

## EXCHANGE RATE PASS-THROUGH INTO RETAIL PRICES\*

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We study exchange rate pass-through and its determinants using scanner data on fast moving consumer goods sold by 1,041 outlets in the United Arab Emirates between 2006 and 2010. The data are augmented with country of origin information. Our main finding is that exchange rate pass-through varies more across retailers within regions than across regions, and in particular that pass-through increases with retailer market share. We also find that exchange rate pass-through is negatively correlated with both product quality and the elasticity of substitution of the product category and positively correlated with the frequency of price adjustment.

### 1. INTRODUCTION

The extent to which prices respond to exchange rate movements and the underlying determinants of those responses are key issues in international macroeconomics. This is not only because of their direct implications for international transmission of shocks, but also for the more general insights they can provide in the study of price-setting behavior (see, e.g., Gopinath and Itskhoki, 2011). In recent years, the increased availability of very detailed data at the micro level has spurred important new work in the (already substantial) exchange rate pass-through literature. Indeed, with the analysis of micro-level data, researchers have been able to provide more reliable measurements of exchange rate pass-through into prices and offer an improved understanding of its microeconomic determinants.<sup>2</sup> In particular, recent work has decomposed pass-through along the supply chain (e.g., Hellerstein, 2008; Nakamura and Zerom, 2010) and has linked pricing to market to firm-level characteristics of exporters (e.g., Berman et al., 2012; Chatterjee et al., 2013) to study the relevance of factors such as variable markups, local costs, and heterogeneous quality in explaining incomplete pass-through.

Variation in price setting behavior at the retailer's level has however received very little attention.<sup>3</sup> Because retailers play a key role in the supply chain, exploring whether they significantly contribute to variation in consumer prices can provide important insights on the transmission mechanism of cost shocks.

Our work fills this gap by linking pass-through to retailer characteristics. Specifically, we study exchange rate pass-through into retail prices using micro data on prices and quantities for about 85% of the fast moving consumer goods (FMCGs) sold across hun-

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<sup>2</sup> For a recent and thorough review of these developments in the literature, see Burstein and Gopinath (2014).

<sup>3</sup> An important exception is Nakamura (2008). The author considers a variance decomposition on prices of 100 products (UPCs) sold across 7,000 groceries in 50 U.S. states and finds that about 2/3 of the variation in prices is driven by retailers' chain-level effects.

dreds of grocery stores in the United Arab Emirates (UAE) between January of 2006 and December of 2010. For each outlet and each period, we have access to transaction data at the barcode level for 30 product categories, along with information on the outlet type, the region it belongs to, and whether the outlet is part of a chain.<sup>4</sup> Because of this availability of outlet-level information in our data, we are able to analyze variation in pass-through across retailers.

Although this is a dimension of heterogeneity that is typically neglected in the literature, our results suggest it matters: We find that exchange rate pass-through varies more across retailers within regions than across regions, and in particular that pass-through increases with retailer market share. We first estimate aggregate pass-through to be around 20% after one year and find it to vary little across regions in the UAE.<sup>5</sup> We then estimate pass-through across retailers within regions and find it is highest for supermarkets and lowest for mini-markets, with groceries in between. To control for any differences in business models across types of outlets, we repeat the analysis restricting the sample to supermarkets only. We estimate that exchange rate pass-through for goods sold in supermarkets with high market share in a region is in most instances significantly larger than for supermarkets with low market share within that same region. The data suggest it is the size of the retailer itself that matters the most for pass-through: We perform a similar exercise for market shares by country of origin and brand and find there is less clear-cut evidence of a systematic relationship with exchange rate pass-through.

Our data also allow us to analyze how pass-through varies with other characteristics of goods. We look at its relationship with the elasticity of substitution within product categories, which we estimate using the methodology in Broda and Weinstein (2006). We then study how pass-through relates to product quality and follow Auer and Chaney (2009) using variation in price within specific product category-weight-package type triplet as evidence of variation in quality. Finally, we provide evidence of a relationship between pass-through and the frequency of price adjustment, along the lines of Gopinath and Itskhoki (2010). These dimensions can help shed light on the determinants of pass-through. Whereas product quality can be viewed as a proxy for markups, which can be used to shield consumers from fluctuations in exchange rates or shifts in costs, the elasticity is a proxy that captures the degree of product heterogeneity of the available varieties within a product group. Product quality varies across products in a specific group, but the elasticity of substitution is constant within a group. Finally, Gopinath and Itskhoki (2010) argue that the observed variation of pass-through with the frequency of price adjustment provides guidance on the construction of models of price setting behavior that are more consistent with the data.

We show that exchange rate pass-through is negatively correlated with product quality and elasticity of substitution. This is consistent with the findings in recent work, such as Atkeson and Burstein (2008), Berman et al. (2012), and Auer and Chaney (2009), which focuses on the behavior of exporters. We find that pass-through is positively related to products' frequency of price adjustment, as in Gopinath and Itskhoki (2010).

We view the evidence on the relationship between pass-through and retailer size as the main, and novel, contribution of our article. We interpret this to strongly suggest that retailers exhibit heterogeneity in price-setting behavior. We argue that such heterogeneity can be accounted for in a framework where retailers differ in the size of their markups and/or the share of total costs that they incur locally. In particular, if large retailers charge lower markups and/or have lower local costs, then exchange rate pass-through will be positively related to retailer market size. This is because the lower the local costs (Corsetti and Dedola, 2005) or markups (Hellerstein,

<sup>4</sup> Transactions data refer to the total units of a particular item (barcode) sold within a particular period in a specific outlet and the price of the item in the particular store at the time (day) of the audit within that period. Outlet types offer a characterization of outlets based on size and function, such as supermarkets, groceries, mini-markets, cafeterias, and pharmacies.

<sup>5</sup> We discuss later in the article how our aggregate findings are in line with existing estimates in the literature.

2008), the higher the portion of the final price that depends on the exchange rate and, ultimately, the higher the pass-through into prices, all else equal.<sup>6</sup>

The role of local costs in affecting the response of consumer prices to exchange rate movements has been explored in previous work. For example, Burstein et al. (2003, 2005) document the importance of distribution costs in determining retail prices, and argue they are the main source of real exchange rate fluctuations during periods of substantial exchange rate movements. There are a few recent studies that provide important insights on the determinants of incomplete pass-through into retail prices, by decomposing it into factors such as local distribution costs and markup adjustment at the wholesale and retail level. Using data on beer (Hellerstein, 2008; Goldberg and Hellerstein, 2013) and coffee (Nakamura and Zerom, 2010) products, these studies show that it is both local costs and markup adjustments (especially at the wholesale level) that explain most of the incomplete pass-through observed in these industries. We cannot provide insights on this decomposition with our data. But although these papers document the importance of local distribution components in explaining low pass-through into retail prices for very specific industries, they treat retailers as one homogeneous entity and thus do not explore whether differences in pricing behavior across retailers exist and how they may matter. We do, instead, provide evidence that there is substantial variation in pricing behavior across retailers.<sup>7</sup>

Heterogeneity in pass-through across retailers has a couple of additional implications that warrant further discussion. First, differences in the structure of retail competition can affect the degree of exchange rate pass-through in an economy. For example, Frankel et al. (2012) argue that changes in the monetary environment that raise real wages and change local retail costs have contributed to the observed decrease in pass-through in developing countries. We add to this observation by arguing that in addition to changes in the monetary environment, any changes in the structure of retail competition and in the distribution of retail stores can also affect local retail costs and markups and thus contribute to changes in the degree of exchange rate pass-through. Furthermore, a possible shift in preferences toward high-quality goods by consumers in developing countries during recent years may have also contributed to a lower degree of exchange rate pass-through.

Second, if costs and markups vary across retailers, as suggested by our results, and if these differences affect their pricing behavior, then treating retailers as a homogeneous group averages out relevant information; this in turn might result in biased inference on aggregate price dynamics. As argued in Nakamura (2008), studying the sources of retail-level variation in prices appears to be a crucial step for our more general understanding of these dynamics.

The rest of the article is organized as follows: In Section 2 we describe the data in more detail. In Section 3, we establish the methodology used to measure exchange rate pass-through. In Section 4 we first report aggregate estimates and then discuss how micro-economic factors affect pass-through, focusing on market share, demand elasticity, product quality, and frequency of price adjustment. We discuss and conclude in Section 5.

## 2. DATA

We use micro data on more than 25,000 FMCGs sold across 1,041 outlets in the UAE. The country, situated in the Arabian Gulf, has a currency pegged to the U.S. dollar and imports the majority of its consumptions goods.

The data are recorded at the scanner (barcode) level and come from Nielsen. They cover sales in 30 product categories between 2006 and 2010.<sup>8</sup> The data set contains price and

<sup>6</sup> Heterogeneity in the degree of price stickiness across retailers is also consistent with this story, if we interpret costs more broadly to include “menu costs” and argue the latter are lower for larger retailers.

<sup>7</sup> Hong and Li (unpublished manuscript) analyze how the vertical and horizontal structure of retail markets interact to affect pass-through, but do not look at retailer heterogeneity along the dimensions considered here.

<sup>8</sup> According to Nielsen, the data cover about 85% of all FMCGs’ sales in United Arab Emirates. The categories are beans, blades, bullion, cereals, cheese, chewing gum, chocolate, cigarettes, cooking oil, carbonated soft drinks,

TABLE 1  
DESCRIPTIVE STATISTICS FOR UNITED ARAB EMIRATES (UAE) DATA

Year	Products	Brands	Manufacturers	Outlets	Chains
2006	25,462	3,158	974	840	12
2007	24,360	2,949	946	912	14
2008	23,908	2,820	976	915	14
2009	23,988	2,756	1,002	1,031	15
2010	25,889	2,828	1,144	1,042	15

NOTES: The data come from Nielsen and cover about 85% of the sales of all fast moving consumer goods (FMCGs) in the UAE. This table shows a breakdown of the available products by various groupings, for each year in the sample. The statistics are for the full sample, that is, not augmented with country-of-origin (COO) information.

quantity information for all products sold by each outlet, along with information on the brand, manufacturer, weight, package type, and whether the item was part of a manufacturer’s promotion.<sup>9</sup> The frequency is monthly for some categories and bimonthly for others. Because of the mixed frequency, we convert all monthly series to bimonthly and use bimonthly data in the analysis.<sup>10</sup> Whereas quantities are based on total sales per period, prices are based on actual prices at the day of the audit. The exact day of the audit during the monthly or bimonthly period varies by store and is not reported by Nielsen. Listed prices reflect the actual prices paid by the consumers. Often times, in advanced countries these two prices differ, as consumers use promotional coupons. However, this is not an issue we face in our data. Customer loyalty programs providing consumers with coupons to be used on selected products did not exist in UAE during the period of this study. Carrefour, the largest retailer, launched the first such program in the UAE on April 12, 2012, two years after the end period of our sample.

Additionally, the data contain information on the location of each outlet, its type, and its chain code (if it belongs to a chain). Location covers three regions in the UAE: Dubai and Sharjah, Abu Dhabi and Al Ain, and Northern Emirates. Type classifies outlets as supermarkets, groceries, self-service, mini-markets, pharmacies, eateries, and convenience stores. The market share of each outlet can be retrieved, since total sales by each outlet are known.

Descriptive statistics for the data set are provided in Table 1. In 2010, 25,899 unique products were sold by 1,041 outlets in the UAE. Retailers sourced these products from 1,144 different manufacturers/distributors, and these products belonged to 2,828 different brands. We observe that some outlets are part of chains, with a total of 15 different chains listed in the data set. To ensure that changes in pass-through are not driven by entry or exit of outlets in our sample over time, we only consider a balanced panel of outlets that existed in all periods between January 2006 and December 2010. This reduced the number of outlets to 431 but still accounted for 96.6% of dollar sales, since the majority of the outlets we drop are tiny stores.<sup>11</sup>

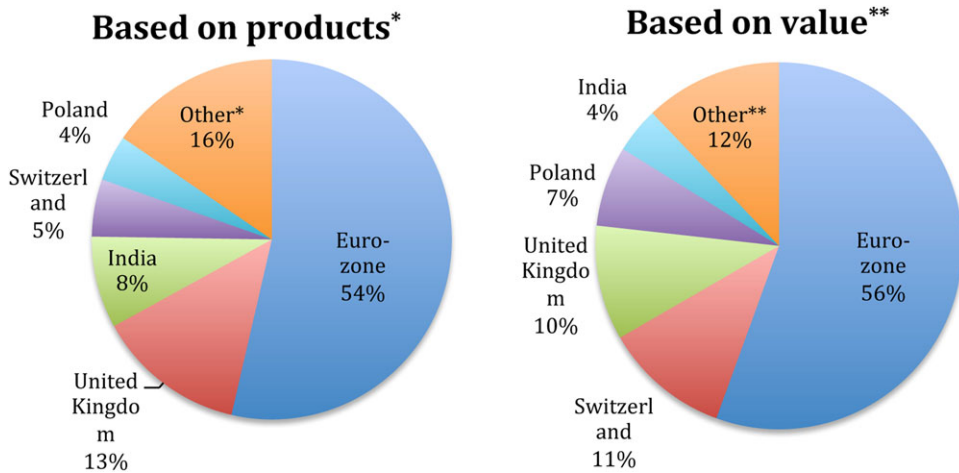
The Nielsen data set is augmented with country-of-origin (COO) information collected from the products’ labels. A team of researchers, equipped with hand-held scanners, visited the largest hypermarket in UAE and recorded COO information for each product that was sold at the store at the time of the visit. To minimize errors and to collect information on products that were out of stock, the team was sent back to the same outlet for a second round of scanning. Any barcodes that appeared to originate from different countries during the two rounds of data collection were dropped. This occurred in less than 1% of the

deodorants, detergents, dish wash, energy drinks, fabric conditioners, insecticides, juices, liquid cordials, male grooming, milk, milk powder, powder soft drink, shampoo, skincare, skin cleansing, sun care, tea, toothbrush, toothpaste, water.

<sup>9</sup> Includes price and nonprice promotions. Examples of nonprice promotions are promotion bundle, promotion free, promotion gift, promotion same, promotion unit, and promotion volume.

<sup>10</sup> We only consider odd months in the analysis: January, March, May, July, September, and November. For the series available at a monthly frequency, we just remove observations for the even months. For the series available at a bimonthly frequency, we divide quantities in half and keep prices the same.

<sup>11</sup> Of the 431 outlets considered in the balanced panel, supermarkets, groceries, and mini-markets/self-service stores account for 10%, 30%, and 60%, respectively.



NOTES: Authors' calculations. The market share of countries exporting fast moving consumer goods (FMCGs) to the United Arab Emirates is shown above. Data from 2010 are used. Market share is measured based on the share of products sold (left) or based on total value of sales (right). Only countries with a currency that fluctuates with the UAE Dirham (and consequently the U.S. dollar) are included in the calculations.

\* Turkey 2.24%, China 1.92%, Egypt 1.92%, Thailand 1.88%, Philippines 1.42%, South Africa 1.10%, Indonesia 1.10%, Argentina 0.92%, Denmark 0.87%, South Korea 0.82%, Morocco 0.59%, Singapore 0.50%, Japan 0.37%, Tunisia 0.32%, Brazil 0.32%, Canada 0.32%, Vietnam 0.27%, Russia 0.23%, Sweden 0.05%.

\*\* Turkey 2.65%, Japan 1.70%, Thailand 1.63%, Egypt 1.30%, South Africa 1.11%, Argentina 1.08%, Korea 0.98%, Philippines 0.62%, Denmark 0.61%, China 0.54%, Singapore 0.42%, Indonesia 0.39%, Morocco 0.33%, Canada 0.23%, Brazil 0.21%, Russia 0.17%, Vietnam 0.15%, Tunisia 0.06%, Sweden 0.01%.

FIGURE 1

COUNTRY OF ORIGIN INFORMATION (DATA FROM 2010)

scanned products. Ideally, we would have liked to be able to scan all products in all stores. However, this was not feasible as it required permission from each store owner, which was not granted.

Both rounds of data collection took place in 2011, and a total of 4,508 products were scanned. Either because many of these products did not exist in prior years or because they existed but were not sold at the particular outlet we visited, we were only able to match COO information with 2,905 products that were sold between 2006 and 2010.<sup>12</sup> We then eliminated products coming from countries with currencies pegged to the U.S. dollar, including other Gulf Cooperation Council (GCC) countries. In the end, we are left with 2,307 products.<sup>13</sup>

After removing nontraded products and products from other countries with a currency pegged to the USD from the sample, we observe that the majority of the remaining products originate from the euro area. This can be seen from Figure 1, which shows countries of origin ranked by number and value of products sold in the UAE. More than half the products in our sample come from the Eurozone. In addition, three other EU countries, namely, the United Kingdom, Poland, and Switzerland, account for about 20%, whether measured by value or by number of products sold.

<sup>12</sup> The rate at which new products are introduced and old products are dropped is quite large. Our analysis shows that in a two-year period, product entry rates were between 40% and 90%, depending on the product category. To put this in perspective, using similar data for the United States, Broda and Weinstein (2010) find that it takes four years to get 40% of new products.

<sup>13</sup> Of the 598 products that we dropped because of the dollar peg, 95% originated from Saudi Arabia. By the end of the data cleaning process, the COO-augmented sample has no observations for three of the categories, namely bullion, milk, and tea.

## 3. METHODOLOGY

We estimate exchange rate pass-through using a specification that is standard in the empirical literature (see, e.g., Gopinath et al., 2010, for a recent application). Specifically, we employ the following pooled regression:

$$(1) \quad \Delta p_{c,t} = \mu_c + \sum_{j=1}^k \alpha_j \Delta p_{c,t-j}^* + \sum_{j=1}^k \beta_j \Delta e_{c,t-j} + \sum_{j=1}^k \gamma_j \Delta y_{t-j} + u_{c,t},$$

where  $\Delta p_{c,t}$  is the average bimonthly change in the (log) price of all products imported from country  $c$ ,  $e_c$  is the bilateral exchange rate between UAE and country  $c$  (UAE Dirhams per unit of foreign currency),  $\Delta p_{c,t}^*$  measures the bimonthly change in the log price level in country  $c$ , and  $\Delta y_t$  measures bimonthly changes in demand conditions in the UAE.

To obtain  $\Delta p_{c,t}$  we proceed in two steps: First, we compute the price  $\Delta p_{ic}$  as a simple average of the prices for each product  $i$  across all outlets. We use a simple average to ensure that sales promotions at an outlet—which are always accompanied by a substantial surge in the quantity sold at that particular outlet—do not drive changes in  $\Delta p_{ic}$ . (Also recall that we only consider a balanced panel of outlets that were audited in all periods, which ensures that changes in average prices of each product are not driven by changes in outlet composition.) Second, we compute  $\Delta p_{c,t}$  as the weighted average price change for all  $\Delta p_{ic}$ 's from country  $c$ . Weights are based on sales volumes of each product. We do this to minimize measurement error that can arise when items with very low sales volume experience sharp price fluctuations and become more important in influencing average prices than the high-volume products with more stable prices.<sup>14</sup>

Exchange rates come from the International Financial Statistics (IFS) database. For robustness, three alternative timing conventions are used: average daily exchange rates over the current bimonthly period, average daily exchange rate over the previous bimonthly period, and exchange rates quoted at the last day of the previous period. We use the first convention for our baseline specification. Results are robust to these different timing conventions, as we show below.

We use foreign CPI data to control for shifts in prices that are not driven by changes in exchange rates. Shifts in foreign prices are proxies for changes in marginal costs, which in turn potentially affect the prices of imported products. For the case of the Eurozone countries, we use country-specific CPI measures unless the product label states EU. In such cases, we use an EU-based CPI measure.<sup>15</sup>

To capture shifts in domestic demand conditions, we compute an output measure based on the value of total sales of FMCGs in our sample. We do not rely on overall GDP. Such a derived measure is a much better proxy for capturing changes in demand of the products under study for three main reasons: (i) Measures of GDP in developing countries are not as accurate as measures in advanced economies; (ii) GDP changes in the UAE are mainly driven by changes in the price of oil and of natural gas and, as a result, they do not reliably reflect changes in demand conditions; and (iii) the data are not available at a bimonthly frequency. An advantage of the detailed data set we have is that we can construct a market-specific measure of GDP that better tracks changes in the demand conditions for FMCGs.

The parameter of interest is  $\beta(k) = \sum_{j=1}^k \tilde{\beta}_j$ , where  $\tilde{\beta}_j$  are the estimated coefficients from the regression specification above with  $k$  lags. Hence,  $\beta(k)$  measures the cumulative percentage change in consumer prices in response to a 1% change in exchange rates. This represents the

<sup>14</sup> For robustness, we have estimated a version of (1) where we do not average prices of the same barcode across outlets. In this case each barcode/outlet combination constitutes a different variety. We still average the resulting price changes by country of origin. Results are very similar in this specification and are available upon request.

<sup>15</sup> For robustness, we considered Producer Price Index (PPI) data instead of CPI where available (mainly EU). The results were qualitatively and quantitatively very similar and therefore omitted from the article.



portion of the exchange rate change that is passed through to prices after  $k$  bimonthly periods. We are interested in the cumulative effect of exchange rates on retailer prices at different time horizons, so we estimate specification (1) varying the number of lags from 1 (two months) to 6 (one year) and computing the summation  $\beta(k)$  each time.<sup>16</sup>

Finally, to account for the adjustment of prices to exchange rate shocks beyond purely nominal stickiness, we also present estimates from an alternative specification, which considers the cumulative price change over the life of a good. Specifically, following Gopinath and Itskhoki (2010), we estimate

$$(2) \quad \Delta_L \bar{p}_{ir} = \alpha^L + \beta^L \Delta_L e_{ir} + \epsilon_{ir},$$

where  $\Delta_L \bar{p}_{ir}$  is the log difference between the last observed new price and the first *new* price of item  $i$  sold at retailer  $r$  in the sample, and  $\Delta_L e_{ir}$  is the cumulative log change in the nominal exchange rate over the corresponding period. We also estimate a version of specification (2) where the first price in  $\Delta_L \bar{p}_{ir}$  is the first observed price in the sample for that good. We include country of origin fixed effects in the regression ( $\alpha^L$ ). Items without a price change between the start and end periods, as defined above, are excluded from the analysis. The coefficient of interest is  $\beta^L$ , which Gopinath and Itskhoki (2010) denote *lifelong pass-through*.

#### 4. RESULTS

Although our primary goal is to provide evidence on the micro-determinants of exchange rate pass-through, we begin this section by using our data to provide aggregate estimates of exchange rate pass-through into retail prices. We then delve into the micro-determinants of exchange rate pass-through and study how it varies with retailer size, product quality, the elasticity of substitution within product categories, and the frequency of price changes.

**4.1. Aggregate Pass-Through.** Estimation of specification (1) with outlets pooled together yields exchange rate pass-through of 20% after one year.<sup>17</sup> The degree of aggregate pass-through over time, along with the 95% confidence intervals, is shown in Figure 2(a). Table 2 reports the estimates of the pass-through coefficients, along with the parameters for other relevant covariates. Pass-through is statistically different from zero at all horizons. Moreover, we find pass-through to be gradual, with about half of the response occurring within six months.

For robustness, we estimate specification (1) using alternative timing conventions for the exchange rates. A summary of the results is in Table 3, which reports the sum of the coefficients of  $\Delta e$  (i.e., the degree of cumulative exchange rate pass-through) for various lags (horizons). The table also shows estimates for a subsample that uses supermarket data only. For ease of comparison, the cumulative coefficients of  $\Delta e$  for lags from 1 to 6 in the baseline specification are shown in column 1. The results are by and large robust to these variations.

To assess the extent to which product replacement can significantly bias exchange rate pass-through estimates (see Nakamura and Steinsson, 2012), we additionally estimate specification (1) using a balanced panel of products, that is, only the products that were available at a store in all five years.<sup>18</sup> The sample size is substantially reduced, as the number of product-outlet combinations drops from 138,137 to 17,275. The degree of exchange rate pass-through over time is shown in Figure 2(b). Long-run pass-through is about 25% when a balanced panel of products is used. The estimates thus do not differ greatly from the baseline case (as a comparison to

<sup>16</sup> For example, to obtain the degree of exchange rate pass-through after two months, we run (1) using one lag and report  $\beta(1)$ . For one year pass-through, we run the regression using six lags and report  $\beta(6)$ . Notice that the number in parenthesis specifies both the number of lags used in the estimation and the number of coefficients added up in the summation.

<sup>17</sup> Some papers measure the degree of exchange rate pass-through after a quarter, a period that is sometimes referred to as short run. Our analysis shows that short-run pass-through is about 3%, calculated as  $\beta(1) + \beta(2)/2$ .

<sup>18</sup> A product here is defined by its barcode and outlet at which it was sold.

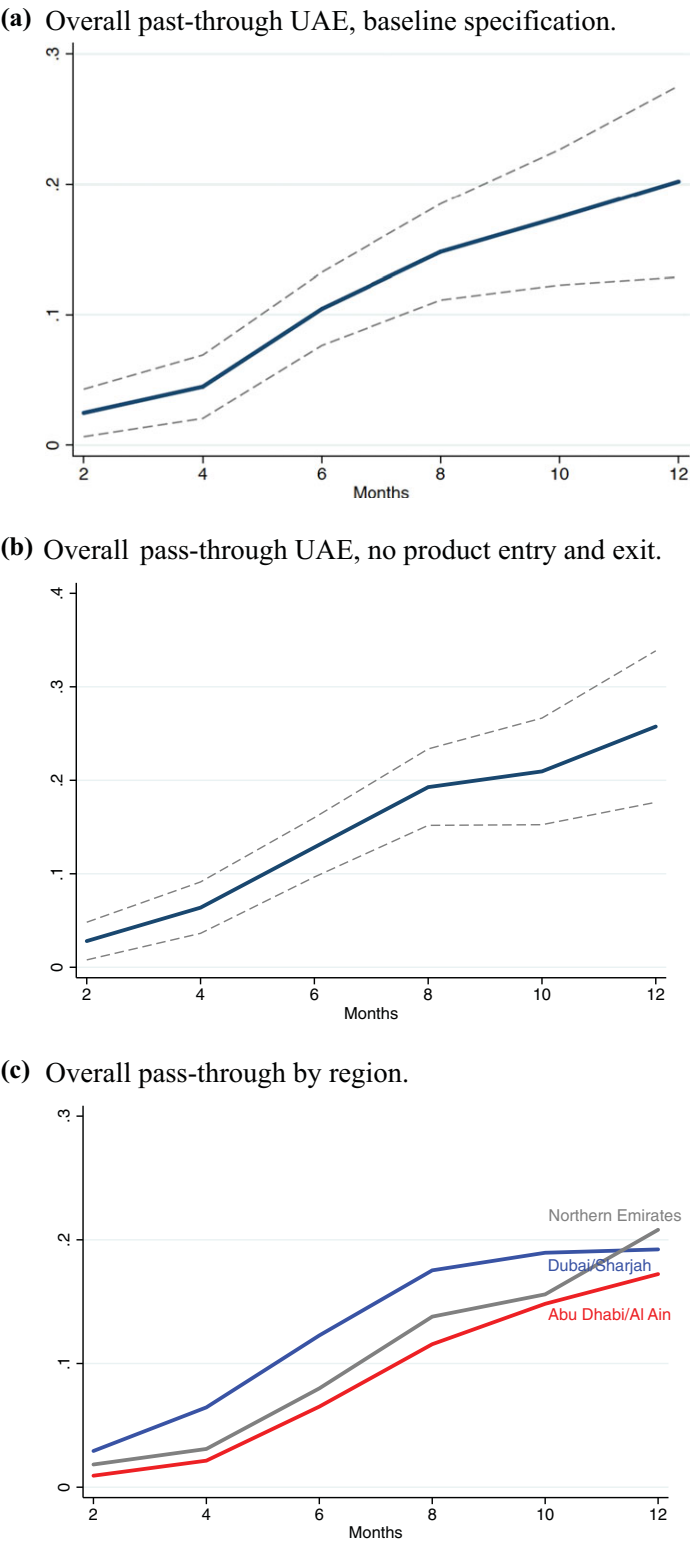


FIGURE 2

AGGREGATE EXCHANGE RATE PASS-THROUGH IN UAE: (A) OVERALL PAST-THROUGH UAE, BASELINE SPECIFICATION; (B) OVERALL PASS-THROUGH UAE, NO PRODUCT ENTRY AND EXIT; (C) OVERALL PASS-THROUGH BY REGION



TABLE 2  
BASELINE AGGREGATE PASS-THROUGH REGRESSION

Horizon, in Months ( <i>k</i> )	2 (1)	4 (2)	6 (3)	8 (4)	10 (5)	12 (6)
$\sum_{j=1}^k e_{t-j}$	0.025*** (0.011)	0.045*** (0.015)	0.104*** (0.017)	0.148*** (0.022)	0.175*** (0.032)	0.202*** (0.045)
$\sum_{j=1}^k p_{t-j}^*$	0.153*** (0.040)	0.148*** (0.044)	0.108*** (0.051)	0.022 (0.066)	0.070 (0.105)	0.085 (0.137)
$\sum_{j=1}^k y_{t-j}$	0.039*** (0.004)	0.041*** (0.005)	0.037*** (0.006)	0.045*** (0.007)	0.065*** (0.010)	0.029* (0.017)
$R^2$	0.21	0.22	0.29	0.32	0.34	0.36
$N$	788	753	718	684	650	616

NOTES: Estimates from specification (1) in the main text. Data cover the period 2006 and 2010 with a bimonthly frequency. The main coefficients of interest are the cumulative pass-through coefficients for different horizons, and they are reported in the first row of the table. Standard errors are in parentheses.

\*\*\*, \*\*, \* denote significance at the 1%, 5%, and 10% level, respectively. Country-of-origin fixed effects are included.

TABLE 3  
ROBUSTNESS ANALYSIS FOR AGGREGATE PASS-THROUGH

	(1)	(2)	(3)	(4)	(5)	(6)
Month						
2 ( <i>k</i> = 1)	0.02	0.02	0.03	0.03	0.03	0.02
4 ( <i>k</i> = 2)	<b>0.04</b>	<b>0.05</b>	0.06	0.06	<b>0.05</b>	0.05
6 ( <i>k</i> = 3)	<b>0.10</b>	<b>0.10</b>	<b>0.14</b>	<b>0.13</b>	<b>0.13</b>	<b>0.12</b>
8 ( <i>k</i> = 4)	<b>0.15</b>	<b>0.15</b>	<b>0.15</b>	<b>0.14</b>	<b>0.15</b>	<b>0.14</b>
10 ( <i>k</i> = 5)	<b>0.17</b>	<b>0.17</b>	<b>0.18</b>	<b>0.15</b>	<b>0.18</b>	<b>0.15</b>
12 ( <i>k</i> = 6)	<b>0.20</b>	<b>0.19</b>	<b>0.14</b>	<b>0.13</b>	<b>0.16</b>	<b>0.14</b>
Supermarkets only	No	Yes	No	Yes	No	Yes
Exchange rate						
Average <sub><i>t</i></sub>	*	*				
Average <sub><i>t</i></sub> − 1			*	*		
End period					*	*

NOTES: This table reports results for variations on specification (1) in the main text. Each column depicts regression results from a different aggregate pass-through specification. Specifically, we consider three alternative timing conventions for the exchange rate: (i) the average daily value of the current month, (ii) the average daily value of the previous month, and (iii) the end-of-period exchange rate for the previous month. For each of these alternatives we consider two samples: (i) all outlets and (ii) supermarkets only. Each of the six regression specifications above is estimated six times. Each time an additional lag is included. The table entries are the sums of the coefficients of  $\Delta e_t$  (i.e., the degree of cumulative exchange rate pass-through for that horizon). Numbers in bold denote that the estimated sum of coefficients for the relevant horizon/specification is significant at the 5% level.

Figure 2(a) makes clear), although the fact that the latter is lower is consistent with the analysis in Nakamura and Steinsson (2012).

We also report estimates of lifelong pass-through (see specification 2) in Table 4, panel I. For both definitions of the lifelong price change discussed above, this measure of pass-through for FMCGs in the UAE is estimated to be higher than for our baseline measure, around 30%. This is not surprising, as we are now conditioning on goods having a price change.

Our baseline aggregate measure of long-run pass-through falls in the mid-range of estimates obtained in related studies that use prices of traded goods at the dock and prices of aggregate baskets that include both traded and nontraded goods at the point of consumption. Using aggregate indices for import prices in OECD countries, Campa and Goldberg (2005) find evidence of partial but relatively large pass-through after a year, with an average value of 64% across the sample of countries. Olivei (2002) and Marazzi and Sheets (2007) estimate lower

TABLE 4  
LIFE LONG PASS-THROUGH AND ITS DETERMINANTS

Specification		Version 1				Version 2			
		$\beta^L$	$t\text{-Stat}(\beta^L)$	$R^2$	$N$	$\beta^L$	$t\text{-Stat}(\beta^L)$	$R^2$	$N$
I.	Overall pass-through	0.31	4.59	0.16	59,393	0.29	3.36	0.15	59,242
II.	By region								
	Dubai—Sharjah	0.35	4.54	0.18	20,318	0.35	3.84	0.18	20,288
	Abu Dhabi—Al Ain	0.28	4.43	0.15	31,923	0.27	3.08	0.14	31,808
	Northern Emirates	0.34	5.06	0.16	7,152	0.23	3.21	0.15	7,146
III.	By retailer type								
	UAE: Supermarket	0.31	4.47	0.16	46,306	0.30	3.34	0.15	46,274
	UAE: Grocery, self-service	0.25	5.56	0.12	13,087	0.19	4.36	0.12	12,968
IV.	By market share—supermarkets only								
	UAE: High	0.32	4.55	0.16	29,628	0.32	3.43	0.15	29,600
	UAE: Low	0.26	3.58	0.19	16,678	0.21	2.54	0.18	16,674
V.	By the elasticity of substitution of the product category								
	UAE: High	0.20	1.94	0.32	9,781	0.01	0.04	0.26	8,625
	UAE: Low	0.31	2.87	0.23	8,625	0.18	0.96	0.26	9,781
VI.	By product quality								
	UAE: High	0.15	1.50	0.09	20,036	0.17	1.57	0.09	19,969
	UAE: Low	0.31	2.55	0.28	14,536	0.21	1.03	0.28	14,515
VII.	By the frequency of price adjustments								
	UAE: High	0.32	4.13	0.19	12,686	0.34	4.68	0.19	12,685
	UAE: Low	0.27	4.40	0.18	12,626	0.27	3.85	0.11	12,624

NOTES: Estimates from specification (2) in the main text for various samples of the data. Data cover the period 2006 and 2010 with a bimonthly frequency. Version 1 uses the first *new* price as the first price for the computation of the “life long” price change of a product. Version 2 uses the first *observed* price as the first price. Observations are clustered by product category.

(and declining) pass-through for U.S. import prices. These studies find aggregate long-run pass-through to be around 50% during the 1980s and 20% in the 1990s. Gopinath et al. (2010) use more recent U.S. good-level data on prices at the dock and find comparable numbers. Pass-through into consumer prices is expected to be smaller, as other factors past the border contribute to making prices more unresponsive to exchange rate movements. Indeed, our benchmark retailer pass-through estimate of 20% is generally lower than the above values.<sup>19</sup> Studies that look at consumer price indices for a selection of developed countries obtain pass-through estimates in the range of 0% to 17%, depending on the sample and specification considered, and in most cases statistically insignificant (e.g., Ihrig et al., 2006; Goldberg and Campa, 2010). These estimates of pass-through into consumer prices tend to be lower than those obtained here. However, as these indices are based on baskets that contain a large portion of nontraded goods, pass-through on only traded goods at the point of consumption is likely to be higher. Although the aggregate specification is not the main focus of the article, showing that our aggregate estimate using data from UAE does not differ from estimates obtained using data from advanced economies, shows that there is nothing particularly different about our data that may create concerns later on in the analysis.

To conclude our aggregate analysis, we show that there is little variation in pass-through across regions. We run specifications (1) and (2) for each region separately, and we discard any outlet-specific information by pooling together all outlets by region. The regression coefficients in (1) for each region are reported in Figure 2(c). We observe that exchange rate pass-through behavior across regions is very similar, both in its extent and its evolution over time. In most

<sup>19</sup> For instance, our estimate is lower than most of the values in Campa and Goldberg (2005), which exhibit substantial cross-country variation around the reported average.

TABLE 5  
OUTLET INFORMATION BY REGION

Region	Number of Outlets per Region by Type					Market Concentration Ratio	
	All	Supermarkets	Groceries	Self-Service	Other*	Top-4	Top-8
Dubai—Sharjah	599	50	129	36	384	0.72	0.92
Abu Dhabi—Al Ain	277	25	135	21	96	0.83	0.89
Northern Emirates	165	10	67	6	82	0.87	0.90
Total UAE	1,041	85	331	63	562	0.28	0.45

NOTES: The table reports a breakdown of outlets by type, along with market concentration ratios (data from 2010).

\*Includes cafeterias, eateries, pharmacies, and convenience stores.

cases the differences are small and not statistically significant.<sup>20</sup> Although we do observe slightly more substantial variation in life long pass-through (see Table 4, Panel II), these findings suggest that pricing to market is relatively uniform across the country.<sup>21</sup>

**4.2. Micro-determinants.** We now turn to the micro-determinants of exchange rate pass-through. In particular, we study how (i) retailer market size, (ii) product homogeneity within product categories (as captured by the elasticity of substitution within each product category), (iii) quality differentiation across products (used as proxy for markups), and (iv) the frequency of price adjustments across categories affect pass-through. Although recent work has linked pricing to market/exchange pass-through to firm-level characteristics of exporters (see, e.g., Berman et al., 2012; Chatterjee et al., 2013), we complement the literature by linking pass-through to retailer characteristics.

To help us organize our intuition and account for the subsequent findings, we build a simple theoretical framework. The essence of the theory, which is available in the Appendix, is the presence of a local, nontraded component of the final retail price, which varies across retailers. Specifically, we assume that the nontraded component—paid in local currency—falls with retail size and rises with the elasticity of substitution of the product category. Because the share of the consumption price, which depends on export price, is then greater for large retailers, the exchange rate pass-through is higher for their products. The theory, which is based on Corsetti and Dedola (2005), can also account for the inverse relation between exchange rate pass-through and both the elasticity of substitution of the product category and product quality.<sup>22</sup>

**4.2.1. Retailer market share.** The first testable hypothesis generated by the model in the Appendix is that exchange rate pass-through increases in retailer size. This happens because as the retailer wedge—which encompasses retail costs and retail markups—decreases in retailer size, the share of the consumption price that depends on export prices, and hence is sensitive to exchange rate movements, is greater.

We first examine how exchange rate pass-through varies across outlet type. Outlets in our sample are defined by Nielsen as supermarkets, groceries, mini-markets, self-services, pharmacies, convenience stores, cafeterias, and eateries based on function and square footage. Table 5 provides the number of outlets and outlet types across the three regions in UAE. The majority of outlets are located in the Dubai and Sharjah region.

<sup>20</sup> In this instance and in subsequent analysis, we refrain from including confidence intervals in the figures to avoid cluttering. The online appendix to the article has tables with significance tests for pass-through differences across all the dimensions that we analyze throughout the article.

<sup>21</sup> A slightly higher pass-through in Dubai and Sharjah for some periods may be due to the fact that their population is mostly comprised of expats, who are more likely to stay in the region for shorter periods, whereas in the other two regions the population is mostly comprised of nationals. Retailers in these other regions may be less willing to pass the burden of exchange rate movements to the consumers as they try to build loyalty with the local population.

<sup>22</sup> Berman et al. (2012) introduce firm heterogeneity in the Corsetti and Dedola model to show that pass-through is low for high-productivity firm. We borrow their adaptation of the model to introduce retailer heterogeneity.

TABLE 6  
OUTLET SALES SHARES BY REGION

Region	% of Sales by Outlet Type		
	Supermarkets	Groceries	Self-service
Dubai—Sharjah	90.5	3.8	5.6
Abu Dhabi—Al Ain	84.8	3.7	11.4
Northern Emirates	87.3	5.3	7.3
Overall, UAE	88.9	3.9	7.9

NOTES: Sales shares by outlet type are computed based on the full, non-COO augmented sample (data from 2010).

Although supermarkets in each region are few, they account for the majority of sales, as the high concentration ratios show. This is shown in Table 6, where sales shares of the three main outlet types are reported for UAE and for each of the three regions. With a market share of 88%, supermarkets account for the majority of sales. Groceries and self-service stores follow with market shares of roughly 4% and 8%, respectively. This is true for all three regions.<sup>23</sup> For the purpose of the analysis that follows, we will only focus on the three main outlet types, namely, supermarkets, groceries, and self-service stores.

Thus, we run specifications (1) and (2) for the three subsets of data corresponding to these outlet types. Moreover, to account for regional differences in demand, we replicate the analysis for each region. The results for (1) are presented in Figure 3, Panel I. For this and subsequent figures, we report UAE-wide pass-through estimates (subpanel (a)) and regional pass-through estimates (subpanels (b) to (d)). Two results stand out: First, exchange rate pass-through is higher in supermarkets than in groceries and self-service stores. Second, within-region variation in pass-through is substantially higher than between-region variation (as a comparison to Figure 2(c) shows).

The finding that exchange rate pass-through is higher for supermarkets than groceries and self-service stores suggests that retail size is positively correlated with pass-through. However, other differences across these outlet types—such as differences in product mix, clientele, management style, and ambience—may also affect the degree of exchange rate pass-through.

To control for these other important dimensions of potential retailer heterogeneity, we replicate the analysis using data from supermarkets only. In each region, we allocate supermarkets into two bins based on their market share, with equal number of outlets in each bin.<sup>24</sup> We then estimate pass-through for each market share bin. Figure 3, Panel II, reports these coefficients: Again, we find that exchange rate pass-through is positively correlated with market share and that this relation is robust across regions. Again, the results by outlet type and market share are qualitatively similar for our life long measure of pass-through (see Table 4, Panels III and IV).

A large body of the empirical literature on the determinants of pass-through has primarily considered characteristics of the *producer* (see Atkeson and Burnstein, 2008; Auer and Chaney, 2009; Berman et al., 2012; Auer and Schoenle, 2013; Chatterjee et al., 2013; Amiti et al., 2014), whereas here we consider characteristics of the *retailer*. Yet, it is of interest to see whether the market share of the exporting country or the exporting manufacturer affects pass-through in our data.

We first consider the market share of the exporting country. To this end, we allocate countries of origin into bins based on their sales shares within the FMCG market in the UAE (see this market share decomposition in Figure 1), and we estimate exchange rate pass-through in each

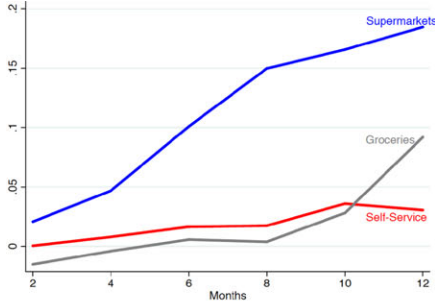
<sup>23</sup> Shares are computed as fraction of observed sales, using the full sample. Outlet market shares and concentration ratios do not significantly change over the sample period. The market shares of the various outlet types are about the same if we consider only the subset of the data containing COO information.

<sup>24</sup> In the country-wide analysis, outlets in the low-share bin have less than 1% market share in their region, whereas outlets in the high-share bin have from 1% to 12% share.

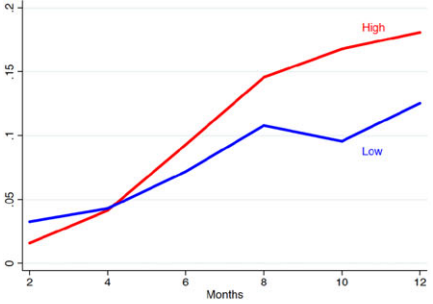
*Panel I: Outlet Type*

*Panel II: By Market Share,  
Supermarkets only*

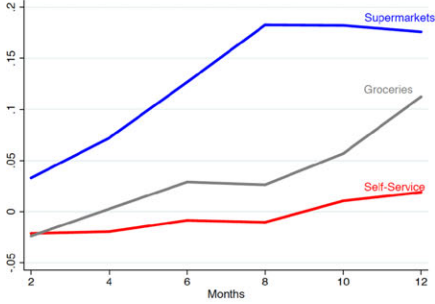
**(a)** United Arab Emirates



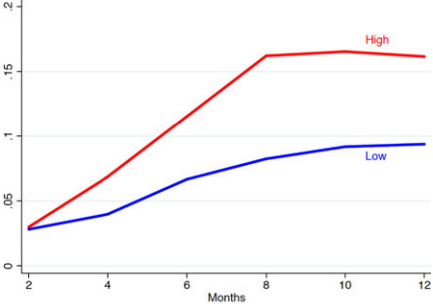
**(a)** United Arab Emirates



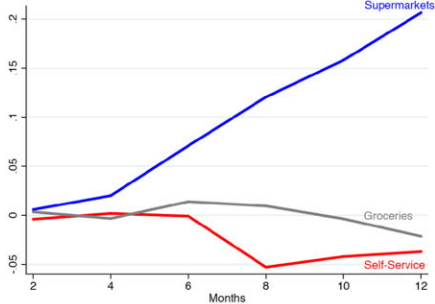
**(b)** Regional: Dubai – Sharjah



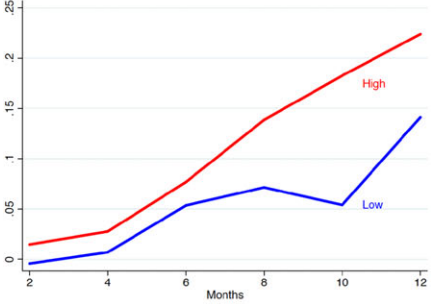
**(b)** Regional: Dubai – Sharjah



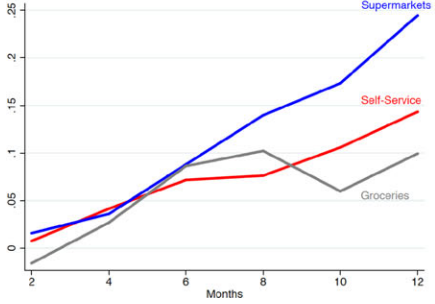
**(c)** Regional: Abu Dhabi – Al Ain



**(c)** Regional: Abu Dhabi – Al Ain



**(d)** Regional: Northern Emirates



**(d)** Regional: Northern Emirates

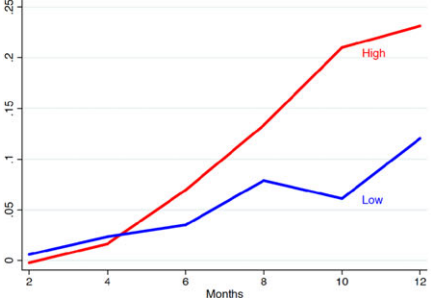


FIGURE 3

bin. The results are reported in Figure 4, Panel I, for the UAE as a whole and for each region separately. Exchange rate pass-through appears to be higher for countries with high market share. However, because it is mainly Eurozone countries that are allocated in the high and medium categories, we cannot say whether higher pass-through is linked to high market share or is specific to movements in the USD–EUR exchange rate during that period (recall that the Dirham is pegged to the US dollar).

To investigate this further, we perform a similar analysis that focuses on the market share of foreign brands/producers exporting to the UAE. The results are reported in Figure 4, Panel II.<sup>25</sup> We do not find a strong relation between brand market share and pass-through as we look across regions. Even if we only concentrate on brands originating from the EU or if we remove the tiniest brands we still fail to see any relation.<sup>26</sup> Panels I and II suggest that it is difficult to draw conclusions along this dimension of the data.

The main takeaway is that our analysis produces strong evidence of a relationship between retailers' market power and pass-through, but rather inconclusive evidence of a relationship between exporting country or exporting producer market share and pass-through.

**4.2.2. Elasticity of substitution.** The second testable hypothesis is that exchange rate pass-through decreases with the elasticity of substitution of the product category. This may happen because as the elasticity of substitution rises, participants along the supply chain (i.e., manufacturers, wholesalers, and retailers) are forced to absorb more of the burden of an increase in costs due to the high sensitivity of consumer demand to price changes. Consequently, exchange rate (and any other cost) pass-through into consumer prices will fall as the elasticity rises.

To test this hypothesis, we first use the full (non-COO-augmented) sample to estimate the elasticity of substitution for each product category, employing a methodology proposed by Broda and Weinstein (2006) and Broda et al. (2006).<sup>27</sup> We then allocate the categories to three equally sized bins as shown in Table A1 in the Appendix.<sup>28</sup> The elasticity of substitution is the lowest in the Liquid Cordials, Suncare, and Blades categories, and the highest in the Chewing Gum, Power Soft Drinks, and Cigarettes categories. Finally, we run the pass-through regressions for each bin.

The regression results by elasticity bin, reported in Figure 5, Panel I, and Table 4, Panel V, confirm the hypothesis above. Exchange rate pass-through is the highest for the low elasticity bin, which suggests it is positively correlated with the degree of product heterogeneity within a particular product group.

**4.2.3. Quality.** Next, we investigate how product quality affects exchange rate pass-through. High quality may proxy for high markup and/or high productivity. Markups can then be used as a cushion to shifts in costs, such as those generated by movements in exchange rates. Therefore, we may expect exchange rate pass-through to fall with product quality. This is another one of the predictions of the model in the Appendix, which uses productivity as a proxy for quality.

Following Auer and Chaney (2009), we use variation in price within specific product category-weight-packaging type triplets as evidence of variation in quality. Examples of such triplets are water-0.33 L-glass, water-0.33 L-tins, and water-0.33 L-pet. In total, 413 such triplets are considered. The deviation between the price of a product and the average price of all products within that same triplet is used to make inferences about quality.<sup>29</sup>

<sup>25</sup> We also restricted the sample to brands from the Eurozone to disentangle the currency effect from the market power effect. Results are very similar; thus we only report those for all brands.

<sup>26</sup> Due to space considerations these results are omitted but are available upon request.

<sup>27</sup> We would like to thank David Weinstein for sharing the code used to estimate the elasticities.

<sup>28</sup> We recall that the COO-augmented sample only has data for 27 categories.

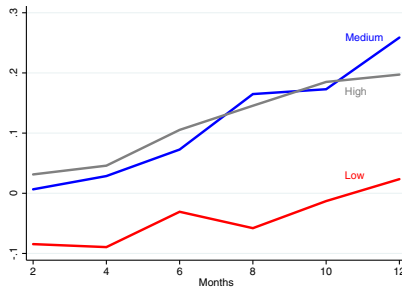
<sup>29</sup> Arguably, price may not always be a good proxy for quality. If a Perrier and a San Pellegrino 1-L, glass bottles of water both sell for a price premium over other goods, but Perrier sells 1,000 units per month, whereas San Pellegrino



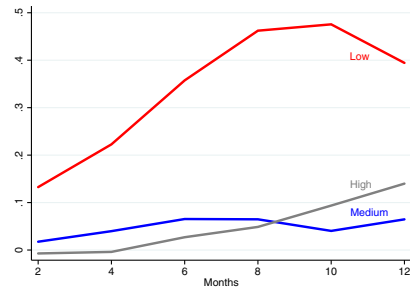
*Panel I: Country-of-Origin  
Market Share*

*Panel II: Brand Market  
Share*

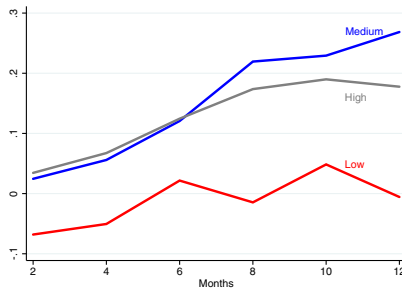
**(a) United Arab Emirates**



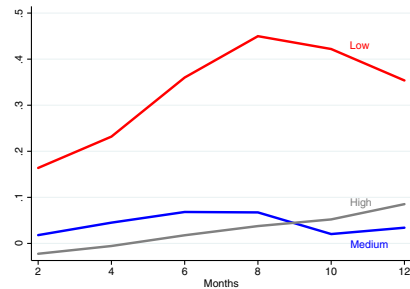
**(a) United Arab Emirates**



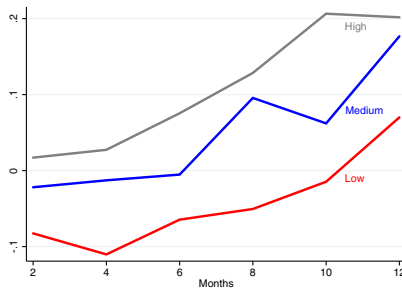
**(b) Regional: Dubai – Sharjah**



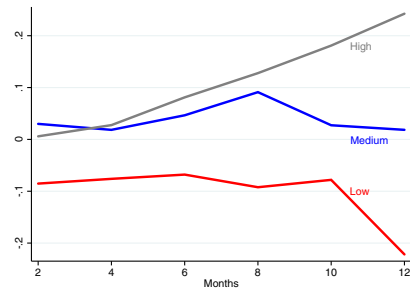
**(b) Regional: Dubai – Sharjah**



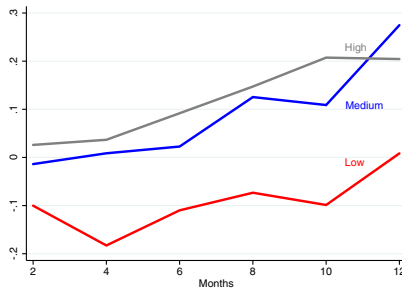
**(c) Regional: Abu Dhabi – Al  
Ain**



**(c) Regional: Abu Dhabi – Al  
Ain**



**(d) Regional: Northern Emirates**



**(d) Regional: Northern Emirates**

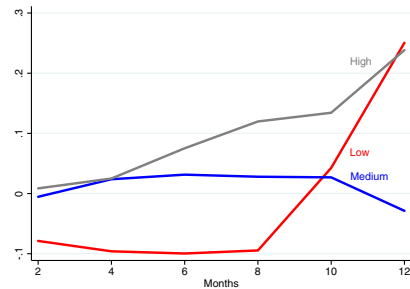


FIGURE 4

EXCHANGE RATE PASS-THROUGH BY COUNTRY-OF-ORIGIN MARKET SHARE AND BRAND MARKET SHARE

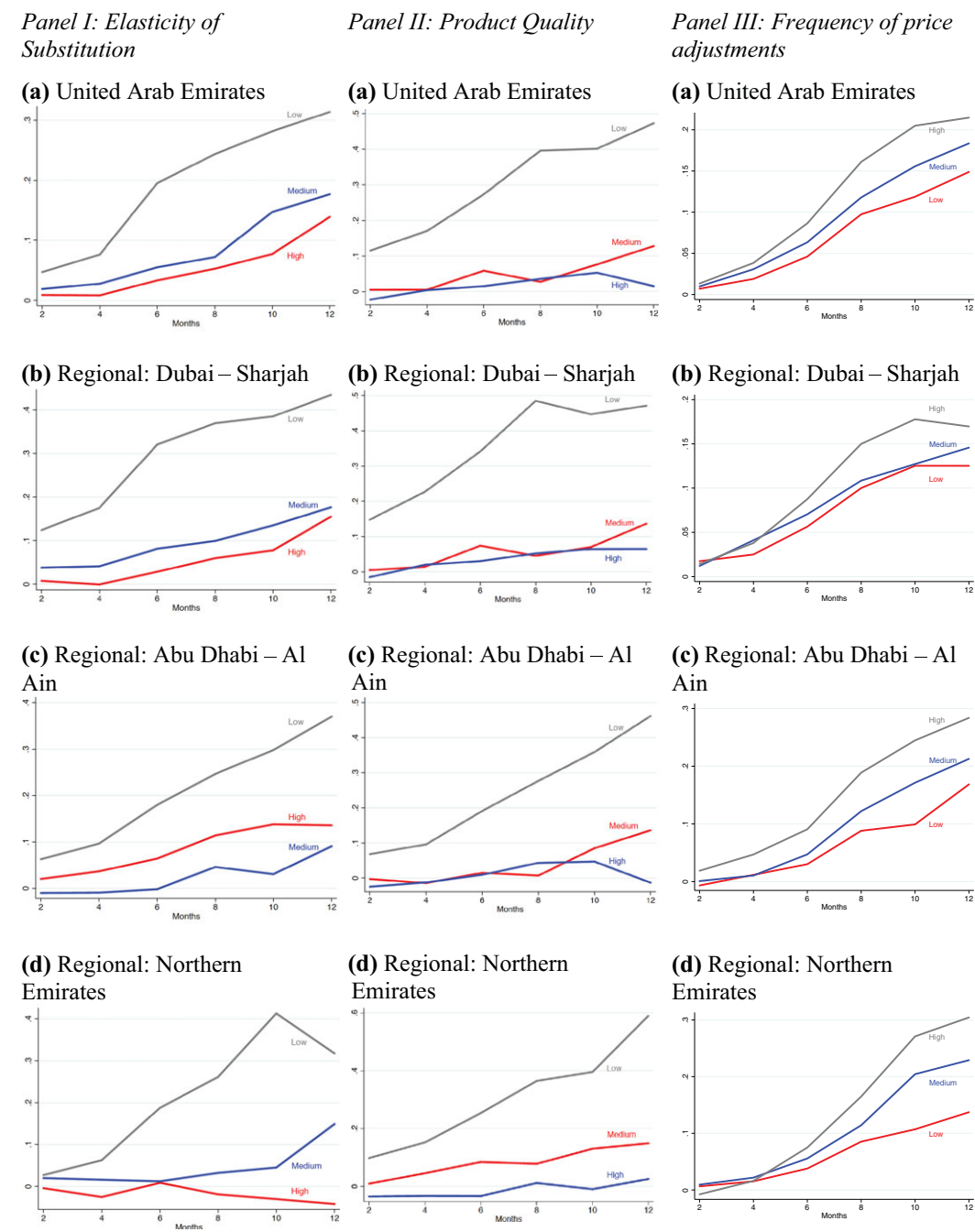


FIGURE 5

EXCHANGE RATE PASS-THROUGH BY ELASTICITY OF SUBSTITUTION, PRODUCT QUALITY, AND THE FREQUENCY OF PRICE ADJUSTMENT

only sells 1, it can be deduced that consumers perceive Perrier as a product of higher quality than San Pellegrino. However, for the purpose of the analysis in this article, what matters is the perception that suppliers have on the quality of their products, as it determines the markups charged. So, if both products have high price, regardless of the quantity sold, we make the assumption here that both exhibit high markups. For a discussion on how quantity and price can be

We allocate products into three quality bins by sorting the price deviations and setting the 33rd and 67th percentile as the cutoff points. We then estimate pass-through for each bin. As before, we run a UAE-wide regression and repeat the analysis for each region. Results for specification (1) are presented in Figure 5, Panel II. Exchange rate pass-through is high for low-quality goods, but low for medium- and high-quality goods. This negative relationship is confirmed when we consider life long pass-through (see Table 4, Panel VI). The results suggest that a certain markup threshold exists, beyond which retailers are able to absorb most of the movement in the exchange rate.

Although this study is among the first to confirm empirically this strong negative relation, possible channels by which product quality affects exchange rate pass-through have been discussed in previous work.<sup>30</sup> Bussiere and Peltonen (2008) emphasize the role of markups, whereas Auer and Chaney (2009) consider changes in the quality and quantity mix of goods produced and consumed in response to movements in exchange rates.

The results warrant a couple of comments. First, if globalization affects the share of quality goods produced and consumed and if it affects market concentration across wholesalers and retailers, then one may expect that two sources of variation in pass-through across time and space may be variations in the average quality of the consumption basket and/or changes in cross-border market toughness.<sup>31</sup>

Second, our results confirm a hypothesis generated by two distinct literatures that link firm heterogeneity and pricing to market, on the one hand, and firm heterogeneity and endogenous quality choice on the other hand. One set of studies documents that high-productivity exporters (Berman et al., 2012) and exporters with high market share (Atkeson and Burstein, 2008) absorb more exchange rate pass-through in their markups. Another set of studies, which endogenize quality choice (see Baldwin and Harrigan, 2011; Johnson, 2012; Antoniadou, 2015), theorize that high-productivity firms have higher market shares and export higher-quality goods. By putting together the predictions of these two literatures, we can formulate the hypothesis that exchange rate pass-through must be lower for high-quality goods. This is because high-quality goods are produced by high-productivity firms that have high market shares and absorb more pass-through in their markups. Our analysis finds strong support for the aforementioned hypothesis.

*4.2.4. Frequency of price adjustment.* Although we have not incorporated nominal price stickiness in our analysis, recent literature has stressed the importance of the interaction between pass-through and the frequency of price adjustment. For example, Gopinath and Itskhoki (2010) use microeconomic data on U.S. import prices and show that the degree of exchange rate pass-through is higher for products with a high frequency of price adjustment. They argue that this relationship can in turn provide more general insights on price setting behavior and show it is consistent with an important role for variable markups in generating incomplete pass-through.

We test this finding in our data: We first estimate the frequency of price adjustment for each product that experiences at least one price change, then allocate the products into three bins based on this frequency, and we finally estimate pass-through for each bin.

Summary statistics for the frequency of price adjustments are collected in Table A2 in the Appendix. Column 1 reports average frequencies for all products in the Nielsen data set, whereas Column 2 reports frequencies for the subset of the data that is used in our analysis. As a reminder, these are imported products with COO information, from countries whose currencies fluctuate with the UAE Dirham. On average, a product experiences a price change

used to extract quality using constant markups, see Khandelwal (2010), Broda and Weinstein (2010), and Feenstra and Romalis (2014).

<sup>30</sup> In related work, Auer et al. (2012) use European car data to show that pass-through is larger for low- than for high-quality cars. Chen and Juvenal (2016) also find that pass-through decreases with quality in the Argentinean wine market using wine ratings as a measure of quality.

<sup>31</sup> For studies that link trade liberalization and quality, see Hummels and Klenow (2005), Verhoogen (2008), and Goldberg et al. (2012). For studies that consider how trade liberalization affects retailers, see Raff and Schmitt (2012).

every four to five periods, with imported products experiencing a much higher frequency of price adjustments across most of the product categories.

Figure 5, Panel III, and Table 4, Panel VII, show results for exchange rate pass-through by frequency of price adjustment for specifications (1) and (2), respectively. At Both the national and the regional levels our evidence supports the finding in Gopinath and Itskhoki (2010), namely, that exchange rate pass-through tends to be higher for products with high frequency of price adjustments. We note that the allocation to frequency bins is based on the full sample of products, that is, not just the subset of products that we use for pass-through regressions. This should somewhat lessen the concern that the frequency of price adjustment is itself an outcome that depends on movements of the exchange rates.

## 5. DISCUSSION

We have documented that substantial variation exists in exchange rate pass-through across several dimensions, pertaining to both retailer-level and product-level characteristics. In particular, we have explored empirically a few testable implications produced by a simple model of price setting where local retailers are heterogeneous in the wedge they add on to the price of imported goods.

Our findings extend the literature on the determinants of exchange rate pass-through (as recently reviewed by Burstein and Gopinath, 2014) by documenting an additional dimension of heterogeneity related to retailers. The strength of the analysis comes from our ability to link prices and quantities of products sold across hundreds of outlets with COO information extracted from the product labels. In addition, the information is provided for 30 product categories that cover more than 85% of the FMCGs sold, at the highest level of disaggregation and at the point of consumption. Importantly, the data include outlet-level information, which allows us to relate pass-through to retailers' characteristics. Finally, our data come from a developing country with a committed dollar peg, where we believe information on cross-border pass-through is most relevant. This is true more generally for economies where gross trade flows constitute a large portion of GDP.

A few comments are in order regarding the UAE. Because of the particularity of the UAE, with its high GDP per capita and the preponderance of its energy sector, concerns might be raised about how much these findings can be generalized. For starters, we are reassured by the observation that our findings on the degree of aggregate pass-through and on the importance of the elasticity of substitution, product quality, and frequency of price adjustments are broadly consistent with the intuition in models that are calibrated and estimated for advanced economies. More specifically, the vast majority of the population is made up by expatriates, whose origin is from developed and developing countries alike. Many of the retailing chains in the UAE, along with their management, are international. Moreover, we recall that we have excluded from our sample goods that are imported from other GCC countries, which have fixed exchange rates relative to the UAE. We then expect bundles of consumption goods and invoicing practices to be generally comparable to (or at least not systematically different from) those of other countries.<sup>32</sup>

Importantly, our analysis further explores variation within the UAE, across its regions. The latter display notable differences along several dimensions, including the degree of urbanization, infrastructure, and demographics, from the "Western-like/developed" Dubai to the more "traditional/developing" Northern Emirates, where UAE citizens make up the majority of the population. Yet, our findings on aggregate pass-through and its potential determinants show remarkable robustness to regional differences. This seems to suggest that the basic insights can be generalized with some degree of confidence to both developing and developed settings.

<sup>32</sup> As shown in Section 3, a large portion of the FMCGs in our sample is imported from the Eurozone. We have anecdotal evidence from informal discussions with sourcing managers that pricing is predominantly in the currency of the producer.

We set out to explore pass-through and its micro-determinants in a developing country where scanner-level data for each retailer were available. The UAE provided a great setting for this study, as it allowed us to measure pass-through in a developing economy and study how retailer heterogeneity affects it. We are relatively confident that the conclusions along the various dimensions we analyzed in this article on the determinants of pass-through (retailer size, category elasticity of substitution, product quality, and frequency of price adjustments) are likely to not only generalize to both developing and developed settings, but also to the analysis of non-FMCGs (although, of course, the *degree* of pass-through for these goods may differ). Regardless, further work is needed to confirm that this is indeed the case.

In addition to replicating our results in various other settings and thus testing their robustness, a couple of extensions are worthwhile for future research on exchange rate pass-through. In particular, it would be informative to study (i) exchange rate pass-through and its implications in a setting where product quality, markups, and the elasticity of substitution are endogenously determined (e.g., Antoniadou, 2015) and (ii) whether nonlinearity in responses play a role, and appreciations/depreciations of exchange rate have different implications for our findings on the micro-determinants of pass-through.

## APPENDIX

A.1. *Additional Tables.*

TABLE A1  
ELASTICITIES OF SUBSTITUTION BY PRODUCT CATEGORY

Group	Category	Elasticity
i. Low	Liquid cordials	4.13
	Sun care	4.88
	Blades	5.80
	Skin cleansing	6.88
	Milk powder	8.65
	Male grooming	9.89
	Skin care	10.92
	Toothbrush	12.61
	Cooking oil	13.60
ii. Medium	Toothpaste	14.01
	Deodorant	19.75
	Water	20.85
	Csd	21.14
	Juices	23.19
	Shampoo	23.80
iii. High	Energy drinks	24.11
	Cereals	24.37
	Fabric conditioner	25.10
	Beans	25.53
	Insecticides	32.91
	Detergents	35.33
	Cheese	35.70
	Dish wash	38.55
	Powder soft drink	39.92
	Chewing gum	86.80

NOTES: Elasticity estimates are based on the full data set, including products without COO information. For more information on how the elasticities are estimated, see Broda and Weinstein (2006) and Broda et al. (2006).

TABLE A2  
FREQUENCY OF PRICE ADJUSTMENTS

	All Products	Products with COO
All	0.18	0.26
Beans	0.22	0.27
Blades	0.17	0.22
Cereals	0.16	0.19
Cheese	0.17	0.23
Chewing gum	0.11	0.43
Chocolate	0.17	0.27
Cigarette	0.06	0.30
Cooking oil	0.29	0.25
Csd	0.11	0.35
Deodorant	0.19	0.20
Detergents	0.21	0.38
Dishwash	0.21	0.22
Energy drinks	0.21	0.34
Fabric conditioner	0.22	0.18
Insecticides	0.22	0.05
Juices	0.16	0.30
Liquid cordials	0.18	0.27
Male grooming	0.18	0.23
Milk powder	0.21	0.27
Powder soft drink	0.16	0.17
Shampoo	0.2	0.25
Skincare	0.16	0.23
Skin cleansing	0.21	0.23
Sun care	0.19	0.27
Toothbrush	0.18	0.14
Toothpaste	0.19	0.20
Water	0.25	0.38
Total observations	699,720	64,342

NOTES: The categories in the table are those for which data are available in the COO-augmented sample . For these categories, the frequency of price adjustment is computed only for those products that have at least one price adjustment in the sample period. We treat products sold in different retailers as different varieties. Column 1 reports mean frequency across all data in each category and Column 2 the mean frequency across the COO-augmented subset of the data in each category.

A.2. *Theoretical Framework.* We present here a simple model of international trade with heterogeneous retailers that can account for the stylized facts presented in the article.

The main feature of the model is the presence of local retail costs that vary across retailers. When these costs are small (large), which we assume to be the case for large retailers that benefit from economies of scale, exchange rate pass-through into consumer prices is high (low) because the share of the final price that depends on the export price and is sensitive to exchange rate fluctuations is high (low). And, by adding additional structure on these retail costs we can also account for the inverse relation between pass-through and the elasticity of substitution.

This model extends Corsetti and Dedola’s (2005) international trade model with local distribution costs by adding heterogeneous retailers. We consider a world economy consisting of two economies: Home (H) and Foreign (F). Goods are produced in country F, shipped to country H, and then sold by heterogeneous retailers. We assume that the upstream and downstream firms (producers and retailers, respectively) are independent and that each type has market power so that prices are set as markups over marginal costs.<sup>33</sup>

<sup>33</sup> We allow producers to have monopoly power so that pricing-to-market is taken into consideration. In particular, pricing-to-market takes into account the heterogeneity in retail costs but also the movements in the exchange rate.



The representative consumer derives utility from consumption of a continuum of varieties as shown in the C.E.S. preferences below:

$$(A.1) \quad U(C_r) = \left\{ \int_{\Omega} \chi_r(\phi)^{\frac{\sigma-1}{\sigma}} d\phi \right\}^{\frac{\sigma}{\sigma-1}},$$

where  $\chi_r(\phi)$  is the consumption of variety  $\phi$  at retailer  $r$  and  $\sigma$  is the elasticity of substitution. The demand for variety  $\phi$  at retailer  $r$  is then given by

$$(A.2) \quad x_r(\phi) = Y P^{\sigma-1} [p_r^r(\phi)]^{-\sigma},$$

where  $p_r^c(\phi)$  is the price consumers pay for variety  $\phi$  at retailer  $r$ , and  $Y$  and  $P$  are income and the price index in the home country, respectively.

The retailer's objective is to choose  $p_r^c(\phi)$  that maximizes profits for variety  $\phi$ . Her profit function is

$$(A.3) \quad \Pi_r(\phi) = \chi_r(\phi) \left[ p_r^c(\phi) - \frac{p_r(\phi)\tau}{\epsilon} - \eta_r w \right],$$

where  $\eta_r w$  are the processing costs incurred by retailer  $r$  that are scaled up by the local wage  $w$ , and  $\frac{p_r(\phi)\tau}{\epsilon}$  is the exporter's price adjusted for any trade costs  $\tau$  ( $\tau \geq 1$ ) and paid in local currency using the nominal exchange rate  $\epsilon$ .

Although we do not explicitly model these retail costs here, we make two key assumptions: (i) They fall with retail size, and (ii) they rise with the elasticity of substitution of the product category. The first assumption accounts for economies of scale: Large retailers are more efficient in processing the paperwork, moving the inventory, shelving the products, completing the transactions, and preparing invoices and financial documents. The second assumption accounts for the extra cost (e.g., advertising, promotions) retailers have to incur in order to sell products facing higher competition.<sup>34</sup>

The profit-maximizing retail price  $p_r^c$ , as a function of the producer price  $p_r$ , is derived to be

$$(A.4) \quad p_r^c(\phi) = \frac{\sigma}{\sigma-1} \left( \frac{p_r(\phi)\tau}{\epsilon} + \eta_r w \right).$$

By substituting (4) into (2) we derive the demand for variety  $\phi$  at retailer  $r$  as a function of the producer price:

$$(A.5) \quad x_r(\phi) = Y P^{\sigma-1} \left( \frac{\sigma}{\sigma-1} \right)^{-\sigma} \left( \frac{p_r(\phi)\tau}{\epsilon} + \eta_r w \right)^{-\sigma}.$$

Given this downstream demand, the upstream producer will set prices  $p_r(\phi)$  for each retailer  $r$  that maximize upstream profits. The production of one unit of variety  $\phi$  requires  $1/\phi$  units of

<sup>34</sup> Most often it is the producers (or the wholesales) and not the retailers who face higher advertising and promotional costs when their products face higher competition in the market. The retailers have less of an incentive to express preference on one product over another (as long, of course, as consumers make a purchase). But regardless of who bears the cost—producers, wholesalers, or retailers—what matters is that these costs are paid in the local currency of the consumer and are not sensitive to exchange rates fluctuations. It is for this reason that we incorporate these costs in  $\eta_r$ . Alternatively, one can rewrite these local costs as  $\eta(\phi, r) = f(\eta_r, \eta_\phi)$ , where  $\eta(\phi, r)$  now encompasses both the processing costs paid by the retailers but also the advertising costs paid by the producer/wholesaler. The solution to the model and theoretical predictions do not change to this alternative specification.

labor and costs  $w^*/\varphi$ , where  $w^*$  is the foreign wage rate and  $\varphi$  is the productivity of the firm. The solution to the producer's optimization problem yields

$$(A.6) \quad p_r(\varphi) = \left( \frac{\sigma}{\sigma-1} \right) \left( \frac{w^*}{\varphi} + \frac{\eta_r w \epsilon}{\sigma \tau} \right).$$

With both the retailer and producer optimization problems solved, we can now re-express the retail price of variety  $\varphi$  at retailer  $r$ . Substituting Equation (6) into (4) yields

$$(A.7) \quad p_r^c(\varphi) = \left( \frac{\sigma}{\sigma-1} \right) \left[ \left( \frac{\sigma}{\sigma-1} \right) \left( \frac{w^* \tau}{\epsilon \varphi} + \eta_r w \right) \right].$$

Finally, we can characterize the degree of exchange rate pass-through into consumer prices. The rate at which retailer prices respond to a depreciation is governed by the relation

$$(A.8) \quad e_{p_r^c(\varphi)} = - \frac{dp_r^c(\varphi)}{d\epsilon} \frac{\epsilon}{p_r^c(\varphi)} = \frac{w^* \tau}{w^* \tau + \eta_r w \epsilon \varphi}.$$

The expression above yields three testable predictions on exchange rate pass-through into retail prices (ERPT-RP): (i) ERPT-RP rises with retailer size, (ii) ERPT-RP decreases with the elasticity of substitution of the product category, and (iii) ERPT-RP decreases with firm (producer) productivity/product quality. The first two predictions come from the structure we imposed above on these retail costs  $\eta$ . The final prediction comes from the assumption that high-quality firms produce high-quality goods.<sup>35</sup>

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<sup>35</sup> The relation between firm (producer) characteristics and exchange rate pass-through has been studied extensively in the literature. Specifically, evidence shows that larger (Atkeson and Burstein, 2008), more productive (Berman et al., 2012) firms, and firms that produce higher-quality goods (Auer and Chaney, 2009) vary their markups more in response to exchange rate shocks. As a result, these firms do more pricing to market, and their exports exhibit a lower degree of pass-through. The assumption that high-productivity firms produce high quality is supported in many studies. For a review, see Antoniadis (2015). Finally, our model can be easily adjusted to incorporate quality choice by the retailers. In their appendix, Berman et al. (2012) illustrate how this is done. That version of this model with quality choice is available from the authors upon request.

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