Australian School of Business Research Paper No. 2012 ECON 29

Multi-Product Firms and Exchange Rate Fluctuations

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January 19, 2012

*We would like to thank Penny Goldberg for advice on this project. We are grateful to Saroj Bhattarai, Linda Goldberg, Gene Grossman, Frederic Robert-Nicoud, Esteban Rossi-Hansberg, and trade workshop participants at Princeton University for many helpful comments and suggestions. Many thanks to João De Negri and IPEA-Brasília for granting access to Secex and RAIS. Comments and questions are welcome. Please contact arpita.chatterjee@unsw.edu.au, dix-carneiro@econ.umd.edu or jvichyanond@imf.org.

Abstract

This paper studies the effect of exchange rate shocks on export behavior of multi-product firms. We provide a theoretical framework illustrating how firms adjust their prices, quantities, product scope, and sales distribution across products in the event of exchange rate fluctuations. In response to a real exchange rate depreciation, firms increase markups for all products, but markup increases decline with firm-product-specific marginal costs of production. We find robust evidence for our theoretical predictions using Brazilian customs data containing destination-specific and product-specific export sales and quantities. The sample period covers the years 1997-2006, during which Brazil experienced a series of drastic currency fluctuations.

JEL classification: F12, F41

Keywords: Multi-product firms, exchange rate pass-through, product ladder, local distribution costs.

1 Introduction

The relatively muted response of consumer import prices to exchange rate fluctuations is a stylized fact that has intrigued economists for many years.[1] Understanding this phenomenon is crucial to many issues faced by policy-makers, since the degree of exchange rate pass-through has implications for how currency devaluations affect inflation and hence the conduct of monetary policy. Furthermore, it may also have important effects on the welfare of exporting firms, importing firms, and consumers. Since there is a symmetry on how import tariffs and exchange rates affect domestic prices, the study of the determinants of exchange rate pass-through may also shed light on how and to what extent domestic prices react to trade liberalization. Finally, understanding exchange rate pass-through is interesting in itself because it helps us understand how firms set prices and how they react to shocks.

The study of exchange rate pass-through in international macroeconomics has for a long time focused on aggregate cross-country data. However, due to the increasing availability of firm- and product-level export and import transaction data, many authors have begun to analyze firm-level responses in order to understand the determinants of incomplete exchange pass-through. This strand of the literature started with Feenstra, Gagnon and Knetter (1993) and Goldberg and Verboven (2001) studying price behavior in the international car market, and is experiencing a recent surge with the availability of official customs data. These data usually cover all international transactions of a given country and provide researchers with an unprecedented level of detail.[2] This change in focus to firm-level data is not surprising given that in the past decade, the international trade literature established firms as the primary

[1] For examples, see Goldberg and Knetter (1997), Burstein, Neves, and Rebelo (2003), Campa and Goldberg (2005), Campa, Goldberg, and Gonzalez-Minguez (2006), Devereux, Engel, and Tille (1999), and Devereux and Engel (2002) among others.

[2] Examples of this recent literature include, Itskhoki, Gopinath and Rigobon (2008) who study currency choice as a determinant of pass-through, Itskhoki and Gopinath (2009) who study the relationship between the frequency of price adjustment and pass-through, and Berman, Mayer and Martin (2011) who study how different exporters react to exchange rate movements.

agents of international commerce.[3] Firms that participate in international trade are heterogeneous in productivity, produce multiple products and often exhibit heterogeneous productivity across different products.[4] In this paper, we explicitly model the effect of exchange rate shocks on the pricing decisions of heterogeneous multi-product exporters and empirically explore implications of within- and across-firm heterogeneity in explaining exchange rate pass-through using detailed transaction-level customs data from Brazil.

Our theoretical framework illustrates how heterogeneous firms adjust their prices, quantities and product scope in the event of an exchange rate depreciation, and how the degree of price and quantity responses varies across products within firms. The two key features of the model are: 1) Each firm faces a product ladder, i.e. there is a core product that the firm is most efficient at producing (the firm's "core competency") and the firm is less efficient at producing products further away from it; and 2) Each firm pays a local per-unit distribution cost, which implies that markups vary depending on how far the product is from the firm's core competency. Within a given firm, optimal markups are higher for products closer to the core competency. For these products, the production costs are relatively low, so that distribution costs constitute a significant fraction of consumer prices, leading to lower perceived demand elasticity and hence higher markups.

Theoretically, we show that in response to an exchange rate depreciation, producer price increases are more pronounced for products closer to the core competency, i.e., those with greater productivity. The reason is that local per-unit distribution costs imply different degrees of markups depending on the firms' product-specific productivities. Also, firms expand their product scope, and their sales distribution across different products becomes less skewed in response to a real exchange rate depreciation. These two results imply that following a devaluation, the importance of non-core (less efficient) products relative to core products increases in firms' export baskets, leading to a within-

[3]See Melitz (2003) and Bernard, Jensen, Redding and Schott (2007).

[4]See Bernard, Redding and Schott (2011), Nocke and Yeaple (2006), Melitz, Mayer and Ottaviano (2011), Eckel and Neary (2011), Arkolakis and Muendler (2011), among others.

firm reallocation of resources towards less efficient use.

We test the theoretical predictions using rich Brazilian customs data. Spanning the period from 1997 to 2006, during which Brazil experienced a series of major exchange rate fluctuations, the dataset has very detailed information at the firm, product, and destination levels. This allows us to use exchange rate variation as well as firm-, product-, and destination-specific information in order to analyze how firms respond to exchange rate movements. We find that the responses of prices, quantities, firm scope, and sales distributions to exchange rate fluctuations are consistent with the theoretical predictions. Our key finding is that the relative position of a product within a firm is a statistically and economically significant determinant of producer price responsiveness to real exchange rate shocks. This result is robust to different measures of within-firm heterogeneity, and after controlling for a rich set of firm, industry and country characteristics. Firm productivity - proxied by a set of firm characteristics - also plays a key role in determining exchange rate pass-through.

The paper is structured as follows. Section 2 discusses the related literature, section 3 describes the theoretical framework and its predictions, section 4 presents the empirical analysis, and section 5 concludes the paper.

2 Related Literature

Our paper is mostly related to Berman, Martin, and Mayer (2011), who study optimal price responses to exchange rate movements from French firms. While their model also features local per-unit distribution costs as the main driver of heterogeneous price responses, their analysis focuses on single-product firms and therefore on how high-productivity firms react differently from low productivity firms.[5] However, most firms participating in international trade produce

[5]Corsetti and Dedola (2005) is the first paper introducing nontradable distribution costs as the source of endogenous markups with CES demand and consequent heterogeneous pricing to market. Hellerstein (2008) uses a detailed dataset with retail and wholesale prices for beer and finds that markup adjustments by manufacturers and retailers explain roughly half of the incomplete transmission of exchange rate shocks, and that local cost

multiple products. By allowing firms to produce more than one product, we are able to obtain additional results, namely on how firms change their product range and how price responses differ from product to product within a firm. Furthermore, we are also able to take advantage of a much larger sample in our econometric analysis, since the overwhelming majority of price observations come from multi-product exporters. Our empirical results also confirm the key conclusion of Berman, Martin, and Mayer (2011) that in response to real exchange rate depreciations, more productive firms increase producer prices further than less productive firms.

Regarding multi-product firms, our study is most similar to Mayer, Melitz and Ottaviano (2011), whose primary focus is to understand how export market conditions, such as market size and degree of competition, affect firms' relative sales distribution across products. We adopt their deterministic formulation of product ladders to show how the relative sales distribution across products changes in response to exchange rate movements.

Mayer, Melitz and Ottaviano (2011) incorporate a linear demand system in their framework in order to allow for endogeneity of markups. In our setup, endogenous markups arise due to the presence of local distribution costs, even though the demand structure is derived from CES preferences.[6] All of our theoretical predictions would be unchanged if we used a linear demand system in our framework. However, CES preferences allow for an analytically tractable framework where we can explicitly demonstrate how distribution and transportation costs affect producer price elasticities as well as empirically test these predictions.

The focus of our paper is to analyze the heterogeneity and the firm-level determinants of pricing-to-market. In addition, we also allow for destination- and industry-level determinants of producer price responsiveness in our analysis, following the tradition of the empirical international macroeconomics litera-

components account for the other half.

[6] An alternative mechanism for endogenous markups and heterogeneous pricing to market is presented in Atkeson and Burstein (2008). In their setup with Cournot competition and nested CES demand over several sectors, high performing firms with larger market share face less elastic demand and hence charge higher markups.

ture (see, for example, Campa and Goldberg (2005) and Campa and Goldberg (2010)).[7]

3 Theoretical Framework

Our theoretical framework features the model of multi-product firms of Mayer, Melitz and Ottaviano (2011) embedded into the model of CES demand and local distribution costs of Corsetti and Dedola (2005) and heterogeneous firms of Berman, Martin and Mayer (2011). In the model, heterogeneous firms in the Home country export to a variety of destinations. As our empirical section uses data from Brazil, we use "Home" to refer to Brazilian firms. Firms can export a number of products to a given destination, with the firm-product specific productivity depending on how far the product is from the firm's core expertise. We analyze how an exchange rate shock affects firms' optimal price and quantity responses as well as the number of products exported. An individual firm's decision cannot affect exchange rate movements. Hence, we treat such movements as exogenous from the point of view of the firm.

3.1 Setup

The representative agent in country (destination) c has utility

$$U_c = \left(\int_X x_c(\varphi)^{1-\frac{1}{\sigma}} d\varphi \right)^{\frac{1}{1-\frac{1}{\sigma}}} \tag{1}$$

where $x_c(\varphi)$ is the consumption of product φ in country c and X denotes the set of traded products. The elasticity of substitution among products is $\sigma > 1$.

Each firm has one product corresponding to its core competency; this is the product which it is most efficient at producing. The productivity associated with this "core product" is a random draw θ from a common and known

[7]Following our theoretical framework, we allow price responses to vary according to industry-specific distribution margins and the distance between Brazil and its export destinations. Also, we control for the heterogeneity of producer price responses according to real exchange rate volatility and market potential of destination countries as potential determinants of currency invoicing decision.

distribution with bounded support; each firm is therefore indexed by θ. We use r to denote the rank of the product in increasing order of distance from the firm's core competency, with $r = 0$ referring to the core product. The productivity of a firm with core competency θ in producing product r for country c is given by

$$\varphi(r, \theta) = \theta \omega_{c\theta}^{-r}, \ \omega_{c\theta} > 1 \tag{2}$$

The above expression defines a firm's competency ladder, where $\omega_{c\theta}$ characterizes the length of the ladder.[8] Products with higher r are further away from the core competency, and the firm is relatively less efficient at producing these products. We denote the total number of products exported by a firm to any destination c (firm scope) as $n_c(\theta)$. Firms employ one unit of labor at Home to produce $\theta\omega_{c\theta}^{-r}$ units of any variety φ. The wage rate at Home is w.

Each firm faces a local distribution cost for each unit of any product it exports to destination c. This cost is meant to capture all expenses associated with delivering the product to a customer after the product has left Home. Per unit distribution costs in country c are measured as η_c units of labor hired in country c.

Because of the presence of local distribution costs, per unit costs depend on both Home and destination wage rates. Let w_c be the wage rate in country c, and ε_c be the nominal exchange rate between Home and country c expressed in Home currency per country c's currency. Therefore, an increase in ε_c is a depreciation in Home's currency vis-a-vis country c's. We call $q_c \equiv \frac{w_c \varepsilon_c}{w}$ the real exchange rate between Home and country c.

Firms face a fixed cost F_c in exporting to destination c. These fixed costs are the same for all firms and products and only depend on the country of destination c. In addition, there is an iceberg transport cost $\tau_c > 1$.

In units of country c's currency, the consumer price of product $\varphi(r, \theta)$,

[8] Our main results are independent of whether the length of the ladder $\omega_{c\theta}$ depends on country c characteristics or firm characteristics θ.

denoted by $\widetilde{p}_c$, is given by:

$$\widetilde{p}_c = \frac{p_c\left(\varphi\left(r,\theta\right)\right)\tau_c}{\varepsilon_c} + \eta_c w_c \tag{3}$$

where $p_c(\varphi(r,\theta))$ is the producer price of the good exported to c expressed in Home's currency. The first term corresponds to the good's price at country c's dock expressed in country c's currency, and the second term captures the distribution cost incurred in country c. The quantity demanded in country c of this product is:

$$x_c(\varphi) = Y_c P_c^{\sigma-1}\left(\frac{p_c(\varphi(r,\theta))\tau_c}{\varepsilon_c} + \eta_c w_c\right)^{-\sigma} \tag{4}$$

where Y_c is the income of country c and P_c is the price index in country c.

For a firm-product specific productivity φ, the cost in the Home currency of producing $x_c(\varphi)\tau_c$ units and selling them in country c is $\frac{w x_c(\varphi)\tau_c}{\varphi} + F_c$, which implies exporting profits of $\pi_c(\varphi) = \left(p_c(\varphi) - \frac{w}{\varphi}\right) x_c(\varphi)\tau_c - F_c$.

Firms choose profit maximizing price for each product and the number of products. The optimal pricing decision for any given product leads to the producer price of:

$$p_c(\varphi) = \frac{\sigma}{\sigma-1}\left(1 + \frac{\eta_c q_c \varphi}{\sigma \tau_c}\right)\frac{w}{\varphi} = m_c(\varphi)\frac{w}{\varphi} \tag{5}$$

Note that the markup, $m_c(\varphi)$, is higher than the usual monopolistic competition markup due to the presence of local distribution costs. Also, the markup increases with the real exchange rate, the measure of distribution cost and with the firm-product specific productivity level φ.[9] For a more productive firm (high θ), for a product closer to the firm's core competency (low r, given θ), or for a depreciated real exchange rate (high q_c), a larger share of the final consumer price does not depend on the producer price, resulting in a lower perceived elasticity of demand and hence higher markups. Note that the

[9] Berman, Martin and Mayer (2011), Bergin and Feenstra (2001, 2002, 2009) and Atkeson and Burstein (2008) have similar predictions on markups.

perceived elasticity of demand is given by:

$$\frac{\partial \ln x_c}{\partial \ln p_c} = -\sigma \left(1 - \frac{\eta_c w}{\eta_c w + \frac{p_c \tau_c}{q_c}}\right) \tag{6}$$

This expression shows that a higher real exchange rate (q_c) implies a more inelastic demand, and hence to higher markups charged. Similarly, more productive firm-product pairs (lower charging lower p_c) face a more inelastic demand curve and hence also charge higher markups. This is the same idea and intuition behind heterogeneity across firms in markups in Berman, Martin and Mayer (2011).

To determine the number of products, note that a firm with productivity θ earns profits $\pi_c(\varphi(n_c, \theta))$ from its marginal product, where $\pi_c(\varphi(n_c(\theta), \theta))$ equals

$$Cwq_c w_c^{-\sigma} Y_c P_c^{\sigma-1} \left(\frac{\tau_c}{\theta \omega_{c\theta}^{-n_c(\theta)+1} q_c} + \eta_c\right)^{1-\sigma} - F_c, \tag{7}$$

where C is a positive constant that only depends on σ. These profits decrease in $n_c(\theta)$. A product further from the core has a higher variable cost. Thus, a firm earns higher profits on products closer to its core competency.

A firm with productivity θ produces $n_c(\theta)$ products, where $n_c(\theta)$ is the largest integer for which (7) is positive. If (7) is positive only for the top product, then the firm is a single-product firm producing only its top product. If the firm-specific productivity θ is so low that it does not earn positive profits even from its top product, then that firm does not export to destination c.

3.2 Key Predictions

Here we present the key predictions from our theoretical mechanism.

Producer price and quantity response: Producer prices increase following a real depreciation. From (5) it is clear that the markup increases with real exchange rate through the impact of the real exchange rate on the local distribution cost component. The producer price elasticity is given by

$$\frac{\partial \ln p_c}{\partial \ln q_c} = \frac{\eta_c q_c \varphi}{\sigma \tau_c + \eta_c q_c \varphi} \tag{8}$$

The producer price elasticity with respect to real exchange rates is less than 1; thus, assuming no general equilibrium implication for the wages in the destination country (w_c), real exchange rate depreciation reduces the price faced by consumers at country c, despite the producer price increase. Hence the quantity response to a real exchange rate depreciation is positive.

Note that the producer price elasticity is specific to each firm and to each product. In fact, (8) increases in both firm-specific and product-specific productivity. Hence, in response to a real exchange rate devaluation, more productive firms increase prices to a further extent than less productive firms. Moreover, multi-product firms further increase producer prices for products closer to the core competency than for those further away. Due to firms' higher efficiency at producing core products and to local distribution costs, production costs account for a relatively small fraction of the consumer price. Consequently, the perceived demand elasticity is lower, leading to higher markups. This translates into higher price increases for these products as a result of a depreciation.

For single-product firms, since the price response is stronger for more productive firms, the quantity response is weaker for those firms. Similarly, for multi-product firms, the quantity response is weaker for products closer to the core competency than for those further away.

Moreover, the producer price elasticity increases in per-unit distribution costs and decreases with transportation costs. This follows from the markup, $m_c(\varphi)$, which is increasing in distribution costs and falling with transportation costs.

In addition to price responses, the theoretical framework yields the following implications regarding firm scope adjustment, and changes in relative sales.

Firm scope: A firm (weakly) increases its number of products exported to destination c in response to a depreciation. The intuition for this result is the following. Before the depreciation, profits for all exported products are positive and are decreasing with the distance of the product from the firm's core competency. The product furthest away from the core competency, or the "marginal product," is the last product that yields positive profits (the next product yields negative profits, reducing total profits). When the depreciation occurs, profits increase for all products, including the pre-depreciation next-to-marginal product, which may now make positive profits. As a result, the firm has an incentive to expand the range of products further down the ladder.

Changes in relative sales: Consider two products of a firm, where product 1 is higher up in the product ladder than product 2, i.e. $\varphi_1 > \varphi_2$. Then the ratio of the sales of product 1 to the sales of product 2 decreases in response to an exchange rate depreciation.[10] The shift in the relative sales distribution following a depreciation is due to the fact that price increases are not homogeneous across products within firms. Since price increases are more pronounced for products closer to the core competency, quantity responses for these products are relatively muted, leading to an increase in sales that is proportionately smaller than an increase in sales of products further away from the core competency. Thus, in the presence of endogenous markups used in this paper, a real exchange rate depreciation implies a within-firm reallocation of resources towards less efficient use. Relative sales also become less skewed in response to a decrease in transportation costs. Similarly, an increase in transportation costs and/or a real exchange appreciation imply tougher competition in export markets which induces a firm to skew its export sales towards its best performing products, in a manner similar to Mayer, Melitz and Ottaviano (2011).[11]

To summarize, we empirically test the following predictions concerning the effects of a real exchange rate depreciation in the home country: (i) Producer

[10] See appendix for derivation.

[11] Mayer, Melitz and Ottaviano (2011) allow for endogenous markups through a linear demand system. In our set up, local distribution costs give rise to endogenous markups. All of our results go through with the specification of markup endogeneity à la Mayer, Melitz and Ottaviano (2011).

prices charged by the home country firms increase following a real exchange rate depreciation; (ii) More productive firms increase producer prices to a further extent than less productive firms. For multi-product firms, increases in producer prices are more pronounced for products closer to the core product; (iii) The producer price elasticity increases with per-unit distribution costs and decreases with transportation costs; (iv) A firm increases its scope of exported products to a given destination; and (v) The skewness of sales across products within a firm decreases.

4 Empirical Analysis

4.1 Data

Here we describe the primary sources of data that we use. In this paper we only use data on manufactured products from firms whose activities are concentrated in manufacturing.

4.1.1 Secex - Customs Data

These records describe every legally registered export transaction from Brazilian firms. For each transaction, the available information includes the exporting firm (establishment level), identified by its unique 14-digit identifier $CNPJ$ (Cadastro Nacional de Pessoa Jurídica); the exported good at the 8-digit level NCM (Nomenclatura Comum do Mercosul)[12]; country of destination; value of the transaction in US$; number of units and/or weight (in kg) of the shipment; and year and month of the transaction. The same type of data is also available for import transactions.

The data present both weight and quantity columns. For some transactions only weight or quantity is reported, and for others both are reported. In order to choose in what unit the unit-values are computed, we construct for every product-destination pair a most frequently reported unit throughout the sample period. We compute unit values dividing total sales of product i, from

[12] The NCM classification coincides with the Harmonized System at the 6-digit level.

firm j, to destination c at time t by the total quantity of product i, from firm j, to destination c at time t. While Secex is available since 1990, there is no information on quantities until 1996, which makes it impossible to compute unit-values. Therefore, we only use data from 1997 to 2006, a period in which Brazil suffered several shocks in its exchange rate.

4.1.2 RAIS

These records consist of all legally registered Brazilian firms. Every year, firms are required by law to report data on each of their establishments and employees as well as several firm-specific variables. In particular, we construct measures of skill composition, number of employees, and average hourly wages for each firm. Firms must also report the industry that best describes their activities at the 5-digit level of the CNAE[13] classification, which coincides with the ISIC Rev. 3 classification at the 2-digit level. Firms are identified by their unique registry number (CNPJ), therefore we merge Secex and RAIS in order to obtain firm-level information for exporters. Unfortunately, RAIS does not provide information on domestic sales, revenue, capital, or other inputs. Consequently, we cannot estimate productivity using the methodology in Olley and Pakes (1996) nor construct cruder variables to proxy for productivity, such as revenue per worker. For that reason, we proxy for productivity jointly using variables such as firm size, skill composition, average hourly wages, importance of imported inputs and export performance. These variables are shown in the literature to strongly correlate with productivity (see for example, Bernard, Jensen, Redding and Schott (2007) and Tybout (2003)). We discuss in greater detail the use of these variables as proxies for productivity in Section 4.2.1, including the empirical evidence available for Brazil.

4.1.3 Aggregate (economy-wide and sector-level) data sources

We obtain data on exchange rates, population, price indices and GDP for different destinations from the Penn World Table (PWT). Information on several

[13] Classificação Nacional de Atividades Econômicas

aggregate variables is available in PWT from 1950 to 2007 for 190 countries. We use data on distribution margins from Campa and Goldberg (2010) as a measure of the importance of distribution costs at the 2-digit CNAE industry level.[14] Finally, we use country-specific import data from Comtrade in order to construct measures of destination-specific product demand at the Harmonized System 6-digit level.

4.1.4 Descriptive Statistics

The firm-level data that we use is very comprehensive and well-suited to empirically explore the hypotheses of the theoretical mechanism we present in this paper. In addition, Brazil underwent major real exchange rate fluctuations over the period of our study, which makes this dataset particularly attractive to study the questions at hand. Figure 1 illustrates the time path of the monthly nominal exchange rate between the Brazilian Real and the US Dollar. The currency was pegged to the dollar until early 1999 when it faced a sharp depreciation. After that, it faced another period of sharp depreciation in 2002 due to uncertainty in Argentina as well as increasing uncertainty vis-a-vis presidential candidate Lula's economic policies prior to taking office. Soon after Lula became president and brought continuity to his predecessor's sound economic policies, the currency started to appreciate gradually. Figure 2 shows the evolution of the annual real exchange rate with respect to the dollar - which is the frequency we will be working with in this paper - and Figure 3 shows the annual variation in the real exchange rate, which depreciated 45% between 1998 and 1999.

Next, we highlight a few important characteristics of the firm-level dataset. An important contribution of our paper is to highlight how within-firm heterogeneity shapes firms' responses to real exchange rate shocks. We model within-firm heterogeneity as a deterministic product ladder within a firm. The empirical counterpart of a theoretical product in our dataset is an 8-digit level

[14] Campa and Goldberg (2010) compute industry-specific distribution costs for a set of 20 countries. In our paper, we only show results using distribution costs at the industry level by using averages across countries also computed in Campa and Goldberg (2010). We do so since the restriction to 20 countries substantially reduces our sample size.

NCM code. In Table 1 we illustrate a few examples of NCM codes. For example, in the eyeglass industry the different products in the data are plastic eyeglass frames, metal eyeglass frames, safety eyeglasses, sunglasses, telescopes, binoculars, etc. These product categories in the data are sufficiently different from each other for them to correspond to the theoretical notion of distinct products and allow for the possibility of different firms having core expertise in different products.

Ours is the first paper to study the multi-product aspect of firms in determining exchange rate pass-through. Half of exporting firms export more than one product in the dataset, and the overwhelming majority of export transactions come from multi-product firms. Guided by our theoretical framework, we define a multi-product firm as a firm-destination-year triplet with strictly more than one product exported. A single-product firm in a given year is defined as a firm-destination-year triplet with only one product exported. We compare multi-product and single-product firms in Table 2. Although multi-product firms account for half of the firms in the data, they account for approximately two thirds of total employment and more than three quarters of total export value. The last column "fraction of unit-value observations" looks at the share of unit-values in our dataset that come from multi-product firms and single-product firms. Almost 90% of unit value observations are associated with multi-product firms.

Conditional on exporting, the overall average number of products exported by a firm to a given country is 5.2, while the median number of products is 2, as seen in Table 3 which lists the top 10 export industries in Brazil. Comparing different industries, we can see that there is a significant degree of heterogeneity across them.[15] In the "Food and Beverages" industry (CNAE 15) the average number of products exported by a given firm to a given destination is 2.4, whereas in the "Assembly of Automotive Vehicles" industry (CNAE 34) the average number of products exported by a given firm to a given destination is 19.

[15] Products are attached to industries using a correspondence table from NCM codes to 2-digit CNAE industries at http://www.ibge.gov.br/concla/cl_corresp.php?sl=3

Consistent with our key modeling assumption, we observe great heterogeneity across products within firms, as Table 4 shows. On average, for a given firm, the revenue generated by the product with the highest revenue is approximately three times greater than the revenue generated by the product with the second highest revenue. In fact, the revenue generated by the top product is roughly twice as large as the revenue generated by the sum of all the other products.

Finally, it is informative to display some descriptive statistics related to Brazilian firms' destinations. The median number of destinations for an exporting firm is equal to 2 in a given year, the 25th percentile is equal to 1 destination and the 75th percentile is equal to 5 destinations. Table 5 shows the top 10 export destinations from manufacturing firms over the 1997-2006 period. They account for 45% of all manufactured goods exports from Brazilian manufacturing firms, with the United States and Argentina accounting for more than one fifth of total exports.

4.2 Econometric Analysis

4.2.1 Response of Prices and Quantities to Real Exchange Rates

In this section, we first test our theoretical predictions concerning producer prices. The two key predictions are that (1) producer prices increase following a real depreciation, and (2) producer prices increases are more pronounced for more productive firms, and within-firm for products closer to the core competency. We estimate the following reduced-form regression to test the first prediction:

$$\ln p_{ijct} = \mu_{ijc} + \Phi(t) + \beta \ln\left(RER_{ct}\right) + X_{jt-1}\gamma + Z_{ict}\delta + \varepsilon_{ijct} \qquad (9)$$

where p_{ijct} is the producer price in 2006 R$ charged by firm j for product i in destination c in year t, μ_{ijc} is a product-firm-destination fixed-effect, $\Phi(t)$ is a 5th degree time polynomial, RER_{ct} is the real exchange rate of country c in year t with respect to Brazil, Z_{ict} is a vector of characteristics of destination c in year t that may also be product i specific, X_{jt-1} is a vector of firm j's characteristics in year $t-1$, and ε_{ijct} is an error term.

The coefficient β captures the long-run response (in the co-integration sense) of the producer price to real exchange rate fluctuations and is the key parameter to be estimated. We estimate (9) using the fixed-effects estimator. For each triplet ijc, β is identified by the correlation between the deviations of log-prices to the mean log-price of ijc across time and deviations of $\ln(RER_{ct})$ to the mean of each country c across time. The real exchange rates RER_{ct} are assumed to follow an exogenous process, as this is a partial equilibrium model. In this specification, and in all those that follow, standard errors are clustered at the firm level, allowing for the unobserved errors to be correlated across products within a firm and over time.

We control for a flexible time trend with the time polynomial term in the regression. We also control for country of destination's per capita GDP ($\ln(PCGDP_{ct})$), GDP ($\ln(GDP_{ct})$), and for a measure of demand of product i in country c at time t ($\ln(Dem_{ict})$). Dem_{ict} is given by one plus the total imports of 6-digit product i into country c, excluding imports from Brazil.

The firm characteristics that we control for include log of firm size measured by number of employees ($\ln(Emp_{jt-1})$), fraction of skilled (high school completed or higher) workers in the firm ($Skill_{jt-1}$), log of the average wage paid in the firm ($\ln(\bar{w}_{jt-1})$), a measure of importance of imported inputs relative to total wage bill at the firm level ($\ln(Imp_{jt-1})$, where Imp_{jt-1} is given by $1+\frac{Total\ Imports\ of\ Firm\ j\ in\ year\ t-1}{Wage\ Bill\ of\ Firm\ j\ in\ year\ t-1}$) and a measure of export performance ($\ln(Exp_{jt-1})$, where Exp_{jt-1} is given by $1+\frac{Total\ Exports\ of\ Firm\ j\ in\ year\ t-1}{Wage\ Bill\ of\ Firm\ j\ in\ year\ t-1}$). All these variables are lagged in order to avoid correlation between contemporaneous shocks to prices and contemporaneous innovations to firm-level characteristics. For example, current levels of employment and wages may immediately react to shocks in productivity, leading to current errors being correlated with current firm-level variables.

All of these firm characteristics are empirically established strong indicators of a firm's latent productivity. Bernard, Jensen, Redding and Schott (2007) survey the literature and document strong supporting evidence from United States manufacturing firms. Tybout (2003) also reports this strong positive correlation between firm productivity, size, wages and export performance. Similar evidence has been established for Brazilian firms. Menezes-Filho, Muendler and Ramey (2008) merged the Brazilian manufacturing survey to RAIS in order to document a strong and positive correlation between wages paid by firms, firm size, capital intensity, occupational skill intensity and workforce productivity in Brazilian manufacturing. Also using the manufacturing survey, Gomes and Ellery Jr (2005) show that firm size and productivity are strongly correlated in Brazil. In addition, they show that exporting firms are larger and more productive. Schor (2004) presents evidence that enhanced access to foreign intermediate inputs following the Brazilian trade liberalization in the 1990's lead to improved firm productivity. Finally, Mizala and Romaguera (1998) conclude that larger and more productive firms pay higher wages in Brazil, after controlling for worker characteristics.

There is one caveat the reader should keep in mind in using firm size and export performance as proxies for productivity. These variables are likely to be positively correlated with firm-specific demand, which is unobserved. However, this problem is also present in any study that estimates revenue-based productivity, without controlling for prices charged by firms. Indeed, prices charged by firms are seldom available in firm-level data, so that it is very difficult to get around this problem in most available datasets.

The quantity counterpart of producer price responsiveness follows naturally. From (8), the elasticity of producer prices with respect to real exchange rates is less than one, hence the consumer price falls and the quantity exported increases following a real exchange rate depreciation. We also estimate equation (9) with the log of quantities exported in the left-hand side, instead of the log of prices.

Table 6 reports the results concerning the responsiveness of producer price and quantity to real exchange rates. The coefficient estimate for log real exchange rate is positive and significant in both cases. Increases in the real exchange rate (real depreciations) are associated with increases in producer prices and quantity exported. The producer price elasticity is estimated to be of approximately 0.23, which implies an exchange rate pass-through to import prices abroad (in the destination's currency) of around 0.77, before local distribution costs (which further attenuate the pass-through to consumers).

The estimated import price elasticity obtained using similar firm-level French data is of 0.83 (see Berman, Martin, and Mayer (2011)). Similarly to our study, this elasticity is also before local distribution costs and is remarkably close to our estimate. Using country- and industry-level data for OECD countries, Campa and Goldberg (2005) obtain an elasticity of 0.64 (Campa and Goldberg (2005)). They also show that the United States have a pass-through of 0.4, which is significantly lower than in other countries in the OECD.

The positive responsiveness of producer prices to exchange rate movements is robust when we separately estimate equation (9) for each industry, the only exception being the Coke, Oil Refining, Nuclear Fuel and Ethanol Industry (CNAE 23) with a coefficient of -0.02. However, this coefficient is statistically non-significant, with a standard error of 0.2. In addition, that industry is the second industry with the smallest number of observations (with roughly 4,000 observations), second only to the Tobacco industry (CNAE 16) with 574 observations. Interestingly, Figure 4 shows a high degree of heterogeneity of producer price responsiveness for different industries. Such heterogeneity is further investigated later in this subsection.

Next we present more detailed results regarding price adjustments for products within a given firm. Our theoretical framework predicts that the response of producer prices to a real depreciation is greater for products closer to the firm's core competency than for those further away. To test this prediction we estimate the following equation:

$$\begin{aligned}\ln p_{ijct} =& \mu_{ijc} + \Phi(t) + \beta_1 \ln(RER_{ct}) + \beta_2 \ln(RER_{ct}) \times Ladder_{ijct} + \\ & \ln(RER_{ct}) \times X_{jt-1}\beta_3 + X_{jt-1}\gamma + Z_{ict}\delta + \varepsilon_{ijct}\end{aligned} \tag{10}$$

In order to test how different firms adjust prices for different products following exchange rate movements, we interact $\ln(RER_{ct})$ with variables indicating the relative position of the product within the firm and with the firm-level variables that proxy for productivity.

$Ladder_{ijct}$ is a variable that indicates the relative position of good i among those sold by firm j to destination c in year t. As we describe in the next paragraph, we separately use four distinct variables that measure this relative position of a product within a firm. The relative position is based on sales of each product of a given firm to a given destination at a given year. Given a firm-destination-year triplet, the product with highest volume of sales is the core product ($r = 0$), the product with second highest volume of sales is the next to core product ($r = 1$), and so on and so forth. It is easy to show that ranking products according to sales is consistent with the model outlined in the previous section: given a firm-destination pair, products with higher sales are those with higher productivity and hence closer to the core competency.

The following "ladder" variables are separately used: $Bottom_{ijct}$ is an indicator for whether product i is below the median ranking for sales of firm j to country c in year t; $NotCore_{ijct}$ is an indicator for whether product i is **NOT** the product with highest sales of firm j to country c in year t - i.e., it is not the core product for triplet jct; $Second_{ijct}$ is an indicator for whether product i is the second product with highest sales of firm j to country c in year t[16]; and $Ranking_{ijct}$ is the sales ranking of product i among the products sold by firm j to country c in year t (with lower rank associated with products with higher export sales).

We also allow the responsiveness of producer price to real exchange rate movements to depend on firm productivity, since our theoretical framework predicts that producer price elasticity is also higher for firms with higher productivity. Our proxies for firm productivity are the same as the ones used in the estimation of equation (9) and are appropriately lagged in order to avoid correlation with the error term.

Table 7 presents the results from the estimation of (10). The prediction on the product ladder is strongly confirmed and robust to the specification of the ladder variable. For all four specifications of the ladder, we observe that firms'

[16]For specifications using this variable, only products ranked first or second are kept.

producer price response is significantly lower for products further away from their core expertise. The magnitude of the product ladder is also economically important. For example, we observe that, all else equal, for products below median sale (of firm j to country c in year t) producer price responsiveness is 8 percentage points lower than for products with above median sales. Also, non-core products present price responsiveness 6% lower than core products. These are economically important magnitudes in view of the overall price elasticity of 0.23 (obtained from the estimated β parameter in Table 6).

We also confirm the prediction that following a depreciation, more productive firms - measured by bigger size, higher fraction of skilled workers, or paying higher wages - increase markups to a greater extent than less productive firms. This set of results lend support to a similar result found in Berman, Martin and Mayer (2011) concerning heterogeneous responses of firms to real exchange rate shocks.[17]

We also find that the higher the ratio between imports of inputs and the wage bill of the firm, the higher the response of prices to a depreciation will be. This may reflect the fact that importers are more productive and hence further increase markups, but it also reflects the fact that following a depreciation, costs of imported inputs increase, leading to an increase in prices.

Theoretically, we attribute the heterogeneity in price responses to productivity dispersion across firms and within-firm productivity dispersion across products. Table 7 confirms our predictions in the data. However, there are additional reasons for heterogeneity in producer price responses across firms - firms operate in different industries, and export to different destinations. For example, these industries may have very different local distribution costs, and different destinations may have different transportation costs. From our theoretical framework, (8) illustrates that the producer price elasticity with respect to real exchange rates increases with distribution costs and decreases

[17] Berman, Martin and Mayer (2011) restrict their sample to only single-product firm-destination-year triplets. To compare our results more directly with theirs we estimated a similar regression restricting our sample to only single-product firms. Our results with regard to firm productivity being a strong determinant of producer price responsiveness are not as robust in this restricted sample. Results are available upon request.

with transportation costs. Also, in our theoretical framework we make the simplifying assumption that all firms price their products in the Home currency. However, the pass-through can also vary according to destination characteristics, such as market size or exchange rate volatility. These factors potentially affect exporters' currency invoicing decisions, and in the presence of price stickiness, may affect the producer price elasticity.[18] In order to allow for the possibility of producer price responsiveness to vary according to several industry and destination characteristics, we estimate the following equation:

$$\begin{aligned}
&\ln p_{ijct} = \mu_{ijc} + \Phi(t) + X_{jt-1}\gamma + Z_{ict}\delta + \qquad (11)\\
&\beta_1 \ln(RER_{ct}) + \beta_2 \ln(RER_{ct}) \times Ladder_{ijct} + \ln(RER_{ct}) \times X_{jt-1}\beta_3 + \\
&\ln(RER_{ct}) \times Dest_{ct}\beta_4 + \beta_5 \ln(RER_{ct}) \times \ln(DISTMG_{ind(i)}) + \varepsilon_{ijct}
\end{aligned}$$

We continue to allow price responses to vary according to the relative position of a good in the product ladder of a given firm (captured by the term $Ladder_{ijct}$) and on the productivity of firms (captured by the term X_{jt-1}). We include two other lagged measures of firm performance as additional measures of firm productivity: number of products exported by firm j to country c in year $t-1$ (denoted by $NUMPROD_{jct-1}$) and number of export destinations of firm j in year t (denoted by $NUMDEST_{jt-1}$). These are also proxies for productivity since our theoretical framework implies that the number of products sold by a firm to a given destination increases with productivity. Likewise, the number of destinations also increases with the productivity of the firm.

In addition, we allow destination characteristics (denoted by $Dest_{ct}$) to affect producer price responsiveness. In the destination characteristics, we include the distance between the largest city in Brazil and the largest city in country c (denoted by $Dist_c$) as our measure of transport cost, market size of country c in year t (measured by GDP_{ct}), and variance of the log of annual real exchange rates between country c's currency and the US dollar (denoted

[18] See Bhattarai (2009) for empirical evidence and literature survey.

by $XRATVOL_c$) as our measure of exchange rate volatility.

We also allow the price responsiveness to vary according to distribution margins at the 2-digit industry level (denoted by $DISTMG_{ind(i)}$). Each 8-digit product i is assigned to a two-digit industry according to a correspondence table that maps NCM codes to CNAE 2-digit industries. Distribution margins are meant to capture the components of the consumer price that are not included in the producer price. We use the measure constructed in Campa and Goldberg (2010), which is calculated from input-output tables of 20 countries and consists of transportation and storage costs as well as wholesaler and retailer charges. We use their industry-specific averages across countries of these distribution margins, in order to be able to use the whole sample. The main results remain unchanged when we restrict the analysis to those 20 countries and use country- and industry-specific distribution margins.

Table 8 confirms our key prediction that product ranking is an important determinant of variability in producer price responsiveness, and hence exchange rate pass-through. Even after controlling for heterogeneity contributed by a host of firm, industry and country characteristics, all four measures of the ladder continue to be statistically and economically significant determinants of price responses to real exchange rate shocks. At the firm level, in addition to firm size and average wages, the number of products exported also emerge as an important determinant of producer price response to exchange rate movements.

An increase in bilateral distance and hence associated transportation costs reduces producer price responsiveness, consistent with our theoretical framework. In addition, an increase in distribution costs, as predicted by (8), increases producer price responsiveness via its impact on the local component of per unit costs.

Our empirical results with regard to exchange rate volatility and market size confirm the empirical evidence and economic intuition from the endogenous currency invoicing literature. Higher exchange rate volatility and smaller market potential are associated with a smaller chance of local currency pricing, and hence a smaller response of producer prices to real exchange rates.

The empirical results in this section firmly establish that product ranking is a key component of producer price responsiveness to real exchange rate fluctuations. We now proceed to empirically test the remaining set of predictions of our theoretical framework.

4.2.2 Response of Product Scope to Real Exchange Rates

Our theoretical mechanism predicts an increase in product scope following a real exchange rate depreciation. Before estimating our full econometric model measuring the extent to which the number of products sold responds to exchange rate fluctuations, we plot, in Figure 5, yearly changes in the number of products a firm sells to a given destination (after filtering for time trends) against deciles of yearly changes in destination-specific real exchange rates. This plot shows a coarse non-parametric relationship between these two variables. As predicted by our theoretical framework, large devaluations of the Brazilian currency vis a vis a destination currency (higher deciles of yearly changes in real exchange rates) are associated with larger increases in the number of exported products by a firm to that given destination. Similarly, larger appreciations of the Brazilian currency vis a vis a destination currency (lower deciles) are associated with larger decreases in the number of exported products by a firm to that given destination.

We econometrically test this prediction by estimating the following equation:

$$\begin{aligned}\ln(1 + NUMPROD_{jct}) = &\mu_{jc} + \Phi(t) + \beta \ln(RER_{ct}) + \\ &X_{jt-1}\gamma + Z_{ict}\delta + \varepsilon_{ijct}\end{aligned} \tag{12}$$

where $NUMPROD_{jct}$ measures the number of products exported by firm j to country c in year t, and μ_{jc} is a firm-destination fixed-effect. We use three specifications in order to estimate equation (12). In all of them, the sample is restricted to the period between the first year a firm starts exporting to a given destination and the last year the firm exports to that same destination.

We restrict our sample in this way because our objective is not to study entry and exit behavior of firms into markets, but rather how product scope changes as a result of real exchange rate movements. Note that in this sample, a firm-destination with zero products exported at time t is included provided it resumes exports some time after time t.

We estimate (12) with OLS and firm-destination fixed-effects. Since firms cannot sell less than zero products to any destination (as a response to exchange rate movements), OLS estimates will be attenuated towards zero. For this reason, we also estimate a Tobit specification. This specification does not include firm-destination fixed-effects, but includes a rich array of firm- and destination-specific controls that are time-invariant.[19] These include 2-digit industry fixed-effects, destination fixed-effects and a complete second order polynomial of time invariant variables such as average over time of: firm size, average hourly wages, skill composition, import intensity, export intensity, per capita GDP at the destination, GDP at the destination and real exchange rates between the Brazilian currency and the destination's. The polynomial includes all possible combinations of interactions between these variables. We also report the estimation of (12) by OLS without including firm-destination fixed-effects but including the same time-invariant covariates used in the Tobit specification. Consequently, we can get a sense of how sensitive the results are to using firm-specific fixed-effects versus using a rich array of time invariant firm- and destination-specific controls.

We report the results in Table 9. In all three specifications, the response of the number of products to real exchange rates is strongly significant and range from 0.15 to 0.2. In particular, estimates obtained estimating equation (12) by OLS with and without firm-destination fixed-effects are very similar, suggesting that our use of a rich rich array of time invariant firm- and destination-specific variable adequately controls for time invariant firm-destination het-

[19] Maximum likelihood estimators of non-linear panel data with fixed-effects that increase with the sample size are typically biased and inconsistent. Even though there are methods to correct for this bias, these are usually computationally challenging, especially in our current situation with over 100,000 fixed-effects. One possible solution is to control for a rich array of observed time-invariant heterogeneity, as we do here.

erogeneity. This response is also economically significant. Table 10 shows the response of the number of products following a one standard deviation shock in yearly changes of $\ln RER_{ct}$ and of firm characteristics such as $\ln(Emp_{jt})$, $\ln(\bar{w}_{jt})$, $Skill_{jt}$, $\ln(Imp_{jt})$ and $\ln(Exp_{jt})$. The response to one standard deviation shocks in exchange rates is larger than the response to one standard deviation changes firm-level characteristics.[20] This shows that fluctuations in exchange rates are as least as important as firm-level fluctuations in explaining number of products exported. Also consistent with our theoretical framework, increases in firm productivity (measured by increase in firm size, in the fraction of skilled workers and in export performance) lead to the export of a larger number of products (changes in wages and in importance of imported inputs are non-significant in explaining changes in the number of products exported).

For our theoretical framework to generate heterogeneous responses of product scope across heterogeneous firms, we would need the length of the ladder $\omega_{c\theta}$ to vary according to θ.[21] We analyze these heterogeneous responses in Table 11. Results using OLS and fixed-effects point towards little heterogeneity in responses to real exchange rates. However, this may be due to the fact that censoring of the number of products variable leads to attenuation bias. Results using the Tobit specification in column (2) suggest that more productive firms react less to exchange rate fluctuations. This in turn suggests that the length of the ladder increases with firm productivity θ. Using our preferred estimates in column (2), the economic importance of the heterogeneity in responses is assessed in Table 11. An increase in firm size of one standard deviation of the cross-sectional distribution leads to an exchange rate response that is lower in 0.02 (or 10% of the average effect of 0.2). An increase in average wages paid

[20] Standard deviations are computed within destination and within firms respectively.

[21] To see that note that assuming a continuous number of products and at least one product being exported, the number of products exported to destination c is given by:

$$n_c(\theta) = \frac{1}{\ln \omega_{c\theta}} \ln \left(\frac{\left(\frac{q_c}{K_c}\right)^{\frac{1}{\sigma-1}} - \eta_c}{\tau_c} \right) + \frac{\ln \theta}{\ln \omega_{c\theta}} + \frac{\ln q_c}{\ln \omega_{c\theta}}$$

Where K_c is a constant that depends only on the country of destination.

at the firm-level by one standard deviation of the cross-sectional distribution leads to a response that is lower in 0.04 (or 20% of the average effect of 0.2 reported in Table 9). Finally, a simultaneous increase of each of the variables in Table 11 in one standard deviation of the respective cross-sectional distribution, leads to a decrease in exchange rate response in 0.09, almost half of the average response across firms.

4.2.3 Response of Skewness of Sales Distribution to Real Exchange Rates

In this section, we test our theoretical predictions concerning the response of relative sales to real exchange rate fluctuations. From our theoretical framework, a real exchange rate depreciation leads to weaker market competition and, in response, firms increase their focus on products further away from their core expertise. Thus, skewness of export sales falls in response to real exchange rate depreciation. We test this prediction by estimating:

$$\ln Skewness_{jct} = \mu_{jc} + \Phi(t) + \beta \ln (RER_{ct}) + X_{jt-1}\gamma + Z_{ict}\delta + \varepsilon_{ijct} \quad (13)$$

where $Skewness_{jct}$ is measured by either sales of the core product relative to sales of the second-most important product of firm j in country c in year t (denoted by $\left(\frac{R^1_{jct}}{R^2_{jct}}\right)$) or sales of the core product relative to sales of the rest of the products of firm j in country c in year t (denoted by $\left(\frac{R^1_{jct}}{\sum_{k\neq 1} R^k_{jct}}\right)$), and μ_{jc} is a firm-destination fixed-effect. We also add an alternative measure of skewness of sales: the Herfindahl index, which measures the concentration of export sales in the top products.

Table 13 reports the results. In all cases skewness decreases in response to a depreciation. The coefficients are statistically significant in all three specifications. We could not find any evidence of heterogeneous responses of skewness of sales to real exchange rate fluctuations.

The results obtained estimating (12) and (13) empirically confirm our theoretical result that following an exchange rate depreciation, firms reallocate resources towards less efficient use. This is consistent with the key theoretical result in Mayer, Melitz and Ottaviano (2011), which predicts that tougher competition in an export market induces firms to skew their sales to that market towards their best performing products, potentially dropping their worst performing ones. In our case, a real depreciation of the Brazilian currency leads to less competitive market conditions for Brazilian exporters. Our empirical results confirm this theoretical prediction taking advantage of variation in real exchange rates across destinations and over time. Mayer, Melitz and Ottaviano (2011) find empirical support for their prediction regarding skewness of export sales in cross-sectional data of French exporters using variation in competition across export markets.

5 Robustness Exercises

In this section, we investigate the robustness of our results regarding the heterogeneity of producer price responsiveness to exchange rate movements.

Our first exercise investigates whether the product ladder result is robust across industries. In order to do so, Equation (10) is separately estimated for each CNAE 2-digit industry. Results are reported in Table 15 and are shown to be remarkably robust across industries. Only four coefficients in the whole table are positive, but none is significantly positive. Two of these come from the two industries with the lowest number of observations (Tobacco (CNAE 16) and Coke, Oil Refining, Nuclear Fuel and Ethanol Industry (CNAE 23)).

The panel used in estimating equation (10) is unbalanced: every year firms add or drop products, so that we cannot observe the price of triplet ijc in every year. We correct for sample selection adopting a Heckman (1979) two-stage procedure that consists in first estimating a Probit selection equation relating an indicator variable for whether product i from firm j is exported to destination c at year t to all the firm- and country-level variables used in estimating equation (10) in Section (4.2.1). Instead of using product-firm-destination fixed-effects, we control for time-invariant heterogeneity including a rich array of product-, firm- and destination-specific variables such as 2-digit industry and destination fixed-effects, a flexible 5th-degree polynomial in the log-ranking of product i from firm j exported to destination c[22], interactions between the 5th-degree polynomial in the log-ranking and $\ln(RER_{ct})$, and a complete second order polynomial of time invariant variables such as the average over time of: firm size, average hourly wages, skill composition, import intensity, export intensity, demand of each product by destination, per capita GDP of the destination, GDP of the destination and real exchange rates between the Brazilian currency and the destination's. We also included in the polynomial the time invariant log-ranking. More importantly for the identification of the coefficients in the main estimating equation, the first step selection equation includes an exclusion restriction: a variable indicating whether product i from firm j is exported to destination c at year $t-1$, which is not included in the main estimating equation.[23] After the first step selection equation is estimated, we used its result in order to construct the inverse Mills ratio (IMR) that is added as another covariate to equation (10). Table 14 shows the result of this two-step estimation. The result regarding the product ladder is robust to the specification correcting for sample selection.

In addition to correcting for sample selection using a Heckman 2-step approach, we also restricted the estimation of equation (10) to firm-product-destination triplets being exported in every year of our sample. Restricting the sample in this way gives us a balanced panel of firm-product-destination triplets with no entry or exit of firms and products. Our results regarding the response of prices to exchange rates along the product ladder is also robust to this sample. Results are available upon request.

Next, we investigate alternative specifications for the $Ladder_{ijct}$ variables in equation (10). In our previous specifications, we allowed the ranking of a given product within a given firm and destination to vary over time. In the next two exercises we use $Ladder_{ijct}$ variables that are constant over time. The specifi-

[22] The ranking is time invariant and obtained after computing total export sales from each product firm j has exported to destination c over the sample period

[23] This exclusion restriction can be theoretically justified if the fixed cost of exporting, F_c, is lower for varieties that were exported in the previous period.

cation in Table 16 keeps only multi-product firms and use only products that were **ALWAYS** core and that were **NEVER** core for a given firm in a given destination. Therefore, we have a fixed ranking, avoiding products changing positions over time in the regressions. The coefficient estimate of -0.08 on the $NeverCore_{ijc}$ variable is still statistically and economically significant.

Another specification for the ladder variable computes rankings at the firm-destination level. For each firm-destination pair, we compute total sales of each product from 1997 to 2006. Rankings are based on these total sales and do not vary over time. Results using this new definition for rankings are shown in Table 17 - note that the ladder variables no longer display time subscripts. We also correct for sample selection in this specification. Results remain robust, except when we compare the core product with the second product in column (3).

In conclusion, our results regarding the across- and within-firm heterogeneity of producer price responses to fluctuations in real exchange rates are robust to correcting for sample selection and to the specification of the ladder variables used. The results are also present when analyzing each industry in isolation.

We also do not have a balanced panel in estimating equation (13). Firms may sell only one product (or none) to a destination in a given year, so that we are unable to compute our skewness measures in these situations. We attempt to correct for sample selection in this case as well adopting a Heckman (1979) two-stage procedure that consists in first estimating a probit selection equation relating an indicator variable for whether a firm-destination appears with two or more products exported at year t[24], to 2-digit industry and destination dummies and all the firm- and country-level variables used in estimating equation (13) in Section (4.2.3). Again, instead of using fixed-effects, we included a complete second order polynomial of time invariant firm- and destination-specific variables such as average over time of: firm size, average hourly wages, skill composition, import intensity, export intensity, per capita GDP of the destination, GDP of the destination and real exchange rate between the Brazilian

[24] In which case we are able to compute our skewness measures

currency and the destination's. More importantly for the identification of the coefficients in the main estimating equation, we have an exclusion restriction in the first stage: an indicator for whether the firm-destination pair appeared with two or more products exported at year $t-1$. Results remain robust, except for when we use the ratio between the sales of the first and second products as our measure of skewness of sales. The coefficient on $\ln(RER_{ct})$ in this case is no longer significant, but it is still negative and in the same order of magnitude as in the estimation without correcting for sample selection.

As a final check, we estimate equations (10), (12) and (13) using two lags in real exchange rates, that is, using $\ln(RER_{ct})$, $\ln(RER_{ct-1})$ and $\ln(RER_{ct-2})$. Our results remain robust when we estimate the specifications with lags and look at their long run responses. Results are available upon request.

6 Conclusion

We present a theoretical framework to explain how multi-product firms adjust prices, product scope and distribution of sales across products in response to exchange rate fluctuations. When there is an exchange rate depreciation, firms increase their product range and raise producer prices. The increase in producer prices is greater for products closer to the core, a consequence of local distribution costs. As a result, firms' sales distributions become less concentrated in products closer to the core, leading to a within-firm reallocation of resources towards less efficient use. We empirically test the theoretical implications on Brazilian customs data and find that firms' responses to exchange rate movements are consistent with our theoretical predictions.

This within and across firm heterogeneity in price responsiveness to real exchange rate movements also has interesting implications for the elasticity of aggregate exports to exchange rates, a parameter that plays a major role in translating economic analysis into policy recommendations (see Hooper, Johnson, and Marquez (2000)). Firm-level data for many countries show that exporters are large and productive, with larger exporters even more so. As noted in Berman, Martin and Mayer (2011), and corroborated here, these are exactly the firms that choose to partially absorb exchange rate fluctuations in their markups, leading to a relatively muted response of aggregate exports to exchange rates. In this paper, we also show that firms absorb exchange rate fluctuations into markups even further for their core products, which on average account for two thirds of total firm-level exports. This observation magnifies the mechanism put forward by Berman, Martin and Mayer (2011) for explaining the relatively small aggregate responses of exports face to exchange rate fluctuations found in the data (see Hooper, Johnson, and Marquez (2000) and Dekle, Jeong and Ryoo (2009)). We leave assessing the quantitative significance of our mechanism in understanding the exchange rate disconnect puzzle in a more quantitatively relevant framework for future work.

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Tables

Table 1: Examples of NCM codes

NCM	Description
64011000	Waterproof shoes made of rubber or plastic with metal toe protector
64019100	Waterproof shoes made of rubber or plastic covering the knees
64019200	Waterproof shoes made of rubber or plastic covering the ankles
64019900	Other seamless waterproof shoes made of rubber or plastic
64021200	Shoes for ski and snowboard made of rubber or plastic
64021900	Shoes for other sports made of rubber or plastic
64029100	Other shoes made of rubber or plastic covering the ankles
64031200	Shoes for ski and snowboard made of leather
64031900	Shoes for other sports made of leather
90031100	Plastic eyeglasses frames
90031910	Metal eyeglasses frames
90031990	Eyeglasses frames, other materials
90039010	Eyeglass hinges
90039090	Other parts for eyeglasses frames
90041000	Sunglasses
90049010	Eyeglasses for correction
90049020	Safety eyeglasses
90049090	Other eyeglasses for protection or similar articles
90051000	Binoculars
90058000	Telescopes
90059010	Parts and accessories of binoculars
90059090	Parts and accessories of telescopes

Table 2: Single- versus Multi-Product Firms

	Fraction of Exporters	Fraction of Employment	Fraction of Export Value	Fraction of Unit-Value Obs.
Single-Product Firms	0.51	0.35	0.22	0.14
Multi-Product Firms	0.49	0.65	0.78	0.86

A firm is considered to be a firm-destination pair.

Table 3: Top 10 Export Industries

2-digit CNAE	Industry	Fraction of Total Export Value	Avg. # of Prod.	Median # of Prod.
15	Food and Beverages	0.25	2.4	1
27	Metallurgy	0.17	3.1	2
29	Machinery and Equipment	0.1	8.9	3
24	Chemicals	0.09	4.3	2
35	Other Transportation Equipment	0.07	16.1	3
34	Assembly of Automotive Vehicles	0.06	18.9	4
19	Leather Products and Shoes	0.04	2.3	1
21	Pulp, Paper and Paper Products	0.04	2.6	1
20	Wood Products	0.03	1.6	1
32	Eletronic Components	0.03	5.1	2
	All	1	5.2	2

Sample of firms primarily active in manufacturing.
2-digit CNAE correspondence from NCM products.
Average and median number of products per firm-destination pair.

Table 4: Relative Importance of Products In Firm Export Sales

	Median
Export Value 1st Product / Export Value 2nd Product	2.7
Export Value 1st Product / Total Export Value of the Rest	1.9

A firm is considered to be a firm-destination pair.

Table 5: Top 10 Destinations for Manufactured Products

Destination	Percentage of Exports
United States	14.8
Argentina	6.8
Netherlands	3.6
Mexico	3.1
Germany	2.8
China	2.8
Italy	2.7
Chile	2.7
Belgium	2.3
Japan	2.2

Table 6: Response of Producer Prices and Quantities to Exchange Rates

	(1) Price	(2) Quantity
$\ln(RER_{ct})$	0.2335***	0.2647***
	[0.020]	[0.048]
$\ln(Emp_{jt-1})$	0.0166*	0.1222**
	[0.010]	[0.054]
$Skill_{jt-1}$	0.0046	0.1164
	[0.036]	[0.076]
$\ln(\bar{w}_{jt-1})$	0.0958***	0.0237
	[0.026]	[0.057]
$\ln(Imp_{jt-1})$	0.0356**	-0.0627*
	[0.017]	[0.038]
$\ln(Exp_{jt-1})$	0.0340***	0.1358***
	[0.009]	[0.027]
$\ln(PCGDP_{ct})$	0.2890**	0.3339
	[0.116]	[0.445]
$\ln(GDP_{ct})$	-0.2934**	0.6598
	[0.124]	[0.440]
$\ln(Dem_{ict})$	0.0009***	0.0010
	[0.000]	[0.001]
Observations	1,915,291	1,916,673
R-squared	0.945	0.937

Robust standard errors clustered at the firm level in brackets
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 7: Responsiveness of Producer Prices to Real Exchange Rates along the Product Ladder

	(1) Top/ Bottom	(2) Core/ Not Core	(3) First/ Second	(4) Log Ranking
$\ln(RER_{ct})$	-0.0544	-0.0612	0.1147***	-0.1576*
	[0.068]	[0.069]	[0.041]	[0.085]
$\ln(RER_{ct}) \times Bottom_{ijct}$	-0.0838***			
	[0.019]			
$\ln(RER_{ct}) \times NotCore_{ijct}$		-0.0628***		
		[0.009]		
$\ln(RER_{ct}) \times Second_{ijct}$			-0.0370***	
			[0.008]	
$\ln(RER_{ct}) \times \ln(Ranking_{ijct})$				-0.0455***
				[0.013]
$\ln(RER_{ct}) \times \ln(Emp_{jt-1})$	0.0235***	0.0253***	0.0107**	0.0352***
	[0.007]	[0.007]	[0.005]	[0.009]
$\ln(RER_{ct}) \times Skill_{jt-1}$	0.0122	0.0162	0.0628**	0.0118
	[0.051]	[0.050]	[0.028]	[0.050]
$\ln(RER_{ct}) \times \ln(\bar{w}_{jt-1})$	0.0503**	0.0535**	0.0135	0.0771***
	[0.021]	[0.021]	[0.014]	[0.023]
$\ln(RER_{ct}) \times \ln(Imp_{jt-1})$	0.0444***	0.0454***	0.0265***	0.0528***
	[0.012]	[0.012]	[0.010]	[0.013]
$\ln(RER_{ct}) \times \ln(Exp_{jt-1})$	0.0090	0.0090	-0.0008	0.0132
	[0.008]	[0.008]	[0.006]	[0.008]
Observations	1,915,291	1,915,291	759,749	1,915,291
R-squared	0.946	0.946	0.977	0.946

Robust standard errors clustered at the firm level in brackets
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 8: Decomposition of Producer Price Responsiveness

	(1) Top/ Bottom	(2) Core/ Not Core	(3) First/ Second	(4) Log Ranking
$\ln(RER_{ct})$	-0.0790	-0.0520	0.0290	-0.0451
	[0.205]	[0.206]	[0.152]	[0.192]
$\ln(RER_{ct}) \times Bottom_{ijct}$	-0.0834***			
	[0.019]			
$\ln(RER_{ct}) \times NotCore_{ijct}$		-0.0705***		
		[0.008]		
$\ln(RER_{ct}) \times Second_{ijct}$			-0.0410***	
			[0.008]	
$\ln(RER_{ct}) \times \ln(Ranking_{ijct})$				-0.0533***
				[0.013]
$\ln(RER_{ct}) \times \ln(Emp_{jt-1})$	0.0262***	0.0273***	0.0103*	0.0390***
	[0.010]	[0.010]	[0.006]	[0.012]
$\ln(RER_{ct}) \times Skill_{jt-1}$	-0.0197	-0.0169	0.0340	-0.0246
	[0.049]	[0.048]	[0.028]	[0.049]
$\ln(RER_{ct}) \times \ln(\bar{w}_{jt-1})$	0.0732***	0.0759***	0.0279*	0.1020***
	[0.022]	[0.022]	[0.015]	[0.026]
$\ln(RER_{ct}) \times \ln(Imp_{jt-1})$	0.0388***	0.0402***	0.0251**	0.0479***
	[0.012]	[0.012]	[0.010]	[0.013]
$\ln(RER_{ct}) \times \ln(Exp_{jt-1})$	0.0068	0.0057	-0.0090	0.0112
	[0.010]	[0.010]	[0.008]	[0.011]
$\ln(RER_{ct}) \times \ln(1 + NUMPROD_{jct-1})$	0.0089***	0.0110***	0.0179***	0.0134***
	[0.003]	[0.003]	[0.004]	[0.003]
$\ln(RER_{ct}) \times \ln(1 + NUMDEST_{jt-1})$	-0.0068	-0.0055	0.0130	-0.0062
	[0.015]	[0.015]	[0.008]	[0.015]
$\ln(RER_{ct}) \times \ln(GDP_{ct})$	0.0369***	0.0373***	0.0389***	0.0394***
	[0.006]	[0.006]	[0.004]	[0.006]
$\ln(RER_{ct}) \times \ln(Dist_c)$	-0.1051***	-0.1087***	-0.0969***	-0.1202***
	[0.021]	[0.021]	[0.012]	[0.019]
$\ln(RER_{ct}) \times \ln(DISTMG_{ind(i)})$	0.0902**	0.0894**	0.0673**	0.0768**
	[0.036]	[0.036]	[0.031]	[0.035]
$\ln(RER_{ct}) \times XRATVOL_c$	-0.8648***	-0.8815***	-0.4617***	-0.8979***
	[0.233]	[0.230]	[0.112]	[0.207]
Observations	1,915,291	1,915,291	759,750	1,915,291
R-squared	0.946	0.946	0.977	0.946

Robust standard errors clustered at the firm level in brackets
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 9: Response of Number of Products to Exchange Rates

	(1) OLS-FE	(2) OLS	(3) Tobit
$\ln(RER_{ct})$	0.1503***	0.1521***	0.1997***
	[0.009]	[0.007]	[0.008]
$\ln(Emp_{jt-1})$	0.0591***	0.0516***	0.0542***
	[0.005]	[0.005]	[0.006]
$\ln(\bar{w}_{jt-1})$	0.0032	-0.0003	-0.0067
	[0.018]	[0.016]	[0.018]
$Skill_{jt-1}$	0.0640***	0.0644***	0.0669***
	[0.019]	[0.019]	[0.021]
$\ln(Imp_{jt-1})$	0.0062	-0.0023	-0.0028
	[0.008]	[0.007]	[0.008]
$\ln(Exp_{jt-1})$	0.0381***	0.0277***	0.0284***
	[0.005]	[0.004]	[0.005]
$\ln PCGDP_{ct}$	-0.2876***	-0.2060***	-0.2294***
	[0.082]	[0.060]	[0.065]
$\ln GDP_{ct}$	0.5093***	0.3988***	0.4553***
	[0.080]	[0.059]	[0.064]
Firm-Destination Fixed-Effects	Yes	No	No
Observations	621,017	621,017	621,017
R-squared	0.712	0.188	–

Robust standard errors clustered at the firm level in brackets
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 10: Economic Importance of Real Exchange Rates on Product Scope

	Standard Deviation Within c or j	Effect Using Coefficients from OLS	Effect Using Coefficients from Tobit
$\ln(RER_{ct})$	0.26	0.04	0.05
$\ln(Emp_{jt})$	0.56	0.03	0.03
$\ln(\bar{w}_{jt})$	0.18	0.001	-0.001
$Skill_{jt}$	0.14	0.01	0.01
$\ln(Imp_{jt})$	0.32	0.002	-0.001
$\ln(Exp_{jt})$	0.54	0.02	0.02

Standard deviation of $\ln(RER_{ct})$ computed within country, the remaining standard deviations are computed within firm.
Coefficients from OLS come from column (1) in Table 9. Coefficients from Tobit come from column (3) in Table 9.

Table 11: Heterogeneous Responses of Number of Products to Exchange Rates

	(1) OLS-FE	(2) Tobit
$\ln(RER_{ct})$	0.1912***	0.4296***
	[0.034]	[0.029]
$\ln(RER_{ct}) \times \ln(Emp_{jt-1})$	0.0048	-0.0123***
	[0.004]	[0.004]
$\ln(RER_{ct}) \times Skill_{jt-1}$	-0.0950***	-0.0715***
	[0.022]	[0.022]
$\ln(RER_{ct}) \times \ln(\bar{w}_{jt-1})$	-0.0152	-0.0622***
	[0.012]	[0.011]
$\ln(RER_{ct}) \times \ln(Imp_{jt-1})$	-0.0040	-0.0209**
	[0.008]	[0.009]
$\ln(RER_{ct}) \times \ln(Exp_{jt-1})$	0.0043	-0.0077
	[0.005]	[0.005]
Firm-Destination Fixed-Effects	Yes	No
Observations	621,017	621,017
R-squared	0.712	–

Robust standard errors clustered at the firm level in brackets
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 12: Economic Importance of Heterogeneous Responses of Product Scope to Real Exchange Rates

	Standard Deviation Cross-Section	Marginal Effect of 1 s.d. on RER Response
$\ln(Emp)$	1.82	-0.02
$Skill$	0.27	-0.02
$\ln(\bar{w})$	0.69	-0.04
$\ln(Imp)$	0.64	-0.01
$\ln(Exp)$	1.00	-0.01

Marginal Effects using Coefficients from Tobit specification in column (2) of Table Table 11.

Table 13: Response of Skewness of Sales to Exchange Rates

	(1)	(2)	(3)
	$\ln\left(\frac{R^1_{jct}}{R^2_{jct}}\right)$	$\ln\left(\frac{R^1_{jct}}{\sum_{k\neq 1} R^k_{jct}}\right)$	Herfindahl
$\ln(RER_{ct})$	-0.0649***	-0.1181***	-0.0222***
	[0.024]	[0.026]	[0.004]
$\ln(Emp_{jt-1})$	-0.0010	-0.0434***	-0.0114***
	[0.010]	[0.014]	[0.003]
$\ln(\bar{w}_{jt-1})$	0.0017	-0.0327	-0.0092
	[0.027]	[0.032]	[0.006]
$Skill_{jt-1}$	-0.0789*	-0.0976*	-0.0145*
	[0.046]	[0.054]	[0.009]
$\ln(Imp_{jt-1})$	0.0113	0.0100	0.0014
	[0.015]	[0.018]	[0.003]
$\ln(Exp_{jt-1})$	0.0176	-0.0087	-0.0046**
	[0.011]	[0.014]	[0.002]
$\ln PCGDP_{ct}$	-0.0033	0.0333	0.0189
	[0.213]	[0.239]	[0.039]
$\ln GDP_{ct}$	-0.1458	-0.2446	-0.0544
	[0.217]	[0.244]	[0.040]
Observations	254,672	254,672	254,672
R-squared	0.582	0.624	0.630

Robust standard errors clustered at the firm level in brackets
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 14: Responsiveness of Producer Prices to Real Exchange Rates Along the Product Ladder: Sample Selection Correction

	(1) Top/ Bottom	(2) Core/ Not Core	(3) First/ Second	(4) Log Ranking
$\ln(RER_{ct})$	-0.0524	-0.0592	0.1169***	-0.1560*
	[0.068]	[0.068]	[0.041]	[0.084]
$\ln(RER_{ct}) \times Bottom_{ijct}$	-0.0841***			
	[0.019]			
$\ln(RER_{ct}) \times NotCore_{ijct}$		-0.0634***		
		[0.009]		
$\ln(RER_{ct}) \times Second_{ijct}$			-0.0372***	
			[0.008]	
$\ln(RER_{ct}) \times \ln Ranking_{ijct}$				-0.0457***
				[0.013]
$\ln(RER_{ct}) \times \ln(Emp_{jt-1})$	0.0236***	0.0254***	0.0107**	0.0353***
	[0.007]	[0.007]	[0.005]	[0.009]
$\ln(RER_{ct}) \times Skill_{jt-1}$	0.0126	0.0166	0.0629**	0.0122
	[0.051]	[0.050]	[0.028]	[0.050]
$\ln(RER_{ct}) \times \ln(\bar{w}_{jt-1})$	0.0502**	0.0534**	0.0135	0.0770***
	[0.021]	[0.021]	[0.014]	[0.023]
$\ln(RER_{ct}) \times \ln(Imp_{jt-1})$	0.0442***	0.0453***	0.0265***	0.0527***
	[0.012]	[0.012]	[0.010]	[0.013]
$\ln(RER_{ct}) \times \ln(Exp_{jt-1})$	0.0092	0.0093	-0.0009	0.0135*
	[0.008]	[0.008]	[0.006]	[0.008]
IMR	0.0147**	0.0144**	0.0103	0.0147**
	[0.006]	[0.006]	[0.006]	[0.006]
Observations	1,915,291	1,915,291	759,745	1,915,291
R-squared	0.946	0.946	0.977	0.946

Robust standard errors clustered at the firm level in brackets
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 15: Product Ladder By Industry

2-digit CNAE	$Bottom_{ijct}$	$NotCore_{ijct}$	$\ln(Ranking_{ijct})$	Obs.
15	-0.0478***	-0.0441***	-0.0429**	112,304
16	0.1022	-0.1785	-0.2088	574
17	-0.0628***	-0.0653***	-0.0632***	74,097
18	-0.0749***	-0.0983***	-0.0692***	82,567
19	-0.0363**	-0.0656***	-0.0703***	83,441
20	-0.0493*	-0.0755***	-0.0704*	53,706
21	-0.1493***	-0.1075**	-0.0957*	26,492
22	-0.1738	0.0095	-0.1089	18,225
23	-0.0835	-0.0664	0.0018	3,959
24	-0.0448***	-0.0032	-0.0025	174,965
25	-0.0972***	-0.0975**	-0.0686***	131,975
26	-0.0338	-0.0180	-0.0259	70,028
27	-0.0370	-0.0102	0.0161	62,361
28	-0.1186***	-0.0666**	-0.0541***	162,350
29	-0.0542	-0.0632**	-0.0293	365,416
30	-0.6539***	-0.3589**	-0.4185***	8,079
31	-0.1389***	-0.1220**	-0.0824***	143,521
32	-0.2877***	-0.1595**	-0.1878***	42,487
33	-0.1535**	-0.0267	-0.1126**	82,016
34	-0.0525	-0.0853***	-0.0514**	129,469
35	-0.2243	-0.0882	-0.0819	6,775
36	-0.0889***	-0.0904***	-0.0978***	80,484

Robust standard errors clustered at the firm level in brackets
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 16: Always Core Products vs. Never Core Products

$\ln(RER_{ct})$	0.0313
	[0.099]
$\ln(RER_{ct}) \times NeverCore_{ijc}$	-0.0847**
	[0.035]
$\ln(RER_{ct}) \times \ln(Emp_{jt-1})$	0.0263**
	[0.010]
$\ln(RER_{ct}) \times Skill_{jt-1}$	0.0355
	[0.074]
$\ln(RER_{ct}) \times \ln(\bar{w}_{jt-1})$	0.0363
	[0.036]
$\ln(RER_{ct}) \times \ln(Imp_{jt-1})$	0.0414
	[0.029]
$\ln(RER_{ct}) \times \ln(Exp_{jt-1})$	0.0030
	[0.017]
Observations	678,395
R-squared	0.962

Robust standard errors clustered at the firm level in brackets
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 17: Ranking Using Total Sales Over The Whole Period and Sample Selection Correction

	(1) Top/ Bottom	(2) Core/ Not Core	(3) First/ Second	(4) Log Ranking
$\ln(RER_{ct})$	-0.0589	-0.0563	0.1198***	-0.0986
	[0.069]	[0.068]	[0.039]	[0.070]
$\ln(RER_{ct}) \times Bottom_{ijc}$	-0.1246***			
	[0.024]			
$\ln(RER_{ct}) \times NotCore_{ijc}$		-0.0552***		
		[0.018]		
$\ln(RER_{ct}) \times Second_{ijc}$			-0.0020	
			[0.015]	
$\ln(RER_{ct}) \times \ln Ranking_{ijc}$				-0.0165*
				[0.010]
$\ln(RER_{ct}) \times \ln(Emp_{jt-1})$	0.0231***	0.0247***	0.0045	0.0271***
	[0.007]	[0.007]	[0.004]	[0.007]
$\ln(RER_{ct}) \times Skill_{jt-1}$	0.0123	0.0151	0.0480*	0.0114
	[0.050]	[0.050]	[0.028]	[0.051]
$\ln(RER_{ct}) \times \ln(\bar{w}_{jt-1})$	0.0488**	0.0529**	0.0226*	0.0597***
	[0.021]	[0.021]	[0.013]	[0.021]
$\ln(RER_{ct}) \times \ln(Imp_{jt-1})$	0.0432***	0.0449***	0.0242**	0.0469***
	[0.012]	[0.012]	[0.010]	[0.013]
$\ln(RER_{ct}) \times \ln(Exp_{jt-1})$	0.0102	0.0091	0.0011	0.0107
	[0.008]	[0.008]	[0.006]	[0.008]
IMR	0.0147**	0.0142**	0.0147**	0.0140**
	[0.006]	[0.006]	[0.006]	[0.006]
Observations	1,915,291	1,915,291	647,594	1,915,291
R-squared	0.946	0.945	0.973	0.945

Robust standard errors clustered at the firm level in brackets
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 18: Response of Skewness of Sales to Exchange Rates: Sample Selection Correction

	(1)	(2)	(3)
	$\ln\left(\frac{R^1_{jct}}{R^2_{jct}}\right)$	$\ln\left(\frac{R^1_{jct}}{\sum_{k\neq 1} R^k_{jct}}\right)$	Herfindahl
$\ln(RER_{ct})$	-0.0332	-0.0626**	-0.0120***
	[0.024]	[0.027]	[0.004]
$\ln(Emp_{jt-1})$	0.0125	-0.0199	-0.0071***
	[0.010]	[0.014]	[0.003]
$\ln(\bar{w}_{jt-1})$	0.0072	-0.0230	-0.0074
	[0.027]	[0.032]	[0.006]
$Skill_{jt-1}$	-0.0805*	-0.1004*	-0.0150*
	[0.046]	[0.054]	[0.009]
$\ln(Imp_{jt-1})$	0.0100	0.0076	0.0010
	[0.015]	[0.018]	[0.003]
$\ln(Exp_{jt-1})$	0.0304***	0.0139	-0.0004
	[0.011]	[0.014]	[0.002]
$\ln PCGDP_{ct}$	-0.0179	0.0077	0.0142
	[0.213]	[0.238]	[0.038]
$\ln GDP_{ct}$	-0.0992	-0.1630	-0.0394
	[0.218]	[0.244]	[0.040]
IMR	0.1449***	0.2538***	0.0467***
	[0.021]	[0.023]	[0.003]
Observations	254,672	254,672	254,672
R-squared	0.582	0.625	0.631

Robust standard errors clustered at the firm level in brackets
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Figures

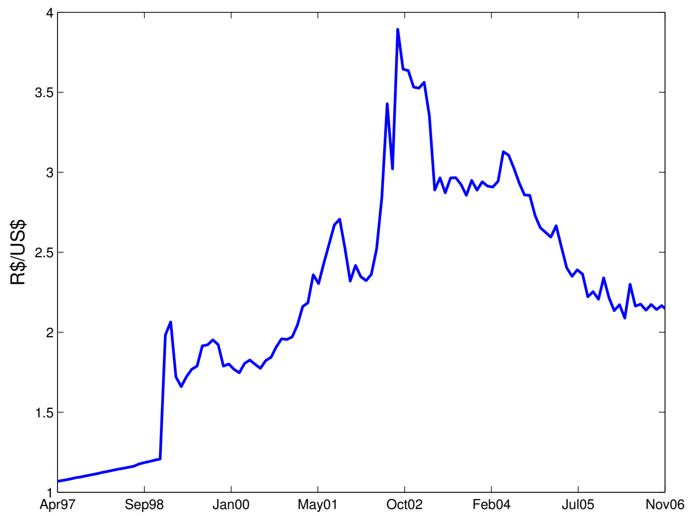

Figure 1: Evolution of the Monthly Nominal Exchange Rate R$/US$, Jan1997-Dec2006

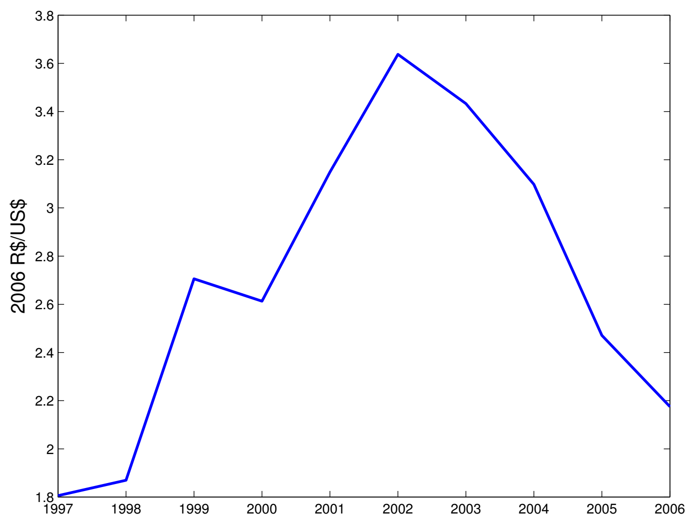

Figure 2: Evolution of the Annual Real Exchange Rate 2006 R$/US$, 1997-2006

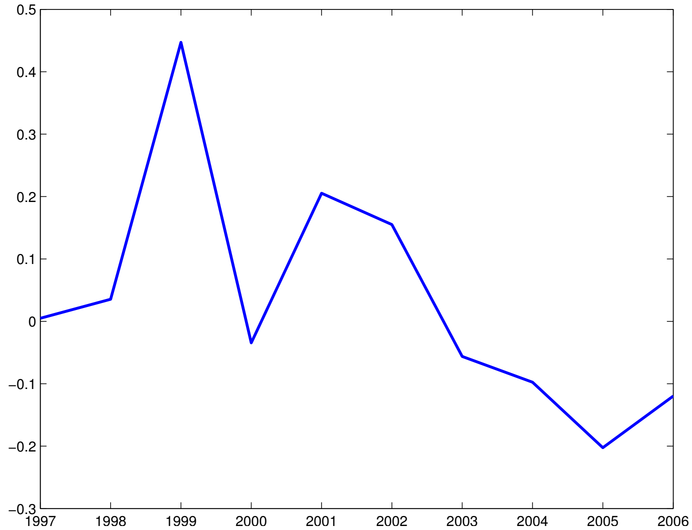

Figure 3: Annual Variation in the Real Exchange Rate 2006 R$/US$, 1997-2006

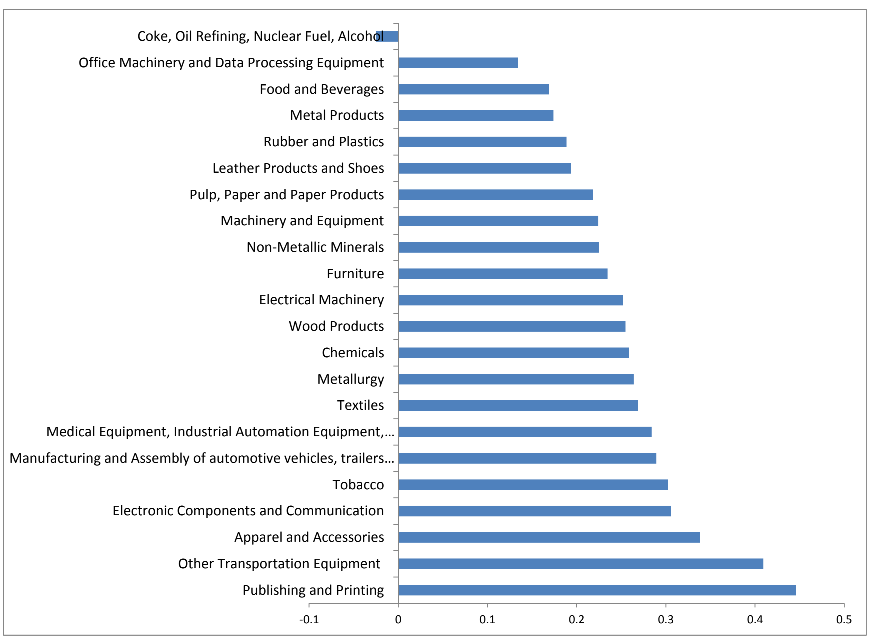

Figure 4: Producer Price Responsiveness to Exchange Rates by Industry

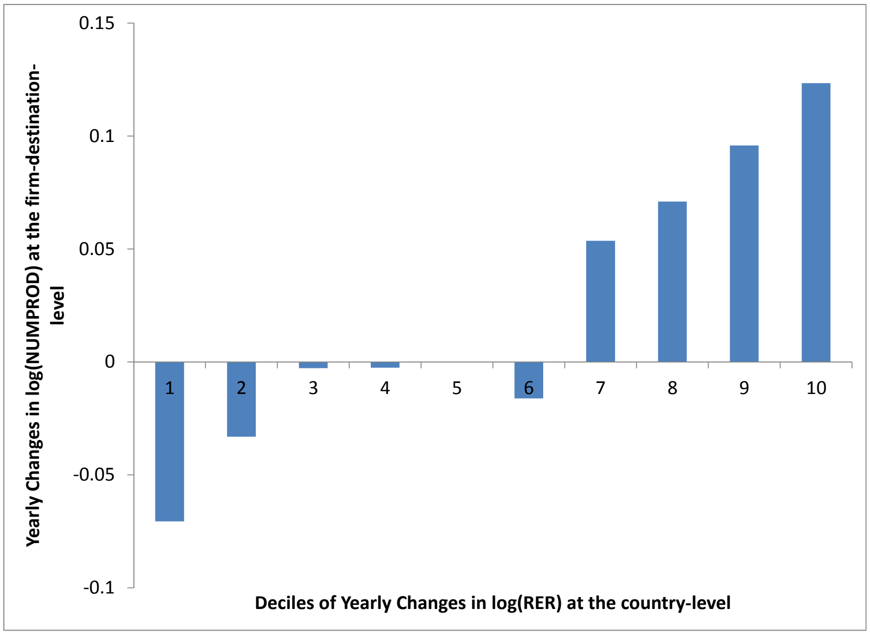

Figure 5: Yearly Changes in $\ln(1 + NUMPROD_{jc})$ by deciles of Changes in $\ln(RER_c)$