles of prices, this share is 30% in the model and 41% in the data for the three most expensive deciles of prices. Both in the model and in the data, this relationship is exponential.

In the model more expensive goods are more likely to be posted in dollars mostly because buyers that have high valuations of goods are more likely to be buyers of type 2 that do not need to pay a transaction cost to pay for goods with dollars. This implies that those sellers that sell high-valuation goods face similar expected willingness to pay for those goods in dollars and in local currency, making dollar pricing more attractive to them. Which data relationship informs the correlation between buyers' valuations and the composition of buyers? The observed relationship between the unit price paid for goods and the likelihood of buyers having liquid assets in dollars. Hence, the fact that more expensive goods are more

FIGURE 4. Price Dollarization: Model and Data
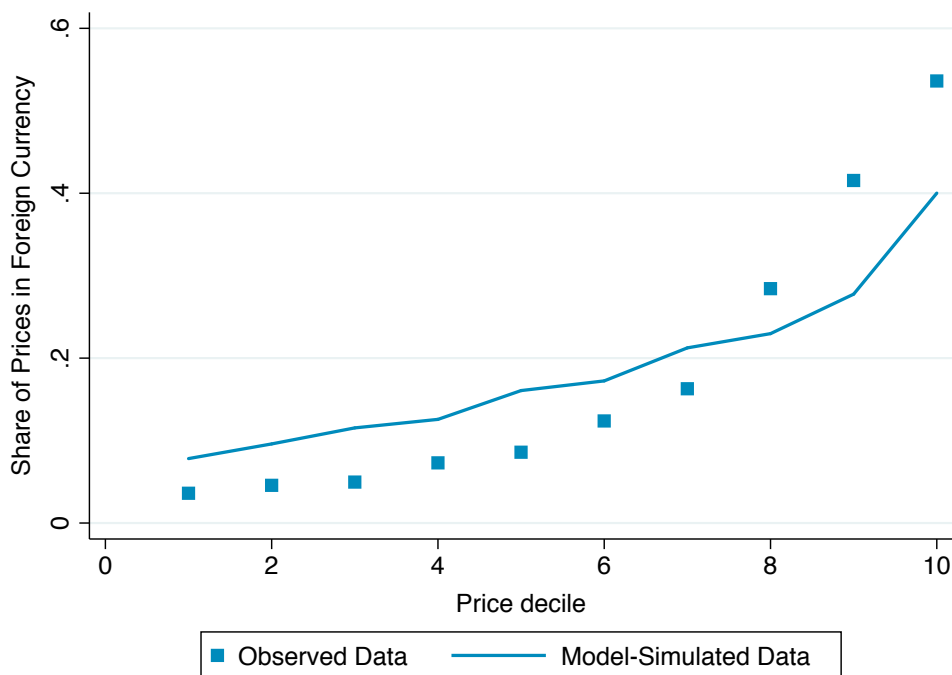
Notes: This figure shows the fraction of original prices set in foreign currency, within each of ten bins of equal frequency. These bins are computed by separating posted prices (in real terms) ordered from low to high into ten bins. The blue dots are computed with observed data on posted prices of new goods that ended up being sold for Uruguay in 2012. The blue solid line corresponds to data generated by simulations from the model with the calibrated parameters.

likely to be bought by buyers with liquid assets in dollars is key in identifying the predicted relationship between price value and price dollarization in the model.

Finally, we perform a counterfactual exercise in which we analyze how the currency choice of prices changes in response to an increase in the domestic inflation rate, both in the data and the model. We leave all remaining parameters in their baseline calibrated values and increase the level of domestic inflation to $\pi_D = 1.1\%$ (equivalent to a 14% annual inflation), which corresponds to the average observed inflation in Uruguay in 2003-04, and compare the model simulations with the observed data for those years.

Results are shown in Figure 5. In the model of a high-inflation economy, the share of prices in foreign currency is 61% compared to the 36% share observed in Uruguay in 2003-04.[16] The average level of price dollarization in 2003-04 is higher than in 2012 in the data, and

---

[16]The fact that the model overestimates the observed average level of price dollarization could be due to the fact that other parameters may have changed at the same time. In particular, the bid-ask spread

also in the model simulated data. Additionally, the positive relationship between price levels and currency of denomination is present both in the data and the model. The higher share of prices in foreign currency in the high-inflation economy reflects the incentives of certain sellers to change the currency denomination of their goods from domestic currency to foreign currency in order to avoid a rapid erosion of the real value of their posted prices.

FIGURE 5. Counterfacutal Exercise: Higher Inflation
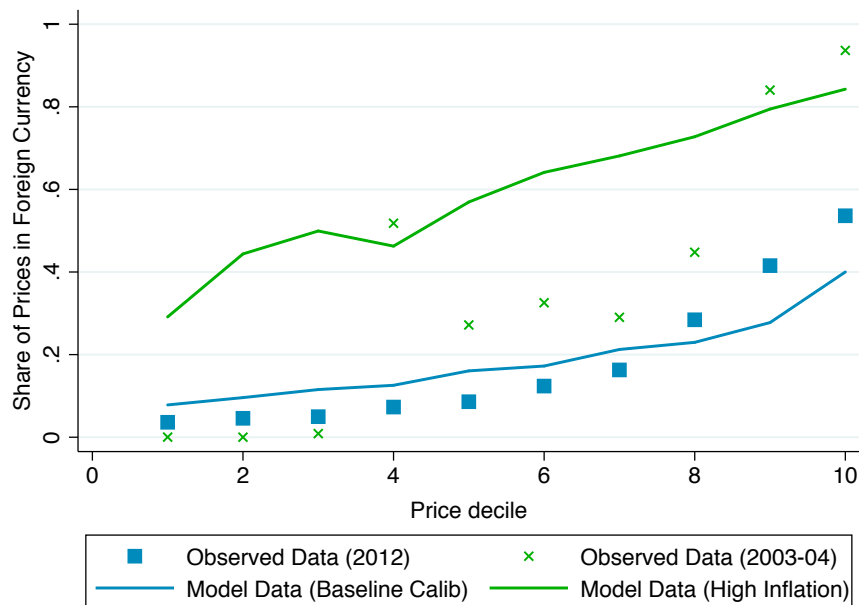
Notes: This figure shows the fraction of original prices set in foreign currency, within each of ten bins of equal frequency. These bins are computed by separating posted prices (in real terms) ordered from low to high into ten bins. The blue dots are computed with observed data on posted prices of new goods that ended up being sold in Uruguay in 2012. The blue solid line corresponds to data generated by simulations from the model with the calibrated parameters. The green crosses are computed with observed data on posted prices of new goods for Uruguay in 2003-04. The green solid line corresponds to data generated by simulations from the a model economy in which $\pi_D = 1.1\%$ (the observed average monthly inflation rate in Uruguay in 2003-04) and all the remaining parameters are set at their calibrated values.

4. CONCLUSION

We document that a significant fraction of prices in domestic markets in emerging economies are set in dollars. Dollar pricing is more likely in those goods that are more expensive and

_____

for exchanging currency was significantly higher in 2003-04 than in 2012, which would lead to lower price dollarization in the model.

more tradeable. A larger share of the variation in the currency of prices correlates with the unit value of prices. We also show that goods take time to sell and that more expensive goods are more likely to be bought by buyers with liquid assets in dollars.

We then develop a search model of currency choice of prices designed to study how inflation and certain features of demand can affect the degree of price dollarization in an economy. Sellers may opt to set prices in foreign currency to avoid a rapid erosion of the real value of their prices at the expense of facing a lower willingness to pay by certain buyers. Sellers that participate in markets in which buyers have easier access to dollars are more likely to set prices in dollars. We provide empirical evidence that argues that these markets are characterized by higher prices. In the model, as in the data, the share of prices in foreign currency decreases with the inflation rate.

References

ALESINA, A. AND R. J. BARRO (2002): "Currency Unions," *The Quarterly Journal of Economics*, 117, 409–436.

ALESSANDRIA, G. (2004): "International deviations from the law of one price: the role of search frictions and market share," *International Economic Review*, 45, 1263–1291.

ARELLANO, C. AND J. HEATHCOTE (2010): "Dollarization and financial integration," *Journal of Economic Theory*, 145, 944–973.

BACCHETTA, P. AND E. VAN WINCOOP (2005): "A theory of the currency denomination of international trade," *Journal of International Economics*, 67, 295–319.

BARRO, R. J. AND D. B. GORDON (1983): "Rules, discretion and reputation in a model of monetary policy," *Journal of Monetary Economics*, 12, 101–121.

BENABOU, R. (1988): "Search, Price Setting and Inflation," *The Review of Economic Studies*, 55, 353.

BURDETT, K. AND K. L. JUDD (1983): "Equilibrium Price Dispersion," *Econometrica*, 51, 955–969.

BURDETT, K. AND G. MENZIO (2017): "The (Q,S,s) Pricing Rule," *The Review of Economic Studies*, 0–37.

BURSTEIN, A. AND G. GOPINATH (2014): "International Prices and Exchange Rates," in *Handbook of International Economics*, ed. by G. Gopinath, E. Helpman, and K. Rogoff, vol. 4, 391 – 451.

CALVO, G. A., A. IZQUIERDO, AND R. LOO-KUNG (2006): "Relative price volatility under Sudden Stops: The relevance of balance sheet effects," *Journal of International Economics*, 69, 231–254.

CRAVINO, J. (2014): "Exchange Rates, Aggregate Productivity and the Currency of Invoicing of International Trade," Manuscript.

DE LOS SANTOS, B., A. HORTAÇSU, AND M. R. WILDENBEEST (2012): "Testing models of consumer search using data on web browsing and purchasing behavior," *The American Economic Review*, 102, 2955–2980.

DEVEREUX, M. B. AND C. ENGEL (2003): "Monetary Policy in the Open Economy Revisited: Price Setting and Exchange-Rate Flexibility," *The Review of Economic Studies*, 70, 765–783.

DEVEREUX, M. B., C. ENGEL, AND P. E. STORGAARD (2004): "Endogenous exchange rate pass-through when nominal prices are set in advance," *Journal of International Economics*, 63, 263–291.

DIAMOND, P. A. (1971): "A model of price adjustment," *Journal of Economic Theory*, 3, 156–168.

——— (1993): "Search, Sticky Prices, and Inflation," *The Review of Economic Studies*, 60, 53–68.

DINERSTEIN, M., L. EINAV, J. LEVIN, AND N. SUNDARESAN (forthcoming): "Consumer price search and platform design in internet commerce," *The American Economic Review*.

DRENIK, A., R. KIRPALANI, AND D. J. PEREZ (2022): "Currency choice in contracts," *The Review of Economic Studies*, 89, 2529–2558.

DRENIK, A. AND D. J. PEREZ (2021): "Domestic price dollarization in emerging economies," *Journal of Monetary Economics*, 122, 38–55.

ELLISON, G. AND S. F. ELLISON (2009): "Search, obfuscation, and price elasticities on the internet," *Econometrica*, 77, 427–452.

ENGEL, C. (2006): "Equivalence Results for Optimal Pass-through, Optimal Indexing to Exchange Rates, and Optimal Choice of Currency for Export Pricing," *Journal of the European Economic Association*, 4,

1249–1260.

GALE, D. AND X. VIVES (2002): "Dollarization, Bailouts, and the Stability of the Banking System," *The Quarterly Journal of Economics*, 117, 467–502.

GOLDBERG, L. S. AND C. TILLE (2008): "Vehicle currency use in international trade," *Journal of International Economics*, 76, 177–192.

GOPINATH, G., E. BOZ, C. CASAS, F. J. DÍEZ, P.-O. GOURINCHAS, AND M. PLAGBORG-MØLLER (2020): "Dominant currency paradigm," *American Economic Review*, 110, 677–719.

GOPINATH, G., O. ITSKHOKI, AND R. RIGOBON (2010): "Currency Choice and Exchange Rate Pass-Through," *American Economic Review*, 100, 304–36.

HEAD, A., L. Q. LIU, G. MENZIO, AND R. WRIGHT (2012): "Sticky Prices: A New Monetarist Approach," *Journal of the European Economic Association*, 10, 939–973.

IZE, A. AND E. LEVY YEYATI (2003): "Financial dollarization," *Journal of International Economics*, 59, 323–347.

KAPLAN, G. AND G. MENZIO (2016): "Shopping Externalities and Self-Fulfilling Unemployment Fluctuations," *Journal of Political Economy*, 124.

KAPLAN, G., G. MENZIO, L. RUDANKO, AND N. TRACHTER (2016): "Relative Price Dispersion: Evidence and Theory," Manuscript.

LAGOS, R. AND R. WRIGHT (2005): "A Unified Framework for Monetary Theory and Policy Analysis," *Journal of Political Economy*, 113, 463–484.

URIBE, M. (1997): "Hysteresis in a simple model of currency substitution," *Journal of Monetary Economics*, 40, 185–202.

ONLINE APPENDIX FOR

"Search, Dollar Pricing, and Inflation"

ANDRES DRENIK

Department of Economics

The University of Texas at Austin

DIEGO J. PEREZ

Department of Economics

New York University and NBER

Appendix A. Data cleaning

A.1. *Online platform*

In preparation for the analysis using micro-data, we undergo a sequence of steps to clean the data. The applied filters for merchandise listings are outlined below. To start, we exclude observations from listings featuring "divisible" goods since our analysis heavily relies on unit prices of goods. We utilize the sellers' product descriptions and platform-provided category descriptions to sort listings into two categories: (1) bulk sales and (2) "divisible" goods. We eliminate all listings containing specific terms (in Spanish) such as promotion, batch, kilo (and variants), gram (and variants), liter (and variants), meter (and variants), centimeter (and variants), kilometer (and variants), pack, units, "2 for 1". We then proceed to identify the goods categories in which these terms frequently appear and remove them entirely (virgin CDs/DVDs, food, cigars/cigarettes, batteries, diapers, hobbies:bills/coins/stamps). Following this, we exclude goods with high prices, namely those exceeding US$10,000 and surpassing the 99% percentile within their respective categories (all prices are converted to a unified currency). To ensure price comparability across different time periods, we standardize all prices, converting them to real December 2012 US$.

In the case of real estate and vehicle listings, we utilize an algorithm to remove listings with "unusual" prices (e.g., 1, 9999999, etc.). Additionally, we employ the platform's categorization to identify vacation properties. Specifically, vacation properties belong to categories such as temporary rental, vacational, seasonal, etc.

In order to provide a better idea of the types of goods included in this platform and within each price decile, Table A1 shows the average price, share of prices in foreign currency and the top 5 categories in terms of sales within each price decile in Uruguay. The platform includes goods with a wide range of prices, from an average of US$3.4 in the lowest decile to an average of US$475 in the highest decile. The most common types of goods sold within the cheapest deciles are apparel and phone cases/chargers/cables. Among the most expensive goods, phone accessories, computers/notebooks, video game consoles and phones are the most transacted items.

TABLE A1. Summary Statistics by Price Decile

Price decile	Avg. Price	% Foreign Curr.	Top 5 Most Common Items
1	3.5	4.3	Women apparel - Phone chargers - Ink cartridges Phone screen covers - Kitchen appliances
2	7.7	3.8	Women apparel - Phone chargers - Phone cases Phone cables - Phone screen covers
3	11.7	4.6	Women apparel - Men apparel - Phone cases Phone batteries - Phone memories
4	16.5	6.7	Women apparel - Men apparel - Phone cases Ink cartridges - Webcams
5	23.3	9.5	Women apparel - Men apparel - Fitness accessories Notebook accessories - Phone memories
6	34.9	16.8	Women apparel - Men apparel - Notebook accessories Wireless networks - Computer memory
7	54.1	22.6	Men apparel - Women apparel - Phones (other brands) Notebook accessories - Computer memory
8	87.6	35.0	Playstation 3 games - Men apparel - Phones (other brands) Computer hard drives - Women apparel
9	157.1	47.4	Phones (other brands) - Computer hard drives - Digital cameras (+11mp) Men apparel - Computer screens
10	480.2	66.5	Phone accessories - Notebooks - Video game consoles Phones (Nokia) - Couches

Notes: This table shows summary statistics of all goods sold in the platform by price deciles. The first column shows the average price in dollars across of all transacted prices withing price decile. The second column shows the share of prices in foreign currency within price decile. The last column shows the top 5 most common transacted categories within price decile.

A.2. *ENGIH and EFHU*

In this appendix, we explain the data used to compute Figure 3 and the moments related to households' holding of liquid assets in dollars that were used as targets of the calibration exercise. Two datasets are used for this purpose: the EFHU (*Encuesta Financiera de los Hogares Uruguayos*)[17], an Uruguayan survey of household finances similar to the Survey of Consumer Finances in the US, and the ENGIH (*Encuesta Nacional de Gastos e Ingresos de los Hogares*) a consumption survey similar to the Consumer Expenditure Survey in the US.

The EFHU survey was conducted in 2013 and contains detailed financial information for a sample of 3,490 Uruguayan households, including several measures of asset holdings. Importantly, the survey distinguishes holdings of different types of assets by currency of denomination of those assets. From these data we construct a measure of dollar holdings at the household level. More specifically, we construct an indicator variable that is equal to one if the households holds cash in dollars or if it possesses a checking or savings account denominated in dollars.

The households surveyed by the EFHU were sampled from the ones that also participated in the national household survey (ECH, the *Encuesta Continua de Hogares*) in 2012, which is similar to the Current Population Survey in the US.[18] The household survey includes several questions that allows for the construction of a measure of household's total monthly income. Since the households surveyed in the EFHU were a subset of those in the broader ECH survey, we are able to match these two datasets and obtain for each household in the EFHU a measure of the total household monthly income, in addition to the indicator of asset holdings in dollars.[19] The average monthly household income in January 2006 terms is 55,159.2 Uruguayan Pesos (approximately US$2,300). The share of households with asset holdings in dollars according to our measure is 9.4%. Figure A.1 shows the relationship between households' income and asset dollarization. While the fraction of households with liquid assets in dollars is close to zero among the poorest households, more than 20% of households in the ninth decile of the income distribution have some type of liquid asset in

---

[17]The data are available upon request from the Economics department at the Facultad de Ciencias Sociales de la Universidad de la República.

[18]Importantly, richer households were oversampled in the EFHU (and a proper sample weight was then assigned to them) to have a better sense of the wealth distribution in Uruguay. Throughout our analysis, we always take those household weights into consideration.

[19]In order to get a measure of income comparable with income measures from the consumption survey conducted in 2006, we deflated income to 2006 levels using the Uruguayan CPI.

dollars. This share is more than 30% for households in the top decile, and for households earning more than US$3,000 per month, this share is close to 60%.

Having measures of asset dollarization and total monthly income at the household level, we fit a local linear regression to estimate the conditional probability of holding assets in dollars given household monthly income. This estimate allows us to merge data from the financial survey with data coming from the consumption survey, which is described below.

FIGURE A.1. Household Income and Access to Dollars
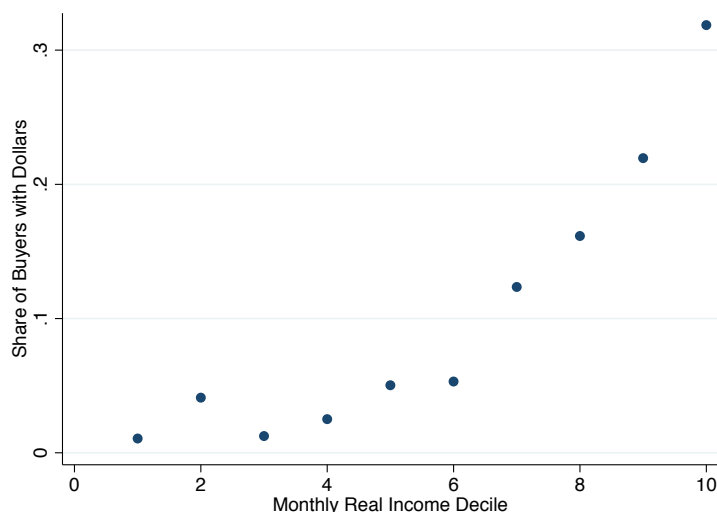
Notes: This figure shows the share of households with either cash holdings in dollars or at least one savings/checking account denominated in dollars by decile of the household monthly real income distribution.

The consumption survey ENGIH 2005-2006 collected expenditure and income data of all members of a total of 6,932 households. The survey covers a total of 1,088 types of goods at a very narrow level (e.g., distinguishing for example between shirts and jeans for women). Not all types of goods are relevant to our analysis, so we identify those that are available for sale in the online platform. This leaves us with 405 groups of goods. The ENGIH provides information on total expenditure in a good and quantities purchased, so we divided the former by the latter to obtain unit prices for each reported transaction. At this stage we are able to construct a dataset with individual transactions, its transacted price and the monthly income of the household purchasing the good. To be consistent with the analysis conducted with the data from the online platform, we exclude unit prices below US$0.5 and above US$1,000 (the range of prices found in the online platform, excluding outliers).

From the income variables included in the ENGIH, we construct a household monthly income measure that is consistent with the income measure constructed from the EFHU dataset (the questions used in the expenditure and household surveys are almost identical, so both measures of income are quite consistent between each other). Figure A.2 shows a comparison of the distribution of household real monthly income obtained from the consumption survey and the households' finances survey. The difference between both distributions is the results of growth of household real income between 2005-2006 and 2012. However, these difference should not be of large concern because, if anything, it results in a lower imputed average asset dollarization across households (which in turn makes it harder to explain price dollarization with our theory).

FIGURE A.2. Distribution of Households' Real Income across Surveys
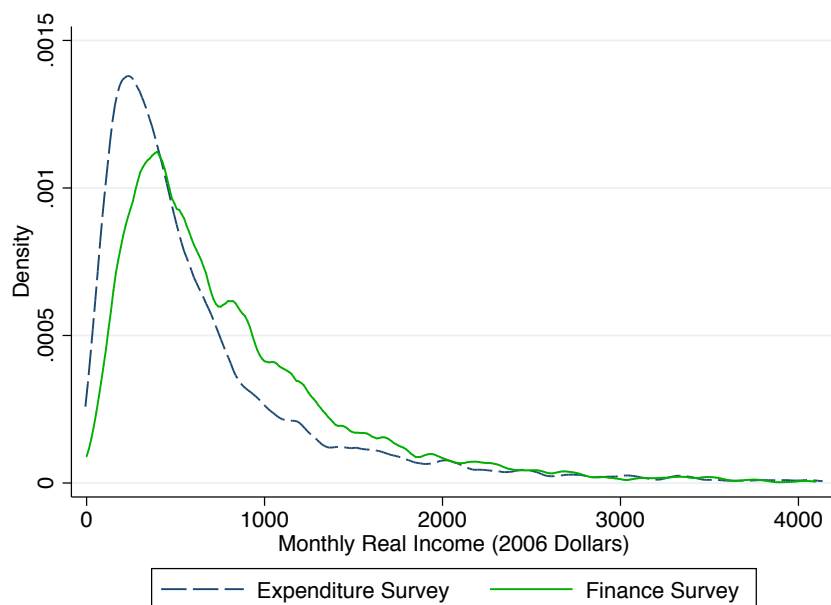
Notes: This figure compares the households' total monthly income distribution from the ENGIH (consumption survey), with the distribution obtained from the EFHU (financial survey). Both distributions were estimated non-parametrically. The green line approximates the income distribution from the consumption survey, whereas the blue dashed line approximates the income distribution from the financial survey.

The main purpose of the data coming from the consumption survey is to estimate a relationship between unit prices of households' purchases with the corresponding monthly households' income. Figure A.3 shows this relationship for three groups of goods: those purchased at a high frequency (less or equal than monthly), at an intermediate frequency

(bi-monthly or quarterly) and at a low frequency (semi-annually or annually).[20] As expected, richer households pay a larger unit price on average than poorer households, for goods purchased at any frequency. However, the slope of the relationship is small for goods purchased at a high frequency (mostly necessities) and large for goods purchased at a low frequency (the richest households buy goods that on average are three times more expensive than the goods purchased by the poorest households).

FIGURE A.3. Transaction Prices and Household Income
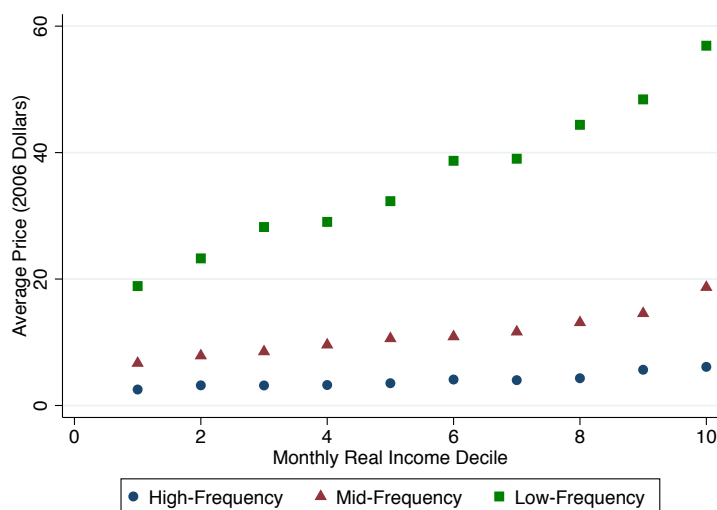
Notes: This figure shows the average transacted unit price measured in dollars within deciles of the households' monthly income distribution. Goods are split into three groups: those purchased at a high frequency (less or equal than monthly), at an intermediate frequency (bi-monthly or quarterly) and at a low frequency (semi-annually or annually).

A.3. *Merging Procedure*

In order to produce Figure 3 in the paper, which shows the relationship between transacted unit prices and the share of buyers of those goods with liquid assets in dollars, we merge data from the expenditure and financial survey. For each recorded transaction in the consumption survey, we impute the expected probability that the household making that transaction had liquid assets in dollars, based on the income of the household and the estimated relationship between household income and asset dollarization obtained from the financial survey.

---

[20]The frequency of purchases is determined by the questionnaire used in the ENGIH survey and not by survey participants.

Finally, we take into account the fact that the consumption survey does not record all the transactions made within a given year, but the data coming from the online platform does. Therefore, we make use of the information provided by the consumption survey about the frequency at which households make purchases of different goods in order "convert" the frequencies of all purchases into a common annual frequency. For example, purchases of goods recorded to be made on a monthly frequency are weighted by a factor of 12. Thus, if a household purchases a certain good every month, the weighted data captured by the consumption survey would give the same relative importance to that good as the data coming from the online platform.

Appendix B. Representativeness Analysis

In this section we discuss the representativeness of our analysis in terms of: (1) the types of goods available for sale in the online platform relative to the average household consumption bundle, and (2) the characteristics of people making online purchases relative to the overall population in Uruguay.

Table B1 presents a comparison between the goods found in the typical household consumption bundle (using data from the consumption survey) and the goods available on the online platform. The second column displays the proportion of total monthly household expenditure allocated to broad categories of goods—categories officially employed in CPI construction. The third column exhibits the expenditure share within the average household consumption basket, considering only types of goods available for purchase on the online platform. Lastly, the fourth column indicates the percentage of items available for sale on the platform relative to the total number of items in each consumption category.

Concerning average expenditure shares, the goods accessible on the online platform encompass nearly one-third of the total average monthly expenditures. Notably, this includes a substantial coverage of durable goods categories such as Apparel, Furniture and Home Appliances, Culture and Recreation. As anticipated, there is minimal coverage of services and food items. Consequently, aggregate price dollarization is expected to be lower in the aggregate, given the presumption that food is typically priced in the local currency.

We also analyze the representativeness of the population making online purchases relative to the overall population. We explore this issue by analyzing micro data from the national household survey (ECH) conducted in 2012. In that survey, all household members are asked whether they have used Internet during the last month and whether they used Internet to make online purchases. We split households into three groups: all household, households in which at least one member used Internet during the last month, households in which at least one member used Internet to make online purchases during the last month. Figure B2 shows the average demographics of the household head for each type of household: all, used internet, shopped online. First, notice that already in 2012 almost 13% of households made purchases online in a given month and more than 75% of households had access to internet. All demographic variables are monotonic in terms of tech-savviness. On average, households making online purchases have heads that tend to be more educated and younger, and more likely to be employed, male, and have liquid assets in dollars. At the household level, those making online purchases have on average a higher monthly income. Those differences

are attenuated when comparing those households with households that have recently used internet (the vast majority of households).

TABLE B1. Representativeness of the Basket of Goods Sold in the Online Platform

Category	Share of total expenditure	Expenditure share on online-platform	Share of items on online-platform
Food and Non-alcoholic Beverages	23.0	0.00	0.00
Alcoholic Beverages and Tobacco	1.52	99.9	80.0
Apparel	4.12	95.3	93.0
Housing and Utilities	30.2	65.3	43.7
Furniture and Home Appliances	3.97	36.9	72.6
Medical Care	10.9	3.80	4.76
Transportation	8.48	5.13	9.09
Communications	4.16	10.1	12.5
Culture and Recreation	5.12	48.6	58.8
Education	1.40	0.00	0.00
Hotels and Restaurants	2.42	0.00	0.00
Other Goods and Services	4.56	22.2	32.0
Total	100.0	31.4	29.8

Notes: This table analyzes the representativeness of the data coming from the online platform by showing the fraction that those goods represent in the average household consumption basket. Data on households' expenditures comes from the national consumption survey from Uruguay (ENGIH) conducted in 2005-2006. The second column shows the average split of total expenditures between large categories (those used when computing the official CPI). The third column shows, for each category and overall, the average expenditure share in goods that are also available for sale in the platform. The last column shows the share of types of goods, within categories and overall, that are available for sale in the platform. Summary statistics were computed using household weights.

TABLE B2. Representativeness of Potential Users of the Online Platform

	All	Used Internet	Shopped Online
HH Income	817.8	971.3	1342.7
	(13.65)	(17.44)	(55.24)
Yrs. of Education	9.85	11.0	12.9
	(0.10)	(0.11)	(0.28)
Employed	0.65	0.76	0.82
	(0.01)	(0.01)	(0.03)
Access to Dollars	0.10	0.13	0.24
	(0.01)	(0.01)	(0.03)
Age	54.5	49.5	47.8
	(0.39)	(0.39)	(0.95)
Male	0.57	0.61	0.71
	(0.01)	(0.01)	(0.03)
N	2627	1994	339

Notes: This table presents a comparison across different types of households surveyed in the national household survey of Uruguay (ECH) conducted in 2012. The second column presents demographic statistics for the overall population, while the third column restricts the sample to households in which at least one member used internet during the reference month, and the last column further restricts the sample to household in which at least one member made an online purchase during the reference month. HH income corresponds to the total household monthly income from all sources of income included in the survey. Access to dollars is a dummy variable that is equal to one if the household has access to liquid assets (cash, checking/savings account) in dollars. The rest of the demographic variables pertain to the household head: age, gender, years of education, dummy variable indicating whether employed or not. Summary statistics were computed using household weights.

APPENDIX C. PRICE DOLLARIZATION: FURTHER RESULTS

FIGURE C.1. Dollarization vs Price percentiles: Additional Countries
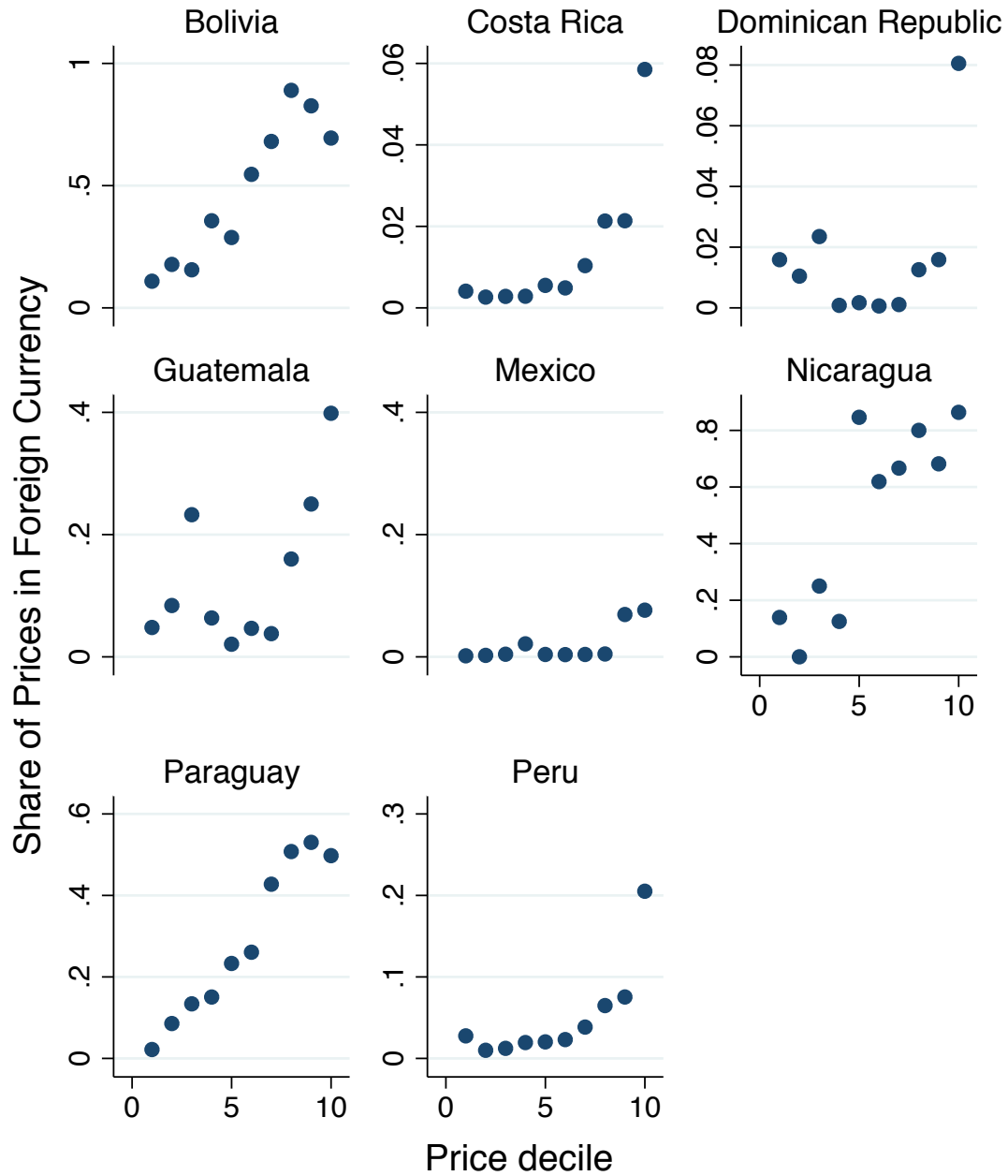
Notes: Each figure shows the fraction of original prices set in foreign currency dollar, by decile of the price distribution. Data correspond to listings of all posted prices in each country as of August 2017 in the online platform.

FIGURE C.2. Share of Prices in Foreign Currency by Category of Goods
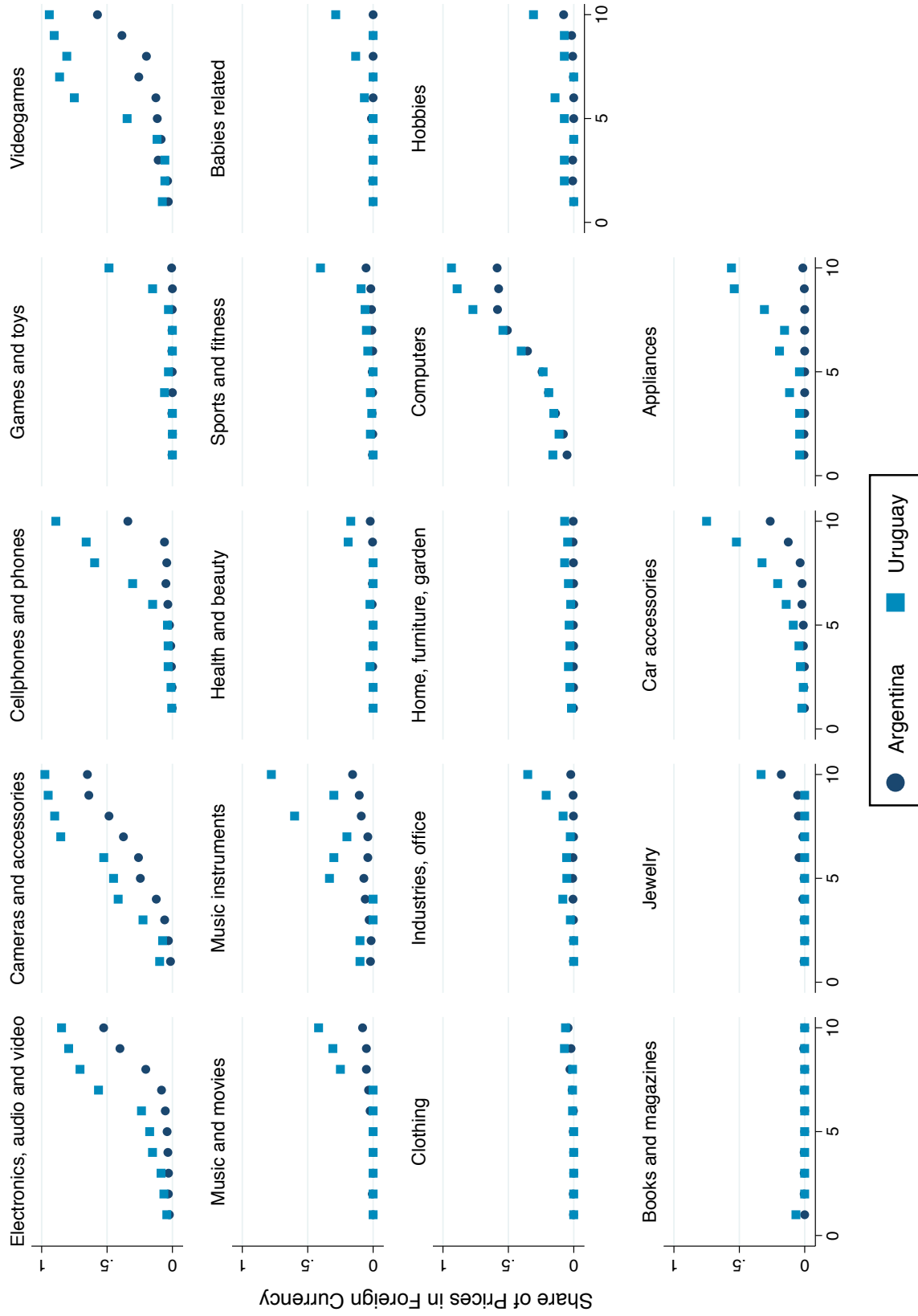
Notes: This figure shows the fraction of transacted prices (measured in real terms) set in dollars in Argentina and Uruguay, by decile of the transacted price distribution. Data correspond to listings of new goods that ended up being sold. Each panel plots the same graph for goods within different categories. These categories are taken from the broadest level of categorization provided by the online platform.

FIGURE C.3. Share of Prices in Foreign Currency: Used Goods
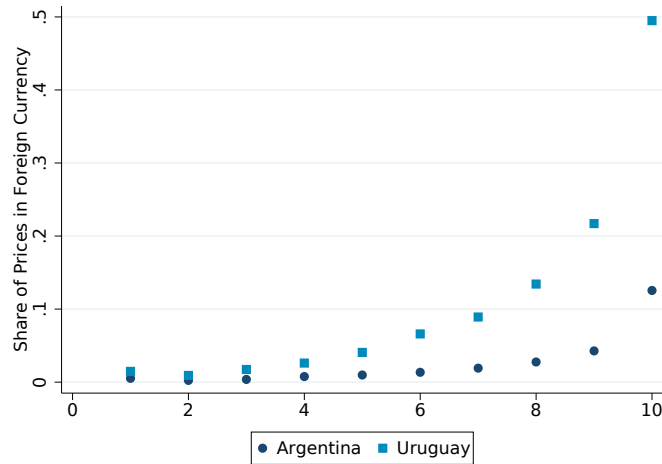
Notes: This figure shows the share of prices set in dollars in Argentina and Uruguay by deciles of the real posted price distribution. Data correspond to listings of used goods that ended up being sold in the platform.

FIGURE C.4. Share of Prices in Foreign Currency: One-time Sellers
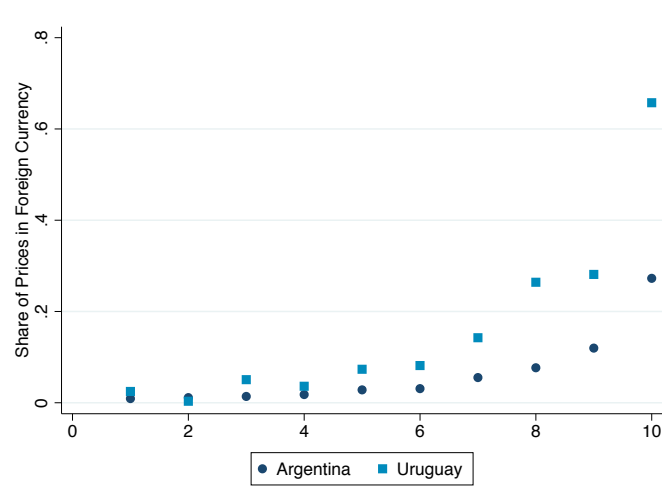
Notes: This figure shows the share of prices set in dollars in Argentina and Uruguay by deciles of the real posted price distribution. Data correspond to listings of new goods that ended up being sold by sellers that only sold once in the platform.

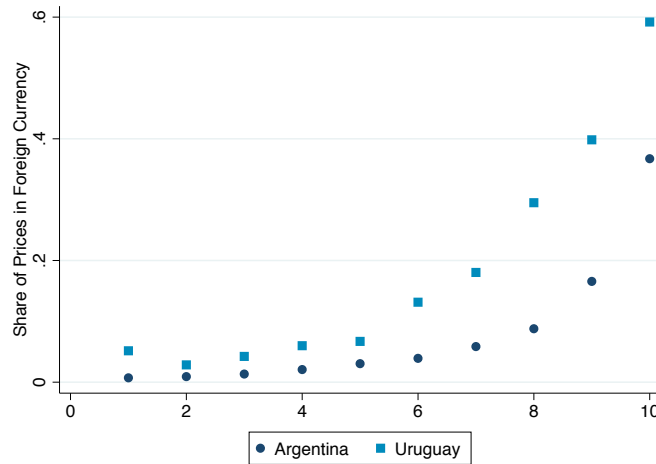Figure C.5. Share of Prices in Foreign Currency: Small Sellers

Notes: This figure shows the share of prices set in dollars in Argentina and Uruguay by deciles of the real posted price distribution. Data correspond to listings of new goods that ended up being sold by sellers that sold between two and ten goods in the platform.

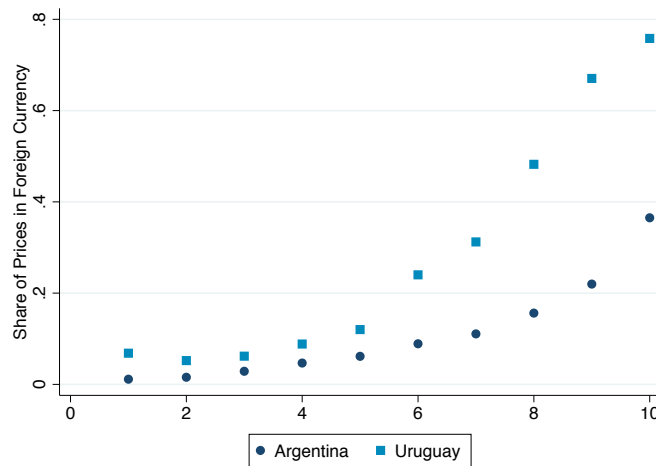Figure C.6. Share of Prices in Foreign Currency: Big Sellers

Notes: This figure shows the share of prices set in dollars in Argentina and Uruguay by deciles of the real posted price distribution. Data correspond to listings of new goods that ended up being sold by sellers that sold more than ten goods in the platform.

FIGURE C.7. The Evolution of Price Dollarization

(A) Argentina
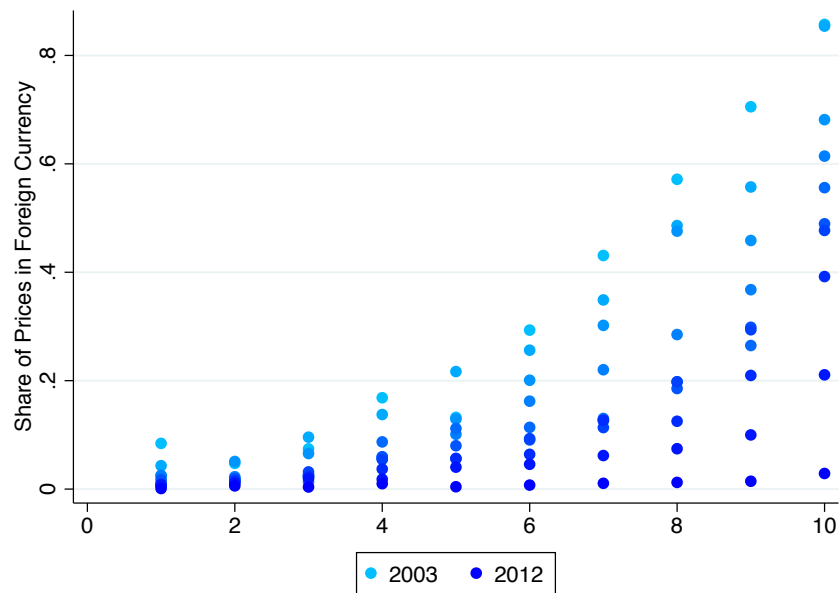
(B) Uruguay
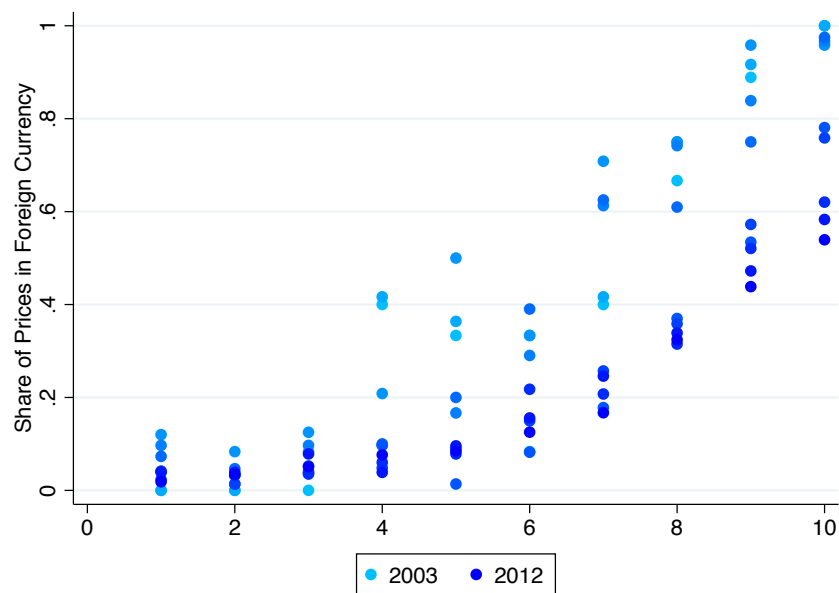
Notes: This figure shows the fraction of prices set in dollars in Argentina and Uruguay for different years, by deciles of the real posted price distribution. Data correspond to listings of new goods that ended up being sold. The intensity of the colors of the dots vary with the year of the data. The lightest blue color corresponds to data from the year 2003 and the darkest blue color corresponds to data from the year 2012.

FIGURE C.8. Share of Prices in Foreign Currency in the Real Estate Market
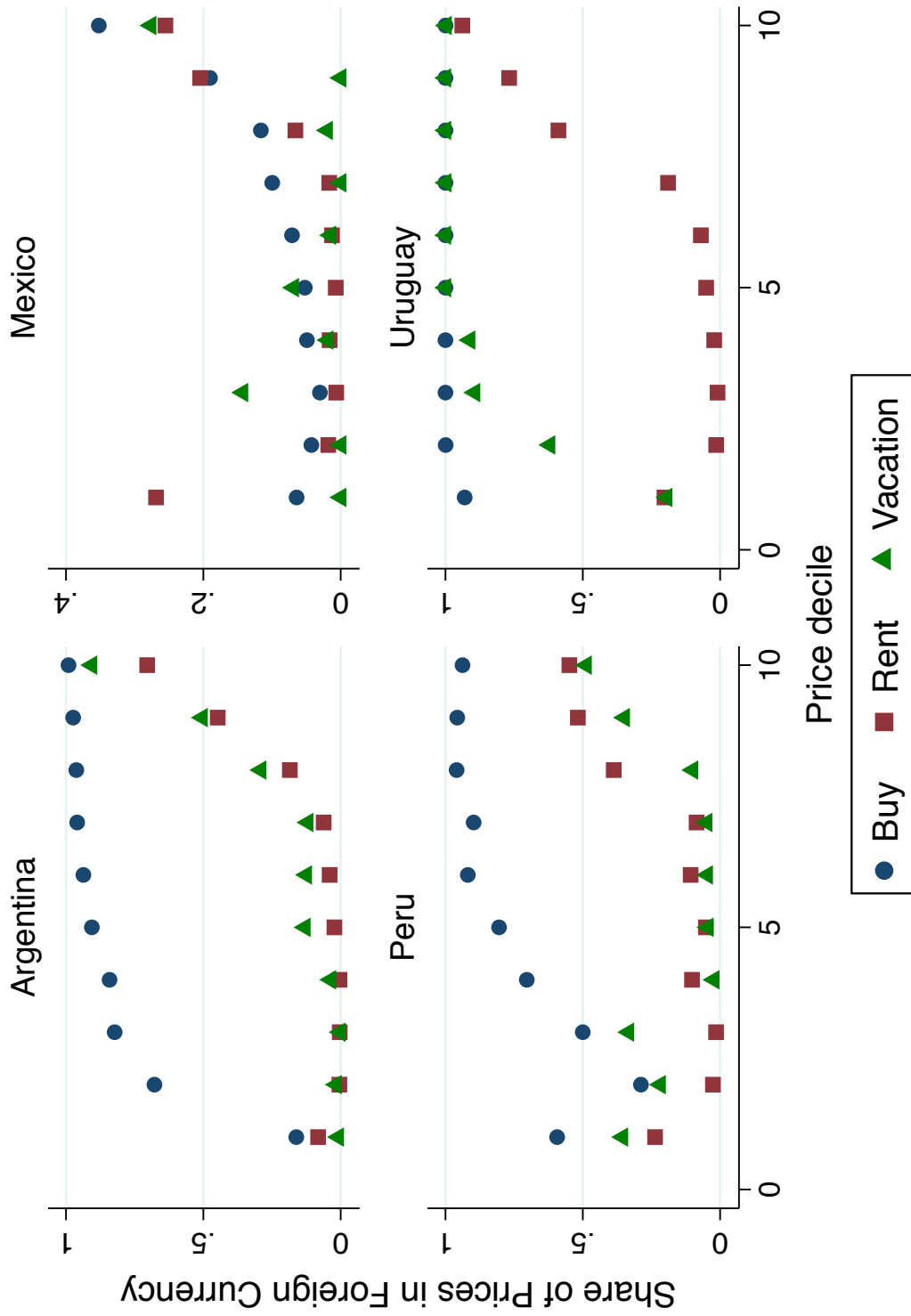
Notes: This figure shows the fraction of original prices set in foreign currency (measured in domestic currency), by decile of the original price distribution. Each panel plots the same graph for different countries.

TABLE C1. Regression version of tables

	Price Dollarization	Price Dollarization	Price Dollarization	Price Dollarization	Time to Sell	Time to Sell	Time to Sell	Time to Sell	Asset Dollarization
Decile 2	0.003***	0.006***	-0.012***	0.004***	1.932***	1.896***	0.074	1.032***	0.001
	(0.000)	(0.000)	(0.001)	(0.001)	(0.014)	(0.014)	(0.046)	(0.043)	(0.001)
Decile 3	0.011***	0.019***	-0.004***	0.011***	2.178***	2.409***	0.727***	1.241***	0.009***
	(0.000)	(0.000)	(0.001)	(0.001)	(0.014)	(0.014)	(0.046)	(0.043)	(0.001)
Decile 4	0.025***	0.028***	0.016***	0.035***	2.654***	2.612***	0.903***	1.243***	0.027***
	(0.000)	(0.000)	(0.001)	(0.001)	(0.015)	(0.014)	(0.046)	(0.043)	(0.001)
Decile 5	0.037***	0.043***	0.045***	0.071***	2.845***	2.468***	0.606***	1.301***	0.033***
	(0.000)	(0.000)	(0.001)	(0.001)	(0.014)	(0.014)	(0.046)	(0.043)	(0.001)
Decile 6	0.058***	0.068***	0.122***	0.142***	2.787***	2.363***	0.495***	1.245***	0.032***
	(0.000)	(0.000)	(0.001)	(0.001)	(0.015)	(0.014)	(0.046)	(0.043)	(0.001)
Decile 7	0.079***	0.103***	0.179***	0.230***	2.518***	2.498***	0.923***	1.323***	0.040***
	(0.000)	(0.000)	(0.001)	(0.001)	(0.015)	(0.014)	(0.047)	(0.044)	(0.001)
Decile 8	0.120***	0.131***	0.304***	0.341***	2.737***	2.987***	1.184***	1.385***	0.046***
	(0.000)	(0.000)	(0.001)	(0.001)	(0.015)	(0.014)	(0.047)	(0.043)	(0.001)
Decile 9	0.181***	0.172***	0.431***	0.421***	3.717***	2.879***	1.059***	1.416***	0.069***
	(0.000)	(0.000)	(0.001)	(0.001)	(0.015)	(0.014)	(0.047)	(0.044)	(0.001)
Decile 10	0.346***	0.244***	0.629***	0.523***	3.276***	3.169***	-0.885***	0.631***	0.068***
	(0.000)	(0.000)	(0.001)	(0.001)	(0.015)	(0.014)	(0.046)	(0.042)	(0.002)
Constant	0.010***	0.173***	0.051***	0.129***	21.295***	13.355***	19.518***	23.895***	0.104***
	(0.000)	(0.001)	(0.000)	(0.003)	(0.010)	(0.027)	(0.033)	(0.146)	(0.001)
N	34387481	34387481	2596691	2596691	34387481	34387481	2596691	2596691	451369
R^2	0.120	0.264	0.249	0.369	0.002	0.072	0.001	0.137	0.019
FE	No	Yes	No	Yes	No	Yes	No	Yes	-
Country	Argentina	Argentina	Uruguay	Uruguay	Argentina	Argentina	Uruguay	Uruguay	Uruguay
P-value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Notes: This table presents the regression-version of Figures 1, 3 and 4 in the paper. Data correspond to listings of new goods that ended up being sold. Price dollarization is an indicator variable equal to one if a transacted price is denominated in dollars and zero otherwise. Time to sell is defined as the number of days elapsed between the day of the original listing and the transaction day for each unit sold. Asset dollarization is an indicator variable equal to one if the household making the transaction holds any liquid asset in dollars. The independent variable labeled as Decile i denotes an indicator variable that is equal to one if the transacted price belongs to decile i in the price distribution (decile 1 is the omitted category). Regressions are estimated by OLS for each country separately. Some specifications include fixed effects at the broadest category level. The last row shows the p-value of a test of the null hypothesis that all coefficients Decile i are equal to zero.

TABLE C2. Share of Listings with Price Changes by Currency

Category	Share of Price Changes		LC < FC Price Changes
	Local Currency	Foreign Currency	(p-value)
Electronics, audio and video	7.8%	6.2%	0.000
Cameras and accessories	9.0%	11.3%	1.000
Cellphones and phones	5.6%	9.0%	1.000
Games and toys	3.7%	2.5%	0.000
Videogames	6.2%	8.4%	1.000
Music and movies	1.1%	0.7%	0.000
Music instruments	4.9%	1.8%	0.000
Health and beauty	4.7%	2.8%	0.000
Sports and fitness	4.6%	1.6%	0.000
Babies related	6.4%	1.5%	0.000
Clothing	2.7%	1.6%	0.000
Industries, office	6.7%	4.2%	0.000
Home, furniture, garden	6.4%	3.0%	0.000
Computers	7.5%	7.7%	1.000
Hobbies	1.0%	1.2%	0.961
Books and magazines	1.1%	1.1%	0.604
Jewelry	2.1%	0.8%	0.000
Car accessories	5.4%	5.5%	0.932
Appliances	8.1%	4.8%	0.000

Notes: This table shows the share of listings in each category that ever had a price change. Price changes are detected by comparing the transacted price with the previous reference price. The previous reference price can be one of the following: (1) the original posted price in the case of the first transaction associated with the listing, or (2) the price of the previous transaction associated with the same listing, for all subsequent transactions. The second column presents the results for listings with prices set in local currency and the third column presents the results for those with prices set in foreign currency. The last column shows the p-value of a test of the null hypothesis that prices set in local currency are more sticky than prices in foreign currency.

TABLE C3. Means of Payment in Uruguay

Mean of payment	% of Transacted Volume in Dollars	Avg. Amount in Dollars	Avg. Amount in Pesos
Debit Cards	4.6%	151	40
Credit Cards	11.1%	198	38
Mobile Payments	12.5%	228	80
Automatic Bank Debit	19.3%	515	220
ATM extractions	9.6%	401	171

Notes: For debit and credit card transactions we consider only transactions made in Uruguay with local cards. Figures expressed in US dollars. Source: Banco Central del Uruguay (2016).

APPENDIX D. OMITTED PROOFS

D.1. *Proof of Proposition 1.*

First we show that $V_i^w \leq u$ for any i by contradiction (we will use this result later). Suppose instead that $V_i^w > u$. Then, for any distribution of non-negative prices the right hand side of equation (1) is equal to $\mathbb{E}[\exp(-r\tau)V_i^w]$, which is smaller than V_i^w – a contradiction.

Next we prove by contradiction both inequalities regarding reservation prices. First, suppose that $p_{1,D} < p_{2,D}$. Using the definition of reservation prices in domestic currency (2), it follows that $V_1^w > V_2^w$. Using this result and $V_i^w \leq u$ it follows that $p_{1,F} = \frac{u-V_1^w}{1+\kappa} < u - V_2^w = p_{2,F}$. Using equation (4) we can express the difference between the values of both buyers as

$$V_2^w - V_1^w = \frac{p(\theta)}{r} \left[f \int_{p_{1,F}}^{p_{2,F}} G_F(p)\mathrm{d}p + (1-f) \int_{p_{1,D}}^{p_{2,D}} G_D(p)\mathrm{d}p \right]. \tag{18}$$

But given that $p_{1,D} < p_{2,D}$ and $p_{1,F} < p_{2,F}$ this implies that $V_2^w - V_1^w > 0$, which contradicts our original assumption.

Now suppose that $p_{1,F} > p_{2,F}$. This assumption, together with the result we just showed $p_{1,D} \geq p_{2,D}$, implies that the right hand side of

$$V_1^w - V_2^w = \frac{p(\theta)}{r} \left[f \int_{p_{2,F}}^{p_{1,F}} G_F(p)\mathrm{d}p + (1-f) \int_{p_{2,D}}^{p_{1,D}} G_D(p)\mathrm{d}p \right]. \tag{19}$$

is positive, again leading to a contradiction.

D.2. *Proof of Proposition 2.*

We show that if the seller chooses prices in foreign currency then any price different from $p_{1,F}$ or $p_{2,F}$ is suboptimal. A similar proof follows for prices in local currency. First, we argue that $p > p_{2,F}$ cannot be an equilibrium since the value associated with posting this price is $e^{-\frac{r}{\pi} \log(p/p_{2,F})} W_{2,F} < W_{2,F}$. This is because no buyer is willing to buy until the real price erodes to the highest reservation value. Second, we argue that $p < p_{1,F}$ cannot be an equilibrium since the value associated with posting this price is $p \frac{q(\theta)}{q(\theta)+r+\pi_F} < W_{1,F}$. This is because the seller would not lose any customers by increasing its price to $p_{1,F}$ and thus increase profits. Finally, any price $p \in (p_{1,F}, p_{2,F})$ cannot be an equilibrium since the profit function is strictly convex in this interval, which implies that the seller can obtain higher profits by choosing the initial price at either the low or high reservation price. To show that the profit function is convex we compute its second derivative. Let $W(p)$ be the profits

associated with setting initial price $p \in (p_{1,F}, p_{2,F})$, then

$$
\begin{aligned}
W(p) &= p\mathbb{E}_t \left[e^{-i_F t} \right] \\
&= p \left[\int_0^{\hat{t}} e^{-i_F t} e^{-q(\theta)\Lambda t} q(\theta)\Lambda \mathrm{d}t + \int_{\hat{t}}^{\infty} e^{-i_F t} e^{-(q(\theta)\Lambda \hat{t} + q(\theta)(t-\hat{t}))} q(\theta)\mathrm{d}t \right] \\
&= p \left[\left(1 - \left(\frac{p}{p_{1,F}} \right)^{-\frac{q(\theta)\Lambda + i_F}{\pi}} \right) \frac{q(\theta)\Lambda}{q(\theta)\Lambda + i_f} + \left(\frac{p}{p_{1,F}} \right)^{-\frac{q(\theta)\Lambda + i_F}{\pi}} \frac{q(\theta)}{q(\theta) + i_f} \right]
\end{aligned}
$$

where $\hat{t} = \log\left(\frac{p}{p_{1,F}} \right) \frac{1}{\pi}$. Its first and second derivatives are given by

$$
\begin{aligned}
\frac{\partial W(p)}{\partial p} &= \left[\left(1 - \left(\frac{p}{p_{1,F}} \right)^{-\frac{q(\theta)\Lambda + i_F}{\pi}} \right) \frac{q(\theta)\Lambda}{q(\theta)\Lambda + i_f} + \left(\frac{p}{p_{1,F}} \right)^{-\frac{q(\theta)\Lambda + i_F}{\pi}} \frac{q(\theta)}{q(\theta) + i_f} \right] \\
&\quad - \left[\frac{q(\theta)}{q(\theta) + i_f} - \frac{q(\theta)\Lambda}{q(\theta)\Lambda + i_f} \right] \frac{q(\theta)\Lambda}{q(\theta)\Lambda + i_f} \left(\frac{p}{p_{1,F}} \right)^{-\frac{q(\theta)\Lambda + i_F}{\pi}},
\end{aligned}
$$

$$
\frac{\partial^2 W(p)}{\partial^2 p} = \left[\frac{q(\theta)}{q(\theta) + i_f} - \frac{q(\theta)\Lambda}{q(\theta)\Lambda + i_f} \right] \frac{q(\theta)\Lambda}{q(\theta)\Lambda + i_f} \left(\frac{p}{p_{1,F}} \right)^{-\frac{q(\theta)\Lambda + i_F}{\pi}} \frac{1}{p} \left(1 - \frac{q(\theta)\Lambda + i_F}{\pi} \right) < 0.
$$

D.3. *Proof of Proposition 3.*

If $\lambda = 0$, we have that there is only one reservation price by currency, $p_{1,c}$ for $c \in \{F, D\}$. This, together with the fact that sellers have no incentive to set prices above the reservation prices, implies that, conditional on a meeting, the probability of the transaction occurring is equal to one and the meeting rate for sellers is $q(\theta) = b$.

We can express the value of the seller as

$$
W_c = p_{1,c} \frac{b}{b + r + \pi_c}. \tag{20}
$$

Using the fact that $p_{1,D} = (1+\kappa)p_{1,F}$, we can express the optimal currency choice of prices as

$$
f = \begin{cases} 0 & \text{if } \frac{b+r+\pi_D}{b+r+\pi_F} < 1 + \kappa \\ x \in [0,1] & \text{if } \frac{b+r+\pi_D}{b+r+\pi_F} = 1 + \kappa \\ 1 & \text{if } \frac{b+r+\pi_D}{b+r+\pi_F} > 1 + \kappa. \end{cases} \tag{21}
$$

Note that f is weakly increasing (decreasing) in a certain parameter if and only if the function

$$J = \frac{b + r + \pi_D}{b + r + \pi_F} - (1 + \kappa)$$

is weakly increasing (decreasing) in the same parameter. Results (1) - (4) follow directly from taking partial derivatives of J with respect each parameter and assessing its sign.

APPENDIX E. QUANTITATIVE ANALYSIS

FIGURE E.1. Time to Sell and 'Multi-currency Buyers': Model and Data

(A) Time to Sell Goods

(B) Share of 'Multi-currency Buyers'
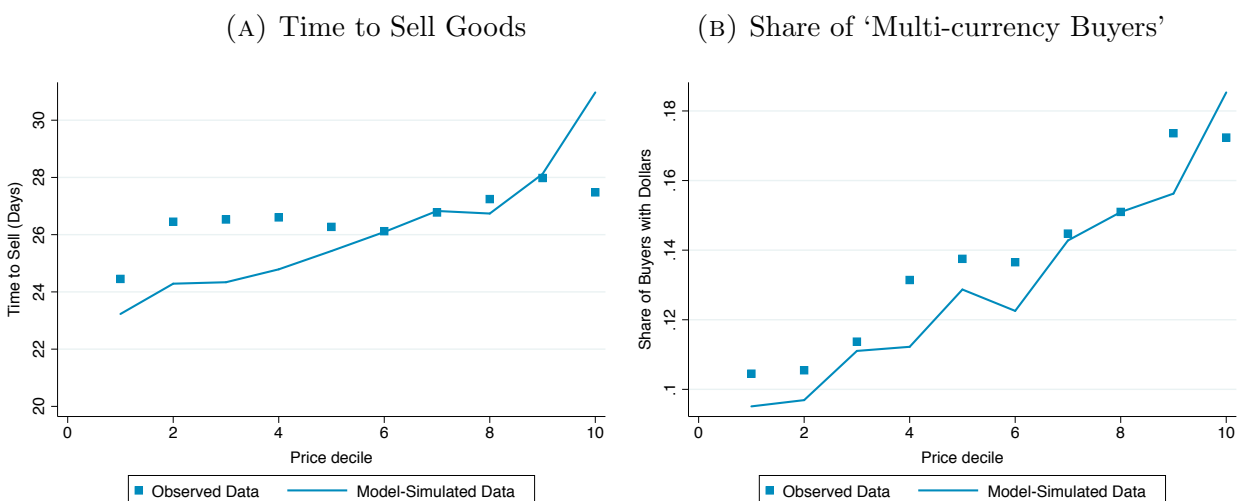
Notes: Panel (A) shows the number of days it takes the average good to be sold, by decile of the transacted price distribution. The blue dots are computed with observed data on posted prices of new goods for Uruguay in 2012. Data correspond to transactions of new goods. The blue solid line corresponds to data generated by simulations from the model with the calibrated parameters. Panel (B) shows the share of 'multi-currency' buyers by decile of the transacted price distribution. The blue dots are computed with data estimates of the average probability of buyers having liquid assets in dollars, for transactions within each decile. The probability of buyers having liquid assets in dollars is estimated using data on income of the household that purchases each good. See Online Appendix A for details on this computation. The blue solid line corresponds to the data generated by simulations from the model with the calibrated parameters. It corresponds to the average value of λ, the share of entrant buyers of type $i = 2$ ('multi-currency buyers').

TABLE E1. Model Fit

Moment	Data	Model
Average price dollarization	18.1%	18.7%
Average time to sell goods (in days)	26	26
Avg. share of multi-currency buyers	12.8%	13.0%
Std. dev. of log prices	1.40	1.38
Std. dev. of time to sell	18	31
Std. dev. of share of multi-currency buyers	0.15	0.16
Corr. log prices - time to sell	0.05	0.07
Corr. log prices - share multi-currency buyers	0.13	0.17

Notes: Multi-currency buyers refer to buyers of type $i = 2$ in the model and households with liquid assets in dollars in the data.

REFERENCES

Banco Central del Uruguay (2016): "Sistema de Pagos Minorista," *Reporte Informativo N 15.*

United Nations (2008): "International Standard Industrial Classification of All Economic Activities (ISIC), Rev. 4," *New York: United Nations.*