

# The Distributional Consequences of Large Devaluations\*

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[PRELIMINARY]

## Abstract

We study how large exchange rate devaluations impact the cost of living at different points on the income distribution. Across product categories, the poor have relatively high expenditure shares in tradeables. Within tradeable product categories, the poor consume lower-priced varieties that contain relatively less domestic value added. A devaluation raises the relative price of tradeables, and within product categories raises the relative price of cheaper varieties. Both effects imply that the devaluation hurts the low-income households more than the high-income ones. We quantify these effects following the 1994 Mexican peso devaluation and show that the distributional consequences can be large. Following the devaluation, the cost of the consumption basket of those in the bottom decile of the income distribution rose between 1.3 and 1.5 times more than the cost of the consumption basket for the top income decile. We supplement the detailed results for Mexico using cross-country evidence.

*Keywords:* exchange rates, large devaluations, distributional effects, consumption baskets

*JEL Codes:* F31, F61

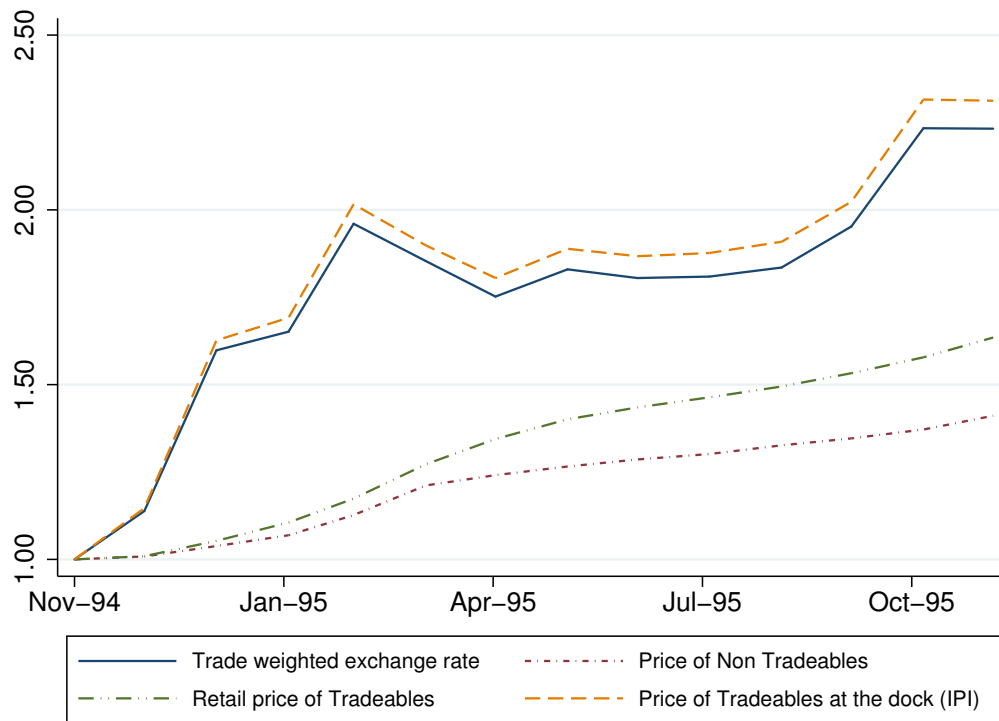
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# 1 Introduction

Large exchange rate devaluations are associated with dramatic changes in relative prices. In the aftermath of a devaluation, the price of tradeable goods “at the dock” moves one-for-one with the exchange rate, the retail price of tradeable goods increases, though less than the exchange rate, while non-tradeable goods’ prices are relatively stable.<sup>1</sup> A clear illustration of such relative price movements is presented in Figure 1, which plots the evolution of these prices following the 1994 Mexican devaluation. The retail price of tradeables is much closer to the price of non-tradeables than to prices of tradeables at the dock, consistent with the importance of local distribution costs in retail prices.<sup>2</sup>

Figure 1: Price changes during the 1994 Mexican devaluation



Notes: This figure plots the trade-weighted nominal exchange rate, the import price index, and the consumption price indices of tradeables and non-tradeables following the November 1994 peso devaluation, each rebased to November 1994.

This paper studies the distributional consequences of such relative prices movements. It is well known that households at different income levels consume very different baskets

<sup>1</sup>These patterns were first documented by [Burstein et al. \(2005\)](#) for 5 large devaluations. In summarizing the literature, [Burstein and Gopinath \(2015\)](#) extend these findings to include more devaluation episodes.

<sup>2</sup>[Burstein et al. \(2003\)](#) estimate that local distribution margins comprise about 50 percent of the retail price of tradeable goods.

of goods.<sup>3</sup> We distinguish two sources for these differences, which we label *Across* and *Within*. Across product categories, the poor spend relatively more on tradeables (such as food), while the rich spend relatively more on non-tradeables (such as personal services). Within product categories, the rich spend relatively more on higher-end goods purchased from higher-end retail outlets. To the extent that the non-tradeable component of consumer prices varies along these dimensions, rich and poor households will face different changes in the retail price of tradeable goods.<sup>4</sup> The changes in relative prices following a large devaluation will thus affect households differentially, generating a distributional as well as an aggregate impact on welfare.

We measure the magnitude of these two effects during the 1994 Mexican devaluation. For this episode, we combine two sources of detailed microdata that are key for studying these mechanisms. The first is household-level expenditures on detailed product categories from the Mexican household surveys both immediately before and after the crisis. The second is monthly data on unique product-outlet level prices that the Bank of Mexico uses to construct the consumer price index. In what follows, we refer to a unique product-outlet combination as a variety. Crucially, the product categories in the household survey can be matched to the consumption categories for which the Bank of Mexico computes consumer price indices. Indeed, these datasets are the two principal inputs underlying the official Mexican CPI. We supplement the results for Mexico using the Economist Intelligence Unit CityData on store prices in a sample of several emerging market devaluations.

We first calculate an income-specific price index that captures the *Across* effect by weighting price indices for disaggregated consumption categories with income-specific expenditure shares from the 1994 household expenditure survey. According to this index, in the 2 years following the devaluation, the consumers in the bottom decile of the Mexican income distribution experienced increases in the cost of living about 1.2 times larger than the consumers in the top income decile. The increase in the price index was 92.7% for households in the poorest decile, compared to 76% for households in the richest decile. The effect is monotonic across all income deciles.

We then compute an income-specific price index that captures the *Within* effect using the unique product-outlet level price data and household expenditure data. First, we use the household survey data to show that high income households tend to pay higher unit

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<sup>3</sup>This was documented as early as the 19th century by Engel (1857, 1895, "Engel's Law"), and confirmed repeatedly in micro data. For recent evidence using household surveys from multiple countries, see Almås (2012).

<sup>4</sup>For example, Jaimovich et al. (2014) document that higher-end retail outlets generate relatively more value added. We provide our own evidence of this effect in Section 4.2.1.

values within detailed product categories (i.e. both the rich and the poor buy bread, but the rich pay more per kilo). This evidence supports the notion that rich households purchase higher-priced varieties. Second, we use the product-outlet level price data to show that, within detailed product categories, higher-priced varieties indeed experienced significantly smaller price increases following the devaluation. Third, we compute a *Within* price index by assuming that all consumers have the same expenditure shares across product categories, but that within each category, the rich consume the more expensive varieties, and the poor the less expensive ones. In our benchmark index, the Within effect implies that inflation for the lower-income consumers was between 9 and 25 percentage points higher than for the higher-income consumers.

Finally, we compute a price index that combines these two effects and show that they are roughly additive, reinforcing each other. Putting the two together, our preferred estimate implies that the households in the bottom decile of the Mexican income distribution experienced increases in the cost of living between 1.3 and 1.5 times higher than the households in the top decile in the two years that follow the devaluation. Absent any changes in nominal income, our combined price index implies a decline in real income of 53% for poor households compared to 42% for rich households. The main finding is thus that both the Across and the Within distributional effects were large and economically significant in the 1994 Mexican devaluation.

Our analysis is expressly about the differences in consumption price levels for households of different incomes, and is silent on how nominal income itself changed for the poor and the rich. As such, our results can be interpreted as differences in compensating variation of changes in the consumption price level across the income distribution. That is, we answer the question, By how much should the nominal income of the poor have changed relative to the rich to leave both groups relatively as well off as before? Our results can be benchmarked to existing studies of how incomes changed during the Mexican devaluation. [Maloney et al. \(2004\)](#) report that median real wages fell by 30%, but that there was not much differential impact by education (which can serve as a rough proxy for income). Changes in asset values/incomes are more difficult to ascertain, but available evidence suggests that assets of the poor suffer larger losses than those of the rich. [Halac and Schmukler \(2004\)](#) document that in a sample of Latin American crises that includes Mexico in 1994, larger depositors and larger borrowers suffered less than small ones, though these results cannot be linked directly to households by income.

One potential concern with our procedure to compute the Within effect is that price differences within categories prior to the devaluation may not reflect differences in product attributes (such as the type of retail outlet), and may come simply from price dis-

persion due to staggered price adjustment. In computing our price index, we focus on a subsample of goods that had already experienced a price adjustment in the 10 months prior to the devaluation. This alleviates the concern that the cheap varieties were simply those that were “due” for an upward adjustment. In addition, we show that before the crisis, there was no differential in the growth rates of more and less expensive varieties. Finally, we show that our results are robust to using a rough classification of pre-crisis prices (such as a binary above/below the median indicator), rather than the actual price.

Most importantly, we provide an independent piece of evidence on the Within effect, based on an entirely different data source and empirical strategy. Namely, we use the Economist Intelligence Unit CityData on store prices. This database reports, at a 6-monthly frequency, the prices of about 160 goods in 140 cities all over the world, from 1990 until today. Crucially for the Within effect identification, for goods bought in stores – such as food, alcohol, toiletries, and clothing – CityData contains 3 price quotes: a super-market/chain store, mid-level/branded store, and a high-end store. We examine whether in several large devaluation episodes including Mexico in 1994, prices in higher-end outlets rose by less than in lower-end outlets.

This empirical exercise has two advantages. First, it uses no information on pre-crisis prices. The independent variable is the binary indicator for the type of store in which the good is sold, controlling for good fixed effects. Thus, it is immune to the “mean reversion” critique. Second, we can examine devaluation episodes in countries other than Mexico. Our main finding is that prices in higher-end stores rose by significantly less than prices in lower-end stores in the aftermath of the devaluations that we study. In Mexico, relative to the lower-end stores, prices in the mid-level stores rose by 7% less, and in the high-end stores by 12% less between 1994 and 1996. The pattern holds for other devaluations as well. We take the sample of devaluations from [Burstein et al. \(2005\)](#): Mexico 1994, Thailand and Korea 1997, Brazil 1998 and Argentina 2001. To this sample we add Iceland in 2007-8. The above pattern is statistically and economically significant in 5 of these 6 episodes. Only in Thailand do we not find that prices in higher-end stores rose by significantly more.

Our paper belongs to the literature on large devaluations, surveyed by [Burstein and Gopinath \(2015\)](#). This literature is focused on understanding the imperfect pass-through into consumer prices, and typically ignores the distributional effects of relative price changes. This literature has highlighted that pass-through into retail prices is imperfect because consumer prices include a large non-traded component (sometimes called “distribution margins”). We study a pattern that has until now been ignored in the exchange rate literature: the importance of the non-traded component in the total consumption bas-

ket varies systematically along the income distribution, both across and within detailed product categories. Some evidence on what we label the Across effect is provided by [Friedman and Levinsohn \(2002\)](#) and [Levinsohn et al. \(2003\)](#) for Indonesia’s 1998 depreciation, and by [Kraay \(2008\)](#) for the Egyptian 2000-05 depreciation. Our paper examines the Across effect more systematically and relates it the interaction between tradeability of products and differences in consumption baskets.

Our paper is also related to a large and growing literature in international trade that models demand non-homotheticities and examines the distributional impact of trade integration across consumers. The closest to ours are papers by [Porto \(2006\)](#) and [Faber \(2014\)](#). [Porto \(2006\)](#) uses household consumer expenditure data in Argentina following Mercosur to trace the distributional impact of this regional trade agreement on different consumers. The analysis incorporates the Across effect but not the Within effect. [Faber \(2014\)](#) shows that following NAFTA, intermediate inputs used in production of higher-quality varieties became cheaper in Mexico, and richer consumers benefited more – a type of Within effect that is differential across product categories according to their intensity of imported input use. Relative to these papers, that focus on long-run changes, we examine the relatively short-run effects following large devaluations. We also, for the first time to our knowledge, combine the analysis of Across and Within effects.

The rest of this paper is organized as follows. Section 2 illustrates the distributional effects of relative price changes when consumption baskets differ across consumers. Section 3 describes the data, and Section 4 the main results. Section 5 presents additional evidence on the Within effect, and Section 6 concludes.

## 2 Conceptual framework

We focus on a setting in which the indirect utility of a household  $h$  is proportional to real income:

$$V^h \propto \frac{W^h}{P^h},$$

where  $W^h$  is nominal income and  $P^h$  is the household-specific ideal price index. A proportional welfare change due to a shock – for instance, a large exchange rate devaluation – is then equal to

$$\widehat{V}^h = \widehat{W}^h - \widehat{P}^h. \tag{1}$$

The change in the price index can be approximated by

$$\widehat{P}^h \approx \sum_{g \in G} \omega_g^h \widehat{P}_g,$$

where  $g$  indexes goods,  $\omega_g^h$  are household-specific expenditure shares, and  $\widehat{P}_g$  are good-specific price changes. To relate the distributional effects of a change in prices across households, it helps to write (1) as:

$$\widehat{V}^h = \underbrace{\widehat{W}^h - \sum_{g \in G} \omega_g^A \widehat{P}_g}_{\text{homothetic-utility } \widehat{V}} - \underbrace{\sum_{g \in G} \widehat{P}_g (\omega_g^h - \omega_g^A)}_{\text{Cov}(\widehat{P}_g, \omega_g^h - \omega_g^A)}, \quad (2)$$

where  $\omega_g^A$  is the economy-wide share of spending on good  $g$ . The first term of this expression is change in welfare that would obtain if utility were homothetic and every  $h$  had the same consumption basket. The second term is the distributional impact across households. The term is reminiscent of a (negative) covariance between price changes and household-level relative spending shares. If the pattern of price changes across  $g$  is positively correlated with  $h$ 's relative spending shares, then  $h$  suffers more from this vector of price changes than the average household, because prices go up on average more in goods that the household consumes more of.

Consider an example in which there are two households, rich and poor,  $h = r, p$ , and two goods, tradeables and non-tradeables:  $g = T, NT$ . Suppose further that the poor have higher expenditure shares in tradeables:  $\omega_T^p > \omega_T^A > \omega_T^r$ . If an exchange rate depreciation leads to a higher increase in the price of tradeables than in the price of non-tradeables –  $\widehat{P}_T > \widehat{P}_{NT}$  – then the last term in (2) will be negative for the poor and positive for the rich. This is the simplest version of what in the empirical analysis below we refer to as the Across effect.

Suppose instead that instead of tradeables and non-tradeables, the two goods were an expensive variety and a cheap variety:  $g = E, C$ , and the poor consumed a higher share of the cheap variety than the rich,  $\omega_C^p > \omega_C^A > \omega_C^r$ . If the price of the cheap variety increased by more after a devaluation,  $\widehat{P}_C > \widehat{P}_E$ , we once again have an anti-poor distributional effect.

The discussion above underscores the point that there is no fundamental difference in how the Across and Within effects work. Both are driven by the covariance of price changes and relative spending shares across the income distribution. Because they rely on different measurement strategies, it is still convenient to separate them in the empirical

analysis. Note also that the expression (1) has a natural compensating variation interpretation: in response to a given vector of price changes  $\widehat{P}_g$ , a compensating variation for household  $h$  is a change in income  $\widehat{W}^h$  that leaves welfare unchanged ( $\widehat{V}^h = 0$ ). Thus, while we state the empirical results in terms of changes in household-level costs of living indices  $\widehat{P}^h$ , they can equivalently be stated in terms of the heterogeneity in the compensating variation across households.

**The role of non-tradeables:** We now show the channels through which changes in the relative price of non tradeables can have differential effects across households with different income. Assume that there is full pass-through from exchange rates into tradeable prices at the dock, and that the price of nontradeable goods is fixed (see [Burstein et al. 2005](#) and Figure 1). In this case, the change in (domestic currency) prices is given by  $\frac{d\widehat{P}_g^{NT}}{dE} = 0$  for each non-tradeable good, and by  $\frac{d\widehat{P}_g^T}{dE} = 1 - \eta_g$  for tradeable good  $g$ , where  $\eta_g$  denotes the non-tradeable component (distribution services) in the retail price of  $g$ , and  $E$  is the nominal exchange rate denominated in units of domestic currency per dollar. We can write the change in the price index for household  $h$  following a devaluation as:

$$\begin{aligned}\widehat{P}^h &= \sum_{g \in G} \omega_g^h \widehat{P}_g = \\ &= \left(1 - \omega_{NT}^h\right) \eta + \sum_{g \in G_T} \omega_g^h (\eta_g - \eta)\end{aligned}\quad (3)$$

Here,  $\omega_{NT}^h \equiv \sum_{g \in G_{NT}} \omega_g^h$  denotes the share of non tradeable goods consumed by household  $h$ , and  $\eta \equiv \frac{1}{N_g} \sum_{g \in G_T} \omega_g^h \eta_g$  is the average share of average share of the tradeable component in the retail price of non-tradeable goods in the economy. Equation (3) shows that the differences in change of the price index for across households are driven by: i) differences in the share of non-tradeable goods  $\omega_{NT}^h$  consumed across households, and ii) differences in the covariance between expenditure shares and the share of distribution services in tradeable product categories.

## 2.1 Within and Across effects: definitions and measurement

This section defines the Across, Within, and Combined price indices. Let there be  $G$  goods categories indexed by  $g$ , and let each  $g$  contain varieties indexed by  $v_g$ . Households will have different expenditure shares both across goods categories  $g$ , and across varieties  $v_g$  within each  $g$ . The change in the household-specific price index is given by (time



subscripts omitted):

$$\widehat{P}^h \equiv \sum_{g \in G} \omega_g^h \widehat{P}_g^h, \quad (4)$$

where as above  $\omega_g^h \equiv \frac{P_g^h q_g^h}{\sum_g P_g^h q_g^h}$  is the share of household  $h$ 's expenditures that go towards good category  $g$ . However, now the change in the price sub-index of good  $g$  varies across households because they consume different varieties:

$$\widehat{P}_g^h \equiv \sum_{v_g} s_{v_g}^h \widehat{P}_{v_g}, \quad (5)$$

where  $s_{v_g}^h$  is household  $h$ 's share of expenditures in variety  $v$  within the good category  $g$ , and  $\widehat{P}_{v_g}$  is the (non-household-specific) change in the price of variety  $v$  of good  $g$ .  $\widehat{P}_g^h$  can vary across households if households of different incomes consume different goods within each good category  $g$ . This would happen, for instance, if the richer households consume systematically higher-priced varieties within each  $g$ .

The change in the aggregate price index is defined by by:

$$\widehat{P}^A \equiv \sum_{g \in G} \omega_g^A \widehat{P}_g^A, \quad (6)$$

where  $\omega_g^A \equiv \frac{\sum_h P_g^h q_g^h}{\sum_h \sum_g P_g^h q_g^h}$  is the economy-wide expenditure share on good  $g$ , and  $\widehat{P}_g^A \equiv \frac{1}{V_g} \sum_{v_g} \widehat{P}_{v_g}$  is the aggregate price index for good  $g$ , that has  $V_g$  varieties.  $\widehat{P}^A$  is the change in the CPI as it would be constructed by national statistical agencies.

We define the *Across* change in the price index for household  $h$  as:

$$\widehat{P}_{Across}^h \equiv \sum_{g \in G} \omega_g^h \widehat{P}_g^A, \quad (7)$$

and the *Within* change in the price index for household  $h$  as:

$$\widehat{P}_{Within}^h \equiv \sum_{g \in G} \omega_g^A \widehat{P}_g^h. \quad (8)$$

In words,  $\widehat{P}_{Across}^h$  is the change in the cost of living for a hypothetical household that has  $h$ 's expenditure shares across  $g$ , and faces the unweighted average price change across all varieties within each  $g$ . By contrast,  $\widehat{P}_{Within}^h$  is the change in the cost of living for a hypothetical household that has aggregate consumption shares across goods  $g$ , but consumes

household  $h$ 's varieties within each good  $g$ .

Using these expressions, we can write the difference in the change of the price indices of two households  $h$  and  $h'$  at different points in the income distribution (where  $\Delta$  denotes a cross-sectional rather than a time difference) as:

$$\begin{aligned}\widehat{P}^h &\equiv \sum_{g \in G} \omega_g^h \widehat{P}_g^h = \underbrace{\sum_{g \in G} \omega_g^h \widehat{P}_g^A}_{\widehat{P}_{Across}^h} + \sum_{g \in G} \omega_g^h (\widehat{P}_g^h - \widehat{P}_g^A) \\ &= \underbrace{\sum_{g \in G} \omega_g^h \widehat{P}_g^A}_{\widehat{P}_{Across}^h} + \underbrace{\sum_{g \in G} \omega_g^A \widehat{P}_g^h}_{\widehat{P}_{Within}^h} + \sum_{g \in G} (\omega_g^h - \omega_g^A) (\widehat{P}_g^h - \widehat{P}_g^A) - \underbrace{\sum_{g \in G} \omega_g^A \widehat{P}_g^A}_{\widehat{P}^A}.\end{aligned}$$

The difference across households is then given by:

$$\begin{aligned}\Delta \widehat{P} &= \Delta \widehat{P}_{Across} + \Delta \widehat{P}_{Within} \\ &+ \Delta \left[ \sum_{g \in G} (\omega_g^h - \omega_g^A) (\widehat{P}_g^h - \widehat{P}_g^A) \right].\end{aligned}$$

The difference in  $\widehat{P}^h$  is not simply a sum of the differences in the Across and Within indices. The third term is a ‘‘covariance’’ across goods between how different price changes are for  $h$  relative to the average and how different  $h$ 's expenditure share relative to the average. It is not formally a covariance because  $\widehat{P}_g^A$  is not the mean across goods, but rather the mean across varieties within  $g$ , and  $\omega_g^A$  is not the mean across goods but an expenditure-weighted average across households. The ‘‘covariance’’ will be positive when  $h$  experiences large deviations from the mean in its household-specific price in its relatively large expenditure categories. In Section 4 we calculate  $\Delta \widehat{P}$ ,  $\Delta \widehat{P}_{Across}$  and  $\Delta \widehat{P}_{Within}$  following the 1994 Mexican devaluation and show that the covariance term is quantitatively small.

### 3 Data

We employ two complementary pieces of data and econometric analyses. The first uses variety-level monthly consumer prices and household-level consumer expenditure surveys for Mexico before and after the 1994 Tequila crisis depreciation episode. Using these

data, we perform the complete analysis: document systematic patterns in the data that drive the results, compute the household-specific price indices and their components as above, and show that the changes in household-specific costs of living following the depreciation vary systematically with income.

The second piece of evidence, concerning only the Within effect, is based on the Economist Intelligence Unit CityData database, that contains price quotes for over 160 goods from 140 cities worldwide.

### 3.1 Mexican data on consumer prices

The Mexican micro data on consumer prices is collected by the Banco de Mexico with the purpose of computing the Consumer Price Index. Since January 1994, the prices that underlie the construction of the CPI are published in the *Diario Oficial de la Federacion* (DOF), the official bulletin of the Mexican government published monthly. Each price quote in the DOF corresponds to a 'specific' product, which is a unique product-city-outlet combination that can be traced through time. An exact product description -i.e. Kellogg's, Corn Flakes, 500gr box- for each specific product was published in the April 1995 DOF. Unfortunately, outlet identifiers are not available in the data for this time period. The specific products are grouped into 313 'generic' categories -i.e. Cereal in Flakes-, representing the goods and services consumed in Mexico. For most generic product categories, the price quotes for the specific goods are expressed in common units -for example, the prices of specific products within the category Cereal in Flakes are quoted per Kilo of Cereal-. These micro price data from the DOF have been used previously by [Ahlin and Shintani \(2007\)](#) and [Gagnon \(2009\)](#).

We focus on a sample of 26,426 specific products grouped into 284 generic categories that can be observed continuously from January 1994 to December 1996.<sup>5</sup> For each specific product, we observe its monthly price, its generic category, the city in which it is sold and the units in which prices are quoted. The DOF also publishes the specific products that are added because of modifications in the product, new products, or changes in the outlets or products that are being sampled by the price inspectors. We focus on the specific products that can be observed continuously through our sample.

Finally, in addition to the micro price data, we also obtain the price indices computed by the Bank of Mexico for each generic category, as well as consumption price indices for more aggregated categories. We also obtain the weight that each generic category is assigned in the aggregate CPI from the household surveys (see below).

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<sup>5</sup>There was a revision in April 1995, in which some of the generic categories were changed.

## 3.2 Mexican household surveys

We use the Mexican household surveys, Encuesta Nacional de Ingresos y Gastos de Hogares, (ENIGH) for 1994 and 1996 to obtain consumption expenditures across consumption categories by household. The key variables that we use from this dataset are the household's city, household's income, households' total expenditures in 547 detailed product categories. Crucially, the product categories in the ENIGH can be mapped in the 313 generic good categories that are used to calculate the CPI – in fact, the weights used to compute the CPI are derived from the ENIGH. In addition, for some product categories the ENIGH reports the total quantity of the good consumed by each household. We combine the total quantities with the expenditure data to compute the unit value paid by each household in each product category.

## 3.3 Cross-country micro data

Cross-country data come from the CityData base compiled by the Economist Intelligence Unit (EIU). The purpose of this database is to compute differences in the cost of living across the world's major cities. The database contains price quotes on 160 goods in 140 cities, and covers the period 1990–present in the best of cases. The price quotes are collected semi-annually in March-April and September-October. Most countries are represented by only one city, namely the largest (usually also the capital). In our sample of devaluations, only Brazil has two cities: Sao Paulo and Rio de Janeiro. Because the database's intended clients are multinationals considering sending headquarter-based workers to live in those locations, the implicit consumption baskets are skewed towards wealthy expatriate families (there price quotes for many categories of private international schools, for example), but include a wide variety of basic foodstuffs and clothing.

Importantly, most goods covered by CityData have 3 price quotes from different types of stores. For foodstuffs and similar items, the lowest category is labeled "supermarket," the middle category "mid-priced store," and the top category "high-priced store." For clothing, the lowest category is referred to as "chain store," and the middle category "mid-priced/branded store." Some items, such as cars, do not differentiate between outlets explicitly, and instead report two prices, a high and a low one. We do not use these prices in the mainline analysis but the results are robust to including them. Thus, we can establish whether prices of varieties of goods sold in higher-priced stores changed by less than varieties of the same good sold in lower-priced stores.

## 4 Price changes during the 1994 Mexican devaluation

This section quantifies the distributional consequences of the 1994 Mexican devaluation that arise from changes in the relative prices of the consumption baskets purchased by different households across the income distribution. Following the discussion in Section 2.1, we proceed in three steps. First we compute the differences in household-specific price indices that arise from differences in expenditure shares across product categories – the Across effect. Second, we compute the differences price indices arising from differences in expenditure shares within product categories – the Within effect. Third, we let these two mechanisms interact, and compute the Combined effect. We conclude this section by recalculating price indices using a variety of alternative assumptions to show the robustness of the results.

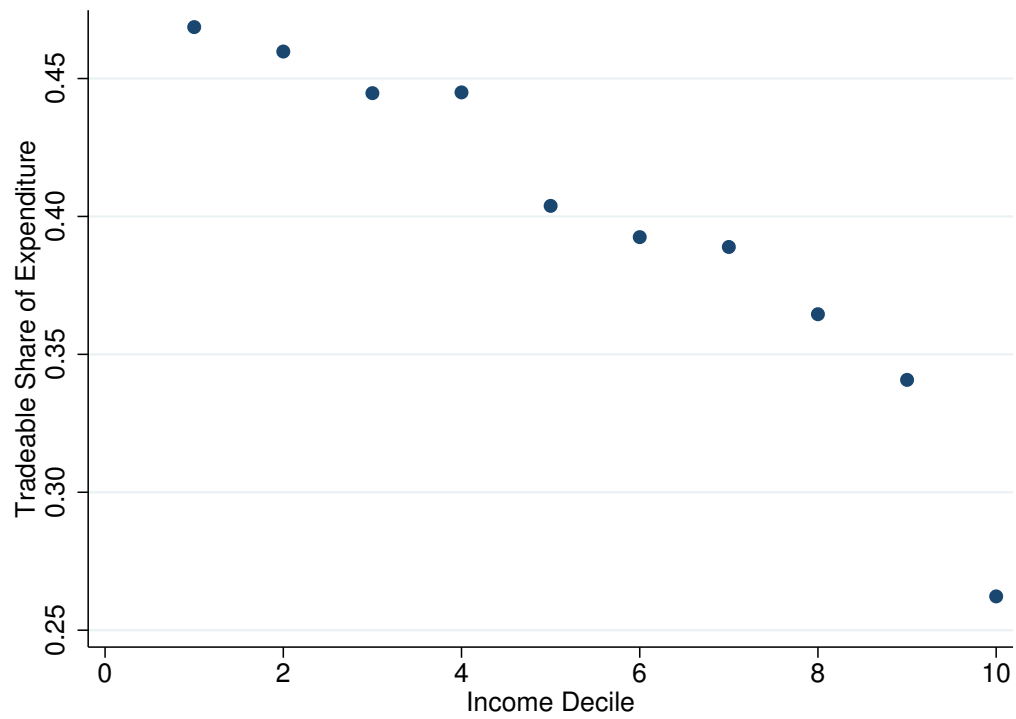
### 4.1 The Across effect

#### 4.1.1 Expenditure differences across product categories

We start by documenting how expenditures in tradeables vs. non-tradeable goods change across the income distribution. We compute the expenditure shares in non-tradeable goods  $\omega_{NT}^h$  from the 1994 household expenditure survey. In particular, we sort households into income deciles and compute the expenditure shares of each decile in tradeable and non-tradeable goods. The resulting expenditure shares are depicted in Figure 2. Expenditure shares on tradeable goods decrease monotonically as we move up the income distribution. This fact has bearing on the distributional effects of an exchange rate devaluation because tradeable prices are likely to rise by more in a devaluation than non-tradeable prices (even though, as shown in Figure 1, pass-through into retail prices is far from complete).

More generally, the nontradeable component of the retail price of the goods normally classified as “tradeables” may vary dramatically across tradeable goods categories. For example, Campa and Goldberg (2010) document substantial variation in distribution margins of tradeable goods. The following section computes price indices that allow for expenditure shares to vary at the household level across detailed product categories.

Figure 2: Tradeable share of expenditure by income decile



Note: This figure plots the expenditure share of tradeables by income decile in the 1994 ENIGH household survey.

### 4.1.2 The Across price index

We calculate the Across price index in equation (7), reproduced here to facilitate the exposition:

$$\hat{P}_{Across}^h \equiv \sum_{g \in G} \omega_g^h \hat{P}_g^A.$$

We obtain the price indices  $P_g^A$  for the aggregate product categories from the Bank of Mexico. We define the product categories  $G$  for two alternative levels of disaggregation for which the Bank of Mexico computes consumer price indices: at the 1-digit (8 good categories), and at 6 digits (37 categories). Appendix Table XXX reports the product categories for different levels of disaggregation. We compute the expenditure shares  $\omega_g^h$  for the product categories from the 1994 household expenditure survey. In particular, we sort households into income deciles and compute the expenditure shares of each decile in each of the  $G$  product categories. We normalize the price indices to equal 100 in October 1994, the month before the devaluation.

Tables 1a and 1b report the resulting price indices for different deciles of the income distribution when the product categories are defined at the 1 and 6 digit levels of disaggregation. Changes in the across price indices  $\hat{P}_{Across}^h$  differ dramatically across the income distribution. Table 1a shows that when the across price index is computed at the 1-digit level of disaggregation, the price index increased by 88.3 percent for the households in poorest decile, compared to only 79 percent for households in the top decile. The relation between the change in the indices and household income decile is monotonic, households of lower income experienced higher inflation in the two years following the devaluation.

This difference in the price indices is even more dramatic when  $\hat{P}_{Across}^h$  is computed at the 6-digit level of disaggregation. Table 1b reports that the change in the 6-digit across price index was 92.7 percent for households in the bottom decile, relative to 76 percent for households in the top decile. Two years after the devaluation, inflation for the bottom decile was 1.22 times higher than inflation for the top decile due to the fact expenditure shares of rich and the poor households differ across product categories.

We next compute the across price indices at the household level. Figure 3 plots a quadratic fit of  $\hat{P}_{Across}^h$  for October 1996 computed at a 6-digit level of disaggregation, computed for households of different income levels. The figure confirms that the relation shown in Tables 1a and 1b between inflation and income is monotonic, while also showing that the price difference between the richest and poorest household exceeds 20

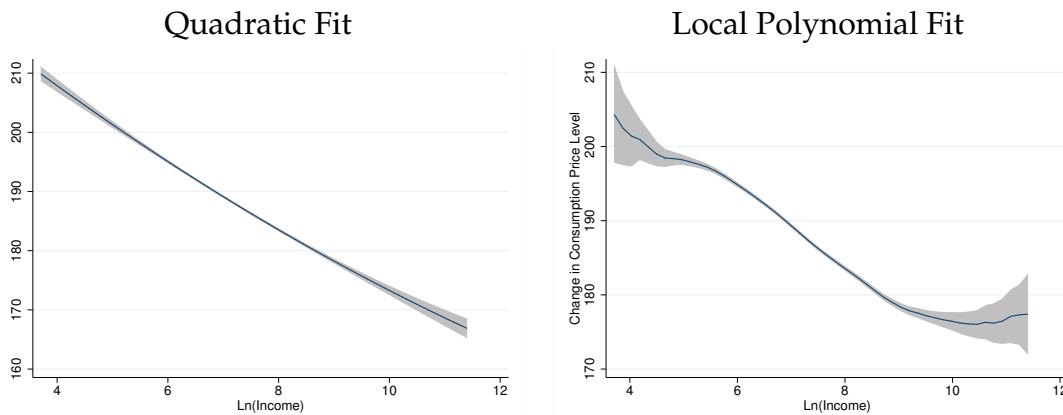
Table 1: The Across price index by income decile, 1994 weights

(a) 1-Digit											
	Income Decile										Aggregate
	1	2	3	4	5	6	7	8	9	10	
Oct. 94	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
April 95	1.24	1.24	1.24	1.24	1.24	1.24	1.24	1.24	1.24	1.23	1.24
Oct. 95	1.45	1.45	1.44	1.44	1.44	1.43	1.43	1.43	1.42	1.41	1.43
April 96	1.72	1.71	1.70	1.70	1.69	1.69	1.68	1.67	1.66	1.63	1.67
Oct. 96	1.88	1.87	1.87	1.86	1.85	1.85	1.84	1.83	1.82	1.79	1.83
(b) 6-Digit											
	Income Decile										Aggregate
	1	2	3	4	5	6	7	8	9	10	
Oct. 94	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
April 95	1.25	1.25	1.24	1.24	1.24	1.24	1.23	1.23	1.23	1.21	1.23
Oct. 95	1.48	1.47	1.46	1.46	1.45	1.44	1.44	1.43	1.42	1.40	1.43
April 96	1.76	1.74	1.73	1.72	1.70	1.69	1.69	1.67	1.65	1.61	1.67
Oct. 96	1.93	1.91	1.89	1.88	1.86	1.85	1.84	1.83	1.81	1.76	1.83

Note: These tables report the Across price indices defined in equation (7) for different income deciles. Table 1a computes the price index using 8 1-Digit product categories for  $G$ , while Table 1b computes the price index using 37 6-Digit product categories for  $G$ . The expenditure weights come from the 1994 household survey.



Figure 3: The Across price index by household income



Note: This figure reports the quadratic and local polynomial fits of the household-specific price level changes against log income, together with 95% confidence intervals. The household-specific price indices are calculated based on the 37 6-digit consumption categories and 1994 expenditure weights. Income is taken from the 1994 household survey.

percentage points.

One well-known limitation of Laspeyres price indices is that they overstate how price changes affect welfare because they are subject to the substitution bias.<sup>6</sup> In particular, differences in the change of the price indices for rich and poor households may not necessarily translate into differences in welfare if poor households are better able to substitute consumption in response to price changes. With this in mind, we recalculate the across price indices using expenditure weights from the 1996 household survey. By using end-of-period weights, the price index is likely to understate the true welfare effects of the price changes. The true welfare change lies between the change predicted by the Laspeyres (1994 weights) price index and the Paasche (1996 weights) price index.

The resulting price indices using 1996 weights are reported in Tables 2a and 2b. The tables show that the magnitude of the observed inflation differences between income deciles is similar to what we obtain under the 1994 weights: inflation for the poorest decile is 27 percentage points higher than inflation for the richest decile. We conclude that the ability to substitute towards cheaper products does not substantially mitigate the disparity in the welfare losses between rich and poor households arising from differences in expenditure shares across product categories.

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<sup>6</sup>See Hausman (2003).

Table 2: The Across price index by income decile, 1996 weights

(a) 1-Digit											
	Income Decile										Aggregate
	1	2	3	4	5	6	7	8	9	10	
Oct. 94	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
April 95	1.24	1.24	1.24	1.24	1.24	1.24	1.24	1.24	1.24	1.24	1.24
Oct. 95	1.46	1.45	1.45	1.45	1.45	1.44	1.44	1.44	1.43	1.42	1.44
April 96	1.73	1.72	1.72	1.71	1.71	1.70	1.69	1.68	1.67	1.65	1.69
Oct. 96	1.90	1.89	1.88	1.88	1.87	1.86	1.86	1.84	1.83	1.81	1.85

(b) 6-Digit											
	Income Decile										Aggregate
	1	2	3	4	5	6	7	8	9	10	
Oct. 94	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
April 95	1.26	1.25	1.25	1.25	1.25	1.25	1.24	1.24	1.24	1.23	1.24
Oct. 95	1.50	1.49	1.48	1.47	1.46	1.46	1.45	1.44	1.43	1.42	1.45
April 96	1.79	1.77	1.76	1.74	1.73	1.72	1.71	1.69	1.67	1.63	1.70
Oct. 96	1.96	1.93	1.92	1.90	1.89	1.88	1.87	1.85	1.83	1.79	1.86

Note: These tables report the Across price indices defined in equation (7) for different income deciles. Table 2a computes the price index using 8 1-Digit product categories for  $G$ , while Table 2b computes the price index using 37 6-Digit product categories for  $G$ . The expenditure weights come from the 1996 household survey.

## 4.2 The Within effect

### 4.2.1 Expenditure differences within product categories

This section uses data from the 1994 household expenditure survey to document that within narrow product categories, richest households tend to purchase more expensive goods. For this purpose, we define the unit values paid by household  $h$  in category  $g$  as:

$$u_g^h \equiv \frac{\sum_{v_g \in g} P_{v_g} q_{v_g}^h}{\sum_{v_g \in g} q_{v_g}^h} = \sum_{v \in g} \omega_{v_g}^{q,h} P_{v_g}.$$

Households that purchase higher quantity shares  $\omega_{v_g}^{q,h} \equiv \frac{q_{v_g}^h}{\sum_{v_g \in g} q_{v_g}^h}$  of more expensive goods will pay higher higher unit values  $u_g^h$  within product categories  $g$ .

We use the 1994 household expenditure survey to study how  $u_g^h$  changes across households of different incomes. The 1994 household expenditure survey contains unit value data for 439 detailed product categories. The product categories in the household survey are more disaggregated than the 313 'generic' product categories for which the Bank of Mexico computes the CPI.<sup>7</sup> We use the unit value data and the income data from the 1994 household survey to estimate the following relationship:

$$\ln(u_g^h) = \beta_1 \ln(Inc^h) + \delta_g + \epsilon_g^h, \quad (9)$$

where  $\ln(Inc^h)$  is the log of household income, and  $\delta_g$  denotes good-level fixed effects. The coefficient of interest  $\beta_1$  is the elasticity of the unit value paid with respect to household income. In an alternative specification, we sort households into income deciles and estimate:

$$\ln u_g^h = \sum_{j=1}^{10} \alpha_j \mathbb{I}_{[h \in Dec. j]} + \delta_g + \epsilon_g^h. \quad (10)$$

where  $\mathbb{I}_{[h \in Dec. j]}$  is the indicator function for whether  $h$  is in income decile  $j = 1, \dots, 10$ .

Table 3 reports the results of estimating equations (9) and (10) using two alternative samples: (i) the entire sample of products for which we observe unit values in the expenditure survey (columns 1 and 2) and (ii) good categories that correspond to food products (columns 3 and 4). The table shows a strong positive correlation between unit values paid and household income: richer households pay higher unit values for products within narrow product categories. The first column reports an estimated coefficient of  $\hat{\beta}_1 = 0.211$

<sup>7</sup>It is possible to aggregate the categories in the survey into the CPI categories. See Section 3.1.

Table 3: Unit values by income

	(1)	(2)	(3)	(4)
	All product categories		Food categories	
$\log(Inc^h)$	0.211***		0.0712***	
	-0.00168		-0.00144	
Decile 2		0.0654***		0.0267***
		-0.00474		-0.00406
Decile 3		0.117***		0.0473***
		-0.00474		-0.00411
Decile 4		0.152***		0.0619***
		-0.00492		-0.00429
Decile 5		0.180***		0.0593***
		-0.00493		-0.00429
Decile 6		0.237***		0.0810***
		-0.00508		-0.00446
Decile 7		0.282***		0.0898***
		-0.00524		-0.0046
Decile 8		0.350***		0.118***
		-0.00541		-0.00473
Decile 9		0.434***		0.134***
		-0.00573		-0.00488
Decile 10		0.666***		0.216***
		-0.00679		-0.00571
Number of categories	439	439	210	210
Observations	290,989	287,588	196,157	192,756
$R^2$	0.832	0.834	0.797	0.803

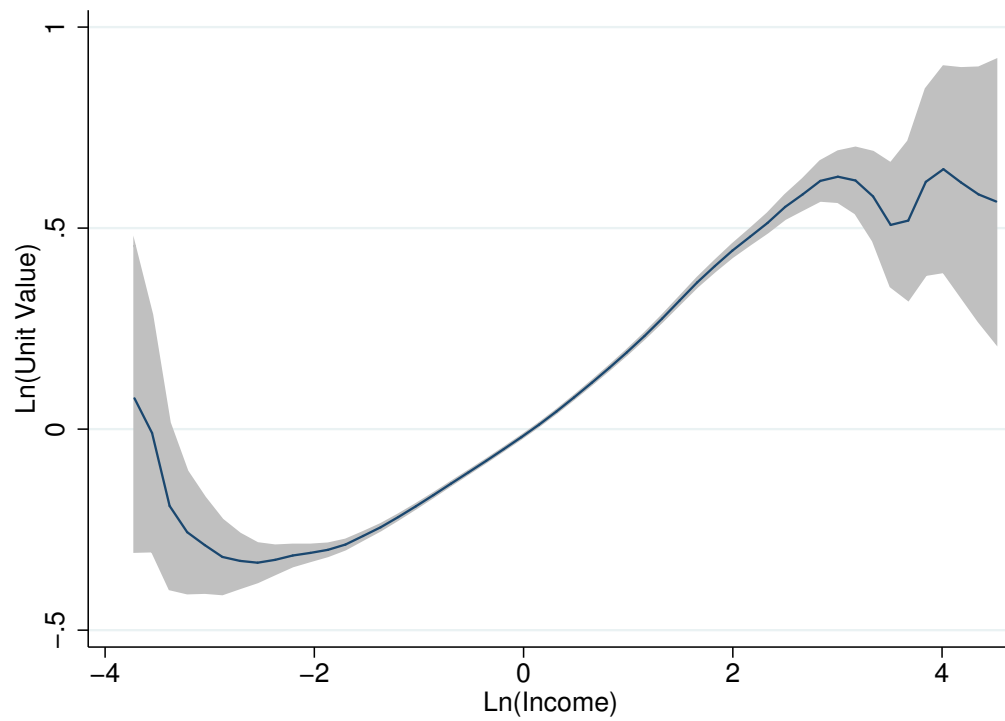
Notes: Robust standard errors in parentheses. \*\*\*: significant at 1%; \*\*: significant at 5%; \*: significant at 10%. All specifications include product fixed effects. This table reports the results of estimating equations (9) (columns 1 and 3) and (10) (columns 2 and 4).

that is highly significant. The second column shows that unit values increase monotonically with household income, as the decile dummies get progressively higher as income increases, with the biggest jump in the last decile. Households at the richest decile pay unit values that are 0.66 log points higher than the unit values the paid by poorer households. This finding is robust to limiting the sample to the food product categories.

Figure 4 plots the log deviations from average unit values paid by households of different incomes. The log-difference in unit values between households in the top and bottom deciles is about 0.7 log points.

Finally, we use the EIU CityData to show that higher prices paid by higher-income households reflect at least partly a greater share of domestic value added. Most product

Figure 4: Unit values by household income



Notes: This figure reports the local polynomial fit of log deviations from mean log unit values within each product against log household income, together with 95% confidence intervals.

categorizations are not detailed enough that we can establish convincingly that a higher posted price is a reflection of higher local value added rather than differences in physical product attributes. Even for a product category item as simple as “butter,” a higher price could reflect the fact that it is made from higher quality milk using better preparation methods. However, for a small subset of categories in CityData, we can be confident that the underlying physical product is the same. When this is the case, we can be sure that higher prices reflect greater domestic distribution margins rather than physical product attributes. There are 5 such products: “Coca Cola (1 l),” “Vermouth, Martini & Rossi (1 l),” “Liqueur, Cointreau (700 ml),” “Cigarettes, Marlboro (pack of 20),” and “Kodak colour film (36 exposures).” To this list we add 3 additional products that are identified precisely enough that we can be somewhat confident the item is more or less identical: “Scotch whisky, six years old (700 ml),” “Gin, Gilbey’s or equivalent (700 ml),” and “Cognac, French VSOP (700 ml).”

Table 4 presents the average log differences in prices of these products across in the medium- and high-end stores relative to the supermarket outlet (the low category). Namely, we report the coefficients from a regression of log prices on product fixed effects and dummies for medium- and high-end stores (with the low-end store the omitted category). We focus on Mexico City in 1994, but the results are quite similar if we take other years and/or other countries. The top row reports the results for the 8 products listed above that are exactly the same physical items. For these items, the medium-level store has on average a 13.5% higher price, and the high-level store a 23% higher price.

The difference in prices across stores for identical products is indeed lower than for the rest of the sample. The second row of Table 4 reports the results for the prices of tradeable categories (primarily food and clothing) for which it cannot be established that the same good is being sold. The sample includes about 100 categories. Some examples are “Butter, 500 g,” “Cornflakes (375 g),” “Soap (100 g),” or “Men’s business shirt, white.” For these items, the difference across stores is about twice as large, 23.7% for the medium-level store and 48.9% for the high-level store.<sup>8</sup>

We can use these results for a back of the envelope calculation of the differences in domestic value added across stores. Berger et al. (2012) find that the average distribution wedge is  $(P_{v_g}^{Retail} - P_{v_g}^{dock}) / P_{v_g}^{Retail} = 0.6$ , where  $P_{v_g}^{dock}$  is the price of  $v_g$  “at the dock,” i.e. before any domestic value was added. Assuming that 0.6 is the unweighted average across the 3 retail prices in different stores, the estimates in Table 4 imply that the distribution margin is 0.55 in the low-end store and 0.64 in the high-end store. Expressed in

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<sup>8</sup>Price differences are smaller for Food (18% and 41% respectively), and larger for Clothing (45% and 78%).

Table 4: Price differences for identical items across stores

	Log-difference in price		N. prices	N. categories
	Medium to Low	High to Low		
Exact same good	0.135***	0.230***	23	8
Not exact same good	0.237***	0.489***	309	105

Notes: \*\*\* significant at the 1% level. This table reports the differences in prices of goods sold in medium-level stores compared to the lowest level store, and in high-level stores compared to low level. The row “Exact same good” compares prices of identical items. There are 8 such items. The row “Not exact same good” compares the prices of goods for which it cannot be established that the physical item sold in different stores is the same item. The prices are for Mexico City in 1994.

multiples of the price at the dock, the low-end store price is 2.25 times the dock price, and the high-end store price is 2.75 times the dock price.

This is likely a lower-bound estimate of the difference in the share of domestic value added between the items bought by the rich and the poor. First, these 8 items are ones in which retail expertise plays little or no role, compared to other items such as cars or clothing. For items in which quality differentiation does exist, retail value added is likely more important. Second, this set of items is dominated by alcohol and tobacco, whose prices include more taxes and are in some cases regulated. This will further compress the (proportional) price differences between retail outlets.

We conclude that, within narrowly defined product categories, richer households tend to purchase more expensive goods. Higher prices paid by higher-income households reflect at least partly a greater share of domestic value added. We explore the implications of this strong positive relation between consumption shares in high-price varieties and household income when we compute the within price index in the next section.

#### 4.2.2 The Within price index

The Within price index is given by equation (8), reproduced here for convenience:

$$\hat{P}_{Within}^h \equiv \sum_{g \in G} \omega_g^A \hat{P}_g^h.$$

We weight the generic product categories  $g$  with the aggregate expenditure weights,  $\omega_g^A$ , that are used for computing the aggregate consumer price index, and allow for differences in the price indices that households face for each generic category:  $\hat{P}_g^h \equiv \sum_{v_g \in g} s_{v_g}^h \hat{P}_{v_g}^h$ . Differences in the price indices  $\hat{P}_g^h$  stem from differences in the expenditure shares  $s_{v_g}^h$  across the different varieties  $v_g$  within each product category  $g$ . While we can observe the price change  $\hat{P}_{v_g}^h$  of every specific variety sampled in the Diario, the expenditure shares

of each different household  $s_{v_g}^h$  are not observable.

We link expenditure shares  $s_{v_g}^h$  to household income following the evidence from Section (4.2.1) that richer households tend to purchase more of the most expensive goods within each product category, and assume that rich households consume high-priced varieties while poor households consume low-priced varieties. We classify varieties as high- or low-priced using three alternative criteria.

First, we split varieties according to whether their average price between January 1994 and October 1994 – the 10 months prior to the devaluation for which we have data – was above or below the average price of the median good in the generic category. Second, we split the January 1994–October 1994 average prices into quartiles in each generic category, and focus on products that are in the highest vs. the lowest quartiles. Third, we focus on the maximum vs. the minimum average prices in each generic category. Focusing on the 10-month average (January 1994–October 1994) as the base period in which we classify products into high or low price, as opposed to the price in one particular month, has the advantage that temporary sales are less likely to be identified as low prices. In Section 4.4, we show that using January 1994 as our base period does not significantly affect our results.

One potential concern with this procedure is that high and low pre-devaluation prices may not reflect differences in product attributes (such as the type of retail outlet), but may come simply from price dispersion due to staggered price adjustment. If some prices are low at the beginning of the sample because they have not been adjusted in a long time, a large increase in these prices may simply reflect that the price is finally being adjusted. To avoid this concern, we limit our analysis to specific products for which we see a price change between January 1994, our base month, and October 1994, the month prior to the devaluation. For this sample of products, we can be sure that changes in prices that occur after October 1994 are not due to the firms resetting old prices.

Finally, the Within price index from equation (8) can only be computed for those goods categories in which identical goods can be observed continuously through time. Unfortunately, this does not encompass all product categories, since some categories were discontinued in the April 1995 revision of the consumer price index. As a consequence, only 284 of the 313 generic categories can be traced before March 1995. The continuing categories account for 82 percent of the expenditures. In addition, there are some generic categories, focusing on apparel, for which the specific product quotes are based on ‘samples’ of products, as opposed to unique individual products. After excluding these product categories, the remaining categories for which identical products that can be observed continuously through time account for 64 of total consumption expenditures. To compute a price index



that reflects the importance of the Within effect for the entire economy we need to take a stand on how the relative price of cheap vs. expensive goods changed for the missing categories.

With this in mind, we compute the within price index under two limiting assumptions. First, we take a conservative approach and assume that the relative price of cheap versus expensive goods remained constant for the missing generic categories. In this case, the Within price index is given by:

$$\widehat{P}_{Within}^h = \sum_{g \in G_M} \omega_g^A \widehat{P}_g^h + \sum_{g \in G_U} \omega_g^A \widehat{P}_g^A, \quad (11)$$

where  $G_M$  is the set of categories for which identical goods that are measured continuously through time,  $G_U$  is the sets of categories for which identical goods that cannot be measured continuously through time, and  $\widehat{P}_g^A$  is an aggregate price index for the goods in category  $g$ . Alternatively, we make the opposite assumption and assume that the change in the price of cheap and expensive goods for the missing categories was equal to the (weighted) average change of the price of cheap and expensive goods that we do observe.

In particular, we assume that for each category  $g \in G_U$ , the price index is  $\widehat{P}_g^h = \frac{\sum_{g \in G_M} \omega_g^A \widehat{P}_g^h}{\sum_{g \in G_M} \omega_g^A}$ .

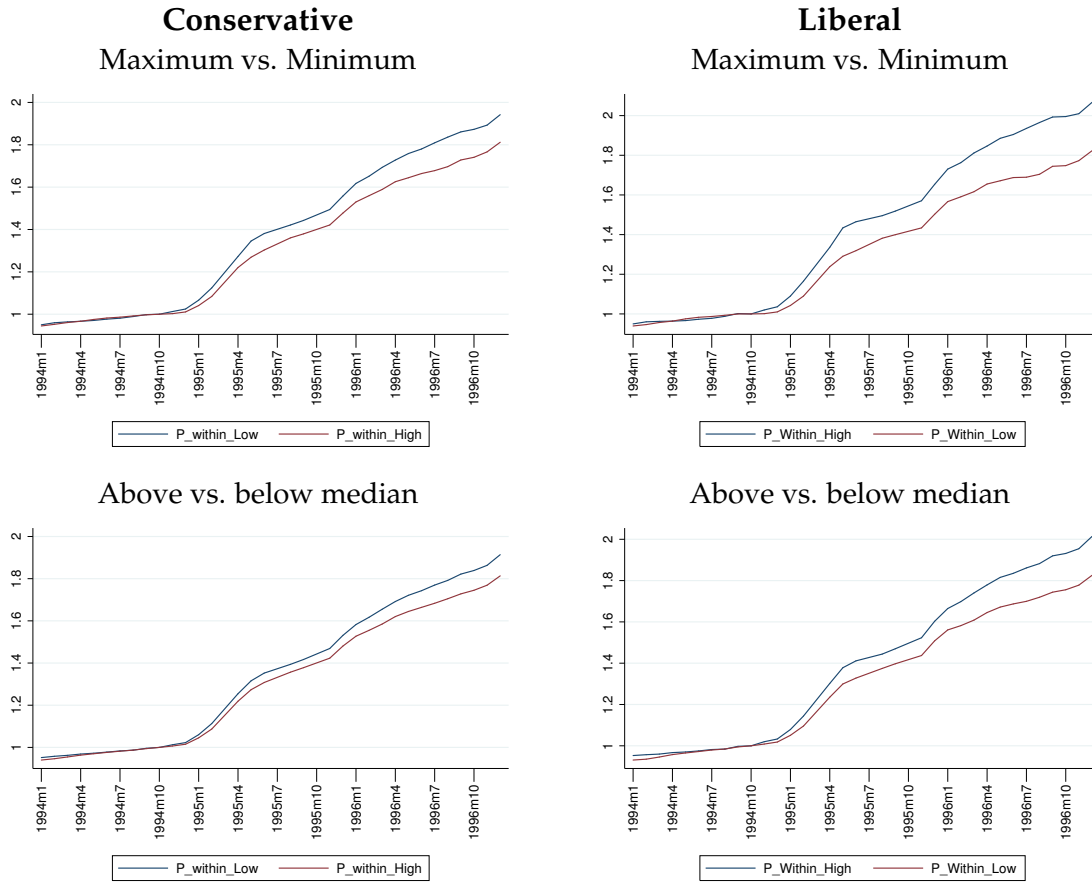
In this case, the within price index is given by:

$$\begin{aligned} \widehat{P}_{Within}^h &\equiv \sum_{g \in G_M} \omega_g^A \widehat{P}_g^h + \sum_{g \in G_U} \omega_g^A \frac{\sum_{g \in G_M} \omega_g^A \widehat{P}_g^h}{\sum_{g \in G_M} \omega_g^A} \\ &= \sum_{g \in G_U} \omega_g^A \widehat{P}_g^h \left[ \frac{1 - \sum_{g \in G_M} \omega_g^A}{\sum_{g \in G_M} \omega_g^A} + 1 \right] = \frac{\sum_{g \in G_M} \omega_g^A \widehat{P}_g^h}{\sum_{g \in G_M} \omega_g^A}. \end{aligned} \quad (12)$$

Figure 5 plots the month-to-month evolution of the price indices computed both when we sort goods according to the median price or when we focus on maximum vs minimum prices within each product category. Note that the price indices for high vs low prices are very close to each other before the October 1994 devaluation. Following the devaluation, the price indices start to diverge. The pattern is evident both when we focus on prices that are above vs. below the median and when we focus on maximum vs. minimum prices.

The exact values for the resulting price indices are reported in Tables 5a and 5b. The first two columns report the price indices when we sort goods depending on whether their average price prior to the devaluation were below and above the median. Even according to our most conservative price index (Tables 5a), inflation was significantly higher for the products that were initially below the median: by October 1996, prices for these goods increased by 9 percentage points more than for the goods that were initially

Figure 5: The Within price indices



Notes: This figure plots the Within price indices. The Conservative price indices are defined in (11), and the Liberal indices in (12). The plots labeled “Maximum vs. Minimum” plot the Within indices for consumers that consume the highest- and the lowest-priced varieties within each product category. The plots labeled “Above vs. below median” plot the Within indices for consumers that buy the varieties priced above and below the median price within each product category.

above the median. According to the ‘liberal’ index, the difference in inflation between these price indices was 17 percent. Columns 3 to 7 show that price indices for goods that were in different quartiles of the price distribution as of the January–October 1994 period. By October 1996, inflation was between 10 and 20 points higher, depending on the choice of the price index, for goods in the cheapest quartile relative to goods in the most expensive quartile. The relation tends to be monotonic, the change in the price index is lower for goods that are in lower quartiles. Finally, the last two columns report the price index for the maximum and minimum price in each generic category. Again, lower-priced goods increased significantly faster than the most expensive goods following the devaluation. If we focus on the liberal index, the inflation for the lowest prices was about 1.3 times higher (100 vs 75 percent inflation) than for the highest prices. This shows that the welfare losses of exchange rate depreciations for poor households can be significantly higher due to the Within effect.

These calculations do not account for substitution effects across varieties within goods. Conventional wisdom and recent evidence (Bems and di Giovanni, 2014) suggest that in crises there is expenditure switching away from more expensive towards cheaper varieties within each good. In our context, this would involve the rich switching to cheaper varieties, but as we show those cheaper varieties also experienced higher price increases, most likely dampening the importance of the expenditure switching effect for the rich. For the poor it is not clear how such expenditure switching will work, as they already consume the cheapest varieties. While it is possible that the poor switch to products that are outside the scope of Mexico’s price data collection, we currently have no way of assessing the potential importance of this effect. Alternatively, it is possible that the poor switch to higher-priced varieties as their price rises by less than for the cheap varieties. While theoretically possible, this appears implausible in the context of a large fall in real incomes.

### 4.3 The Overall effect

In this section we compute the Overall price index, defined in equation (4), which we reproduce here for convenience:

$$\hat{P}^h \equiv \sum_{g \in G} \omega_g^h \hat{P}_g^h.$$

This index combines the two mechanisms captured by the Across and Within price indices computed above. Since we do not observe the varieties consumed by each household, we

Table 5: The Within price index

(a) Conservative								
	Below Median	Above Median	Quart. 1	Quart. 2	Quart. 3	Quart. 4	Min	Max
Oct. 94	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
April 95	1.25	1.22	1.27	1.24	1.22	1.23	1.27	1.22
Oct. 95	1.47	1.42	1.49	1.44	1.42	1.44	1.49	1.42
April 96	1.69	1.62	1.71	1.65	1.62	1.63	1.73	1.63
Oct. 96	1.84	1.75	1.85	1.79	1.74	1.75	1.87	1.74

(b) Liberal								
	Below Median	Above Median	Quart. 1	Quart. 2	Quart. 3	Quart. 4	Min	Max
Oct. 94	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
April 95	1.30	1.24	1.33	1.27	1.23	1.24	1.34	1.24
Oct. 95	1.52	1.44	1.56	1.47	1.43	1.46	1.57	1.43
April 96	1.78	1.65	1.81	1.70	1.63	1.67	1.85	1.66
Oct. 96	1.93	1.76	1.96	1.85	1.75	1.76	2.00	1.75

Note: These tables report the Within price indices defined in equation (8). Table 5a reports the price indices under the Conservative assumptions (equation 11), while Table 5b reports the Liberal price indices (equation 12). Columns labeled Below/Above Median report the price indices for consumers that buy the varieties priced above/below the median price in each product category. Columns labeled Quart. 1/2/3/4 report the price indexed for consumers buy varieties with prices in the 1/2/3/4th quartiles of the price distribution within each product category. Columns labeled Min/Max report the price indices for consumers that buy the maximum and minimum priced varieties in each product category.

report the comparison of a hypothetical poor and a hypothetical rich household. The poor household is defined as one that has across-goods expenditure shares  $\omega_g^h$  of a household in the bottom income decile, and on top of that consumes the cheaper varieties within each  $g$ . The rich household has  $\omega_g^h$  of the top income decile, and within each  $g$  consumes the more expensive varieties.

We follow the procedure described in Section 2.1 to compute the indices  $\widehat{P}_g^h$ . As discussed in Section 2.1, the indices  $\widehat{P}_g^h$  cannot be computed for all product categories. We proceed as above, and compute the Overall price index under the two limiting assumptions from the previous section. In particular, we compute the conservative version under which there is no Within effect in categories where it cannot be directly measured:

$$\widehat{P}^h = \sum_{g \in G_M} \omega_g^h \widehat{P}_g^h + \sum_{g \in G_U} \omega_g^h \widehat{P}_g^A, \quad (13)$$

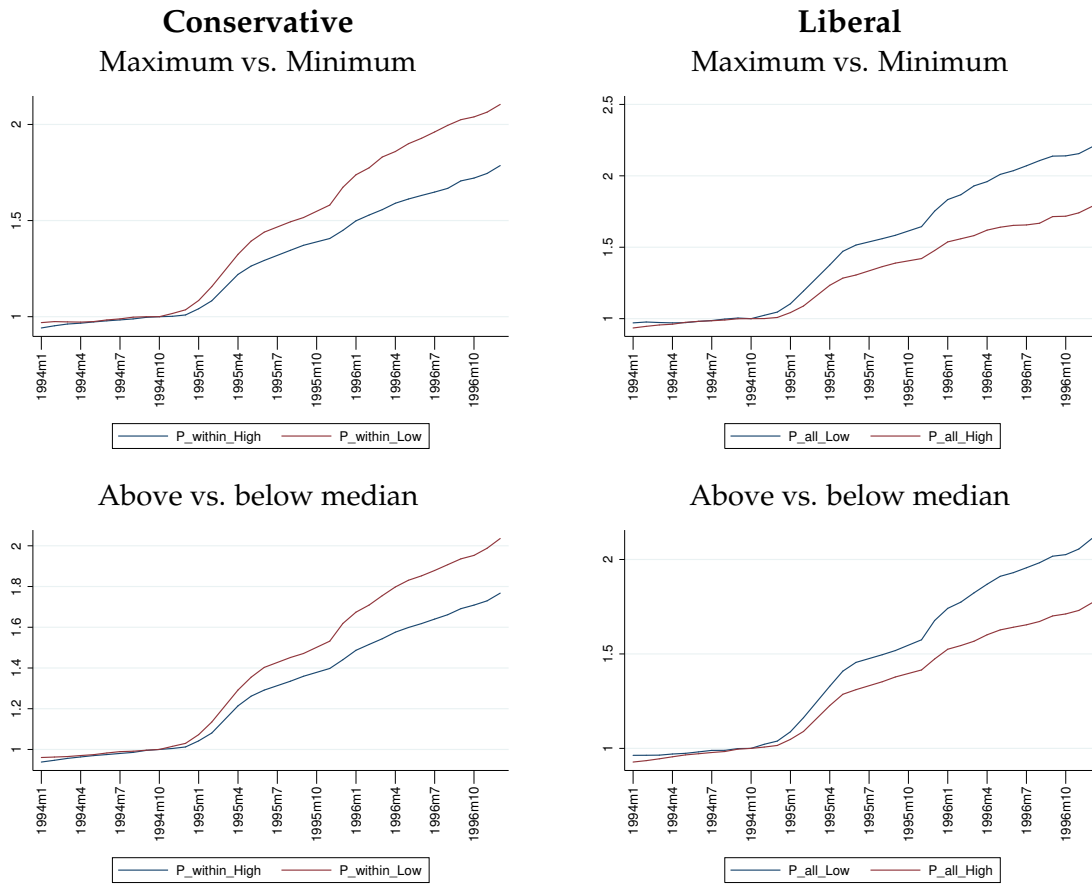
and a liberal version in which the Within effect is equally strong in the unmeasured categories as it is in measured ones:

$$\widehat{P}^h = \sum_{g \in G_M} \omega_g^h \widehat{P}_g^h + \sum_{g \in G_U} \omega_g^h \frac{\sum_{g \in G_M} \omega_g^h \widehat{P}_g^h}{\sum_{g \in G_M} \omega_g^h}. \quad (14)$$

Figure 6 plots the month-to-month evolution of the Overall price index under our two alternative assumptions, computed both when we sort goods relative to the median price and when we focus on maximum vs minimum prices within each product category. Note that the price indices for high vs low prices are very close to each other before the October 1994 devaluation, after which the price indices start to diverge.

The corresponding price index values are reported in Tables 6a and 6b. Overall, the difference in inflation faced by rich and poor households is startling. According to our most conservative index, if we split goods according to median prices, the change in price two years after the devaluation was more than 1.3 times higher for the poorest households compared to the richest ones. In the other extreme, under the liberal index and using maximum vs. minimum prices, inflation for the poorest households was 42 percentage points, or about 1.6 times, higher than for the richest households. In the following section, we show that the magnitude of these results is robust to a number of alternative assumptions that we can use to build the price indices.

Figure 6: The Combined price indices



Notes: This figure plots the Combined price indices. The Conservative price indices are defined in (13), and the Liberal indices in (14). The plots labeled “Maximum vs. Minimum” plot the Combined indices for consumers that consume the highest- and the lowest-priced varieties within each product category. The plots labeled “Above vs. below median” plot the Combined indices for consumers that buy the varieties priced above and below the median price within each product category.

Table 6: The Overall price index

(a) Conservative						
	Below Median	Above Median	Quart. 1	Quart. 4	Min	Max
Oct. 94	1.00	1.00	1.00	1.00	1.00	1.00
April 95	1.29	1.21	1.31	1.23	1.32	1.22
Oct. 95	1.53	1.40	1.55	1.41	1.58	1.41
April 96	1.80	1.58	1.82	1.59	1.86	1.59
Oct. 96	1.95	1.71	1.98	1.72	2.04	1.72

(b) Liberal						
	Below Median	Above Median	Quart. 1	Quart. 4	Min	Max
Oct. 94	1.00	1.00	1.00	1.00	1.00	1.00
April 95	1.33	1.23	1.35	1.24	1.38	1.23
Oct. 95	1.57	1.42	1.61	1.43	1.64	1.42
April 96	1.87	1.60	1.90	1.61	1.96	1.62
Oct. 96	2.03	1.71	2.06	1.71	2.14	1.72

Note: These tables report the Overall price indices defined in equation (4). Table 6a reports the price indices under the Conservative assumptions (equation 13), while Table 6b reports the Liberal price indices (equation 14). Columns labeled Below/Above Median report the price indices for consumers that buy the varieties priced above/below the median price in each product category. Columns labeled Quart. 1/4 report the price indices for consumers buy varieties with prices in the 1/4th quartiles of the price distribution within each product category. Columns labeled Min/Max report the price indices for consumers that buy the maximum and minimum priced varieties in each product category.

## 4.4 Robustness

In this Section we show that the baseline assumptions used to calculate the Within effects are not crucial for the findings in the previous two sections. In particular, we recalculate the price indices under three alternative approaches. First, we change the base period, and classify varieties as high- and low-priced according to their relative position in January 2014. The advantage of this alternative is that it pushes back the date at which goods are classified as either cheap or expensive as far back from the devaluation date as possible (our data starts in January 1994, so we cannot go back farther). The disadvantage is that observations in an individual month will be inherently more noisy than a 10-month average.

Another potential concern is that there may be substantial product heterogeneity even within product categories, so that comparing high- vs. low-priced products may not be a meaningful exercise. To alleviate this concern, we re-calculate the Within effect for those products in which prices are quoted in the most comparable units: kilos and liters. Finally, we recompute our results focusing on the entire set of varieties, instead of limiting our sample to the set of varieties that experienced a price change prior to the devaluation.

Table 7 reports these alternative results. To facilitate exposition, we report the change in the Overall price index one year and two years after the devaluation, and omit the version of the price index in which prices are sorted into quartiles. We continue to find large differences between the price changes faced by poor vs. rich households for all these alternative price indices. The difference in the change price is somewhat smaller when we use January 94 as the base period. This is not surprising, since focusing on any one particular month would lead us to identify temporary sales as low prices. The difference becomes larger than the baseline if we focus on goods that for which prices are denominated in kilos or liters, or if we do not condition on prices changes.

## 5 Additional evidence on the Within effect

### 5.1 Additional evidence of the Within effect in Mexico

This section provides three pieces of supporting evidence on the Within effect using the Mexican CPI data. First, we estimate whether, following the depreciation, prices increased systematically more for lower-priced varieties. In particular, we estimate the following specification:

$$\hat{P}_{v_g} = \beta \ln \left( P_{v_g}^0 \right) + \delta_g + \epsilon_{v_g}, \quad (15)$$



Table 7: Robustness: the Overall price index under alternative assumptions

	Conservative				Liberal			
	Below Median	Above Median	Min	Max	Below Median	Above Median	Min	Max
<b>Base period: January 94</b>								
Oct. 94	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Oct. 95	1.51	1.40	1.54	1.41	1.55	1.43	1.58	1.44
Oct. 96	1.93	1.72	1.94	1.73	1.99	1.74	2.00	1.74
<b>Including only prices quoted per Kg or per Liter</b>								
Oct. 94	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Oct. 95	1.53	1.41	1.58	1.41	1.62	1.48	1.75	1.47
Oct. 96	1.95	1.74	2.05	1.74	2.15	1.91	2.38	1.88
<b>Including products with no price changes 10 months prior to the devaluation</b>								
Oct. 94	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Oct. 95	1.52	1.39	1.54	1.39	1.55	1.38	1.63	1.36
Oct. 96	1.93	1.71	1.95	1.72	1.95	1.69	2.10	1.68

Note: These tables report the Overall price indices defined in equation (4) under alternative assumptions. Table 6a reports the price indices under the Conservative assumptions (equation 13), while Table 6b reports the Liberal price indices (equation 14). Columns labeled Below/Above Median report the price indices for consumers that buy the varieties priced above/below the median price in each product category. Columns labeled Min/Max report the price indices for consumers that buy the maximum and minimum priced varieties in each product category.

where  $\widehat{P}_{v_g}$  is the one- or two-year log change in the price of the specific product  $v_g$  in category  $g$ ,  $\ln(P_{v_g}^0)$  is the initial price of product  $v_g$  computed as the log of the average price of the good between January and October 1994,  $\delta_g$  are generic categories specific fixed effects, and  $\epsilon_{v_g}$  is an error term. The coefficient of interest  $\beta$  captures the semi-elasticity of the (relative) change in price with respect to the (relative) initial price of variety  $v_g$ . In addition, we estimate the alternative regression:

$$\widehat{P}_{v_g} = D_{v_g,High} + \delta_g + \epsilon_{v_g}, \quad (16)$$

where  $D_{v_g,High}$  is a dummy indicating whether the average price of the good between January and October 1994 was either (i) above the median price in the category, or (ii) in the highest quartile in the category, depending on the specification. In specification (ii) we limit the sample to products that are either in the highest or in the lowest quartiles. Hence, the coefficient on  $D_{v_g,High}$  captures the average difference in the price change for products that (i) are above the median relative to products that are below the median, or (ii) are in the highest quartile median relative to products that are in the lowest quartile. We focus on a sample of goods for which we can observe price quotes continuously through the first two years. We focus on two samples of products: either the universe of goods covered in the *Diario*, or a subset of products that are in categories where price quotes are based on units that are easily comparable and that showed a change in price in the 10 months prior to the devaluation.<sup>9</sup>

The results are reported in Table (8). The coefficients on  $\beta$  and on the  $D_{v_g,High}$  dummies are negative across all the specifications, indicating that prices that were high before the devaluation increased by less following the devaluation. This result holds for both changes one and two years after the devaluation. The results are also robust to using city-product fixed effects instead of product fixed effects, and to using January 94 as the base period in which we classify prices.

## 5.2 Changes in the price distribution

Our hypothesis suggests that, within each product category, the difference between high and low prices should have shrank in the months following the devaluation. We check whether this prediction holds using data from the *Diario*. In particular, for each product category, we compute the log difference between the highest and lowest price in each month, as well as the standard deviation of log prices within categories. We then com-

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<sup>9</sup>Similar results obtain in a wide range of alternative samples of products.

Table 8: The Within effect: additional evidence from the Diario

	(1)	(2)	(3)	(4)	(5)	(6)
	All products	Limited sample	All products	Limited sample	All products	Limited sample
<b>One-year changes: <math>\hat{P}_{v_g} = \log P_{v_g}^{Oct95} - \log P_{v_g}^{Oct94}</math></b>						
$\log(P_{vg}^0)$	-0.082*** (0.0145)	-0.117*** (0.0176)				
$D_{v_g,High}^{Median}$			-0.079*** (0.00707)	-0.077*** (0.0101)		
$D_{v_g,High}^{quartile}$					-0.141*** (0.00759)	-0.132*** (0.0108)
<b>Two-year changes: <math>\hat{P}_{v_g} = \log P_{v_g}^{Oct96} - \log P_{v_g}^{Oct94}</math></b>						
$\log(P_{vg}^0)$	-0.116*** (0.0181)	-0.157*** (0.0233)				
$D_{v_g,High}^{Median}$			-0.100*** (0.00949)	-0.095*** (0.0129)		
$D_{v_g,High}^{quartile}$					-0.180*** (0.00954)	-0.166*** (0.0113)
Observations	12,998	4,893	12,998	4,893	6,521	2,478
Categories	312	85	312	85	310	85

Notes: Robust standard errors in parentheses. \*\*\*: significant at 1%; \*\*: significant at 5%; \*: significant at 10%. The table reports the results of estimating equations (15) and (16). "All products" refers to regressions that include all products for which we observe price quotes continuously through our sample. "Limited Sample" refers to products in categories with comparable units, and for which we observe a price change between January and October 1994.

Figure 7: Price dispersion following the devaluation



Note: This figure reports measures of price dispersion around the devaluation. “Median  $P_{max} - P_{min}$ ” and “Mean  $P_{max} - P_{min}$ ” (left axis) plots the median/mean differences between the maximum and minimum prices within product categories. “Median sd” plots the median standard deviation in prices within product categories.

pute the mean and median of the price differences and standard deviations across all product categories. We focus our analysis on categories in which prices are denominated in comparable units.

Figure 7 plots the month-to-month evolution of these series. Following the month of the devaluation (indicated by the red vertical line), the log difference between maximum and minimum prices falls both when we focus on the median or on the average category. In addition, the standard deviation of prices in the median category also falls. This pattern is consistent with low prices increasing faster than high prices due to the change in the exchange rate.

### 5.3 Cross-country evidence on the Within effect

This section provides evidence on the Within effect using the EIU CityData. The first useful feature of these data is that it reports prices for three different types of outlets. Thus, we can establish whether the prices increased systematically less in higher-end stores fol-

lowing large depreciations. In particular, we estimate the following specification:

$$\widehat{P}_{v_g} = \beta_1 MED_{v_g} + \beta_2 HIGH_{v_g} + \delta_g + \epsilon_{v_g}, \quad (17)$$

where  $\widehat{P}_{v_g}$  is the log change in the price of variety  $v_g$  of good  $g$ ,  $MED_{v_g}$  is the dummy for whether  $v_g$  is sold in a medium-level store, and  $HIGH_{v_g}$  is the dummy for whether  $v_g$  is sold in a high-end store. The low-end store is the omitted category. The specification includes good fixed effects. That is, the coefficients  $\beta_1$  and  $\beta_2$  come from the variation in price changes across stores within a product. There are only 3 price quotes per product, one for each store. The maintained hypothesis is that  $\beta_1$  and  $\beta_2$  are negative and significant: prices went up by less in higher-end stores. Since this approach does not use information on the actual initial price, it is immune to the “mean reversion” concern.

We restrict the sample of goods to tradeables for which 3 price quotes are available. The broad product categories are Food, Alcohol, Tobacco, Clothing, Household supplies, and Personal care. For some subsets of goods, the prices quoted in the different-level stores are actually identical. The extent of this problem varies a great deal across countries, from only a few categories exhibiting this feature in Mexico, to most categories in Argentina. The exact same prices across stores could be due to regulation (for instance, on the price of cigarettes or alcohol), as well as idiosyncrasies in the particular types of stores in which the data are collected in different countries. The identical prices across stores are a problem for us because the goal of the exercise is to capture the differences in prices of goods actually bought by the rich and the poor. If there is no price difference across stores, then the type of store is not informative of who is buying the good. For this reason, we drop the products in which the prices are the same in the low and the medium store, or the same in the medium and the high store.

Table (9) reports the results for 6 devaluation episodes. These are the 5 episodes analyzed in depth by [Burstein et al. \(2005\)](#) (Mexico 1994, Brazil 1998, Argentina 2001, Korea and Thailand 1997), plus a more recent depreciation episode, Iceland 2007-2008. The Iceland episode is interesting because unlike the others, it was a much more protracted depreciation, with the Icelandic real exchange rate falling by 45% between the fall of 2007 and the fall of 2008. We take the September/October 2007 prices as the pre-depreciation values for Iceland. Of these countries, only Brazil has information on more than 1 city: Sao Paulo and Rio de Janeiro. The Brazilian specifications include product×city fixed effects instead of product effects.

The EIU data are collected semi-annually in March-April and September-October. Thus, the prices are not measured the exact months of the devaluation and exact 1- and

2-year horizons post-devaluation. The pre-devaluation prices are the closest observation strictly before the episode. Thus, the Mexican devaluation happened in November 1994, and we take the September-October 1994 prices as the pre-period. The column labeled “<1 year” reports the results for the price changes from September-October 1994 to September-October 1995, namely less than 1 year from the devaluation. The second column treats the price changes to September-October 1996 (less than 2 years from devaluation), the third to September-October 1997 (less than 3 years). The same convention is adopted for other countries.

In all episodes except Thailand, the prices for medium- and high-level store rose by significantly less than the prices for the lower-end stores. In all cases except for Argentina and Korea, the prices in the high-level store rose the least, followed by the medium-level store prices. For Mexico, the results are quite strong at all horizons, including less than 1 year. In all other cases, the effect becomes detectable at the <2 year horizon. The magnitudes are relatively similar across countries, with the medium-level store prices rising by 5-10% less than the low-level store, and the high-level store prices rising 10-15% less.

Table 9: Price changes in different stores, EIU CityData

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Mexico November 1994			Brazil November 1998			Argentina December 2001		
Horizon	<1 year	<2 years	<3 years	<1 year	<2 years	<3 years	<1 year	<2 years	<3 years
Dep. Var.: $\hat{P}_{v_g}$									
$MED_{v_g}$	-0.068** (0.028)	-0.068*** (0.025)	-0.098*** (0.026)	0.000 (0.012)	-0.037** (0.018)	-0.059*** (0.019)	-0.052 (0.039)	-0.087*** (0.033)	-0.061** (0.030)
$HIGH_{v_g}$	-0.118*** (0.030)	-0.120*** (0.027)	-0.128*** (0.031)	-0.016 (0.013)	-0.073*** (0.020)	-0.129*** (0.022)	-0.075* (0.045)	-0.087** (0.040)	-0.061 (0.038)
Obs.	236	236	239	567	557	553	157	160	159
$R^2$	0.803	0.874	0.862	0.624	0.652	0.716	0.865	0.837	0.843
	Korea September 1997			Thailand June 1997			Iceland 2007-2008		
Horizon	<1 year	<2 years	<3 years	<1 year	<2 years	<3 years	<1 year	<2 years	<3 years
Dep. Var.: $\hat{P}_{v_g}$									
$MED_{v_g}$	-0.011 (0.049)	-0.110** (0.043)	-0.074* (0.039)	0.035 (0.031)	0.019 (0.032)	0.014 (0.030)	-0.016 (0.027)	-0.043 (0.029)	-0.109*** (0.028)
$HIGH_{v_g}$	-0.011 (0.051)	-0.107** (0.053)	-0.110** (0.046)	0.003 (0.036)	-0.097** (0.039)	-0.037 (0.037)	-0.040 (0.030)	-0.077** (0.033)	-0.166*** (0.032)
Obs.	191	187	197	197	197	197	280	272	274
$R^2$	0.706	0.775	0.763	0.781	0.827	0.871	0.528	0.686	0.748

Notes: Robust standard errors in parentheses. \*\*\*: significant at 1%; \*\*: significant at 5%; \*: significant at 10%. All specifications include product effects, except Brazil, which includes product×city fixed effect. This table reports the results of estimating equation (17) for 6 devaluation episodes. In each country panel, the first column reports the results on the price change less than 1 year since depreciation, the second column the price change less than 2 years since depreciation, and the third column less than 3 years.

## 6 Conclusion

Large exchange rate devaluations affect the prices faced by high- and low-income households differentially. Large devaluations are associated with an increase in the relative price of tradeable goods. Poorer households tend to spend a larger share of their income on tradeable product categories. In addition, within tradeable product categories, the poor consume lower-priced varieties that contain relatively less domestic value added. Both of these effects imply that the devaluation hurts the low-income households more than the high-income ones. Using the 1994 Mexican peso devaluation, we show that the distributional consequences can be large. In the two years following the devaluation, inflation of the consumption basket of those in the bottom decile of the income distribution was between 24 and 41 percentage points higher than for the basket of those in the top decile. Differences in expenditures shares within narrow product categories account for at least half of the difference. Cross-country evidence is suggestive that the results for Mexico are informative of the likely effects of other devaluations.



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