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Large Devaluations and Inflation Inequality: Evidence from Brazil

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Abstract

In the aftermath of large devaluations, prices of tradable goods/lower-priced varieties increase significantly more than the prices of nontradables/higher-priced varieties. These relative price changes may lead to inflation inequality when household consumption baskets are different across the distribution of income. Using Cravino and Levchenko [2017]'s methodology, we show that inflation of poor households in Brazil was at least 11 percentage points higher than of the rich in the aftermath of the 2002 large devaluation. A detailed case study of the City of São Paulo estimates an inflation inequality ranging from 8 to 11 percentage points in the city.

Keywords: Exchange Rate Devaluation, Pass-Through, Inflation, Inequality

JEL Codes: F31, F41, E31

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1 Introduction

Figure 1 presents the evolution of the Brazilian trade-weighted nominal exchange rate (R$/US$) in recent years. From 1995 to 1998, the exchange rate was very stable as Brazil adopted an stabilization plan based on a pegged exchange rate regime. Since the collapse of the pegged regime, the exchange rate has been susceptible to high levels of volatility. In this paper, we discuss an often overlooked channel by which exchange rate shocks may lead to distributional consequences. We follow the methodology developed by Cravino and Levchenko [2017] to study the distributional consequences of large exchange rate shocks in Brazil.

Among the possible large devaluation[1] episodes we observe in Figure 1 (1999, 2002 and 2008), we focus on the 2002 episode for two reasons. First, we need a large devaluation episode that was sustained in the following years. Such devaluations usually produce changes in the relative price of tradable/nontradable goods, as initially documented by Burstein et al. [2003], which we will exploit in the empirical exercise. Only the large devaluations of 1999 and 2002 meet these criteria as the 2008 episode was not sustained. However, a major revision of the Brazilian consumer price index (CPI) in June 1999, only a few months after the devaluation, prevents us from studying this episode with the Cravino and Levchenko [2017] methodology. Second, the 2002 devaluation episode was triggered by investors electoral concerns and, as such, the shock was exogenous to the economic fundamentals of the Brazilian economy at the moment. As described by Campello [2016], "Brazil's long-term prospects seemed promising to analysts and investors alike" (p. 92) at the beginning of 2002, but "markets' fears turned into outright panic as Lula's leadership in the presidential race consolidated" (p. 95). The result of the Lula shock was a sharp fall in stock and bonds market, a halt on foreign capital inflows and, consequently, a large devaluation episode of the Brazilian exchange rate. In April 2002, the Brazilian trade-weighted exchange rate devalued 7 percent and

[1] We use the term devaluation and depreciation interchangeably throughout this paper.

the cumulative devaluation after 12 and 24 months were 44 and 40 percent, respectively. Moreover, consumer prices of tradable goods increased by 19 and 25 percent one and two years after the devaluation while prices of nontradable goods increased only by 10 and 16 percent over the same period.

The goal of the Cravino and Levchenko [2017]'s methodology is to calculate the changes in households cost of living following a large nominal exchange rate shock or, putting it another way, to measure the inflation inequality produced by the exchange rate shock. The methodology consists in a decomposition exercise of the consumer price index that highlights two types of effects. The *Across* effect explores differences in relative price changes and expenditure shares across products and across the income distribution. Data from the 2002-2003 consumer expenditure survey show that poorer households in Brazil consume relatively more tradable (especially food) than nontradable goods (such as services). Following a consumption pattern predicted by the Engel's Law and present in the Brazilian data, households expenditure share of tradable goods decreases with the level of income, while the expenditure share of nontradables increases. As prices of tradable goods increased by a greater extent compared to prices of nontradable goods after the large devaluation, we expect that households at the bottom of the income distribution faced higher increases in their cost of living than households at the top. The *Within* effect explores differences in price changes and expenditure shares within product categories. Lower quality goods purchased from lower-end retail stores are consumed in a higher proportion by low-income households than high-income households. Then, if prices of lower quality goods increase relatively more than high-quality goods within product categories, the price level of low-income households will increase relatively more than high-income households.

We estimate that the difference in inflation due to the *Across* effect of households situated in the first and tenth deciles of the income distribution was 11 percentage points two years after the shock. This translates into an increase of the cost of living that was 1.52 times higher for households in the bottom of the income distribution compared to the top.

The computation of the within effect requires observing the price quotes of each variety used to construct the consumer price index. These data are not available to the public for the official Brazilian consumer price index. To circumvent this problem, we compute the *Within* effect using data from a consumer price index for the City of São Paulo, which is among the most traditional and broadly used indices in Brazil. We, then, proceed as follows. First, we show that the pattern of relative price changes in the aftermath of the devaluation is the same using IPCA (the official consumer price index) or IPC-FIPE (the CPI for the City of São Paulo). Second, we compute the *Across* price index using the IPC-FIPE and find that the results are qualitatively the same as the ones obtained using IPCA: households in the first decile of income faced higher inflation compared to households in the tenth decile (of around 3 percentage points) after the large devaluation shock. After documenting that both IPCA and IPC-FIPE deliver similar results for the *Across* effect, we use the city of São Paulo as a study case for the *Within* effect.

We estimate that the difference in inflation due to the *Within* effect of households in the first and tenth deciles of the income distribution in the City of São Paulo was between 2 and 5 percentage points. The increase in the cost of living of poor households relative to the rich was 1.11 times higher in the most conservative case and 1.40 times higher in the less conservative one. For the City of São Paulo, we can also estimate the combined effect which ranges from 8 to 11 percentage points and translates into an increase in the cost of living of the poor that is 1.39 to 1.67 times higher than the increase of the rich.

This paper is related to the vast literature on the relationship between prices and exchange rates, especially with the literature on exchange rate pass-through. As reviewed in greater detail by Burstein and Gopinath [2015], two stylized facts have been produced in the exchange rate pass-through literature. First, pass-through into consumer prices is lower than into border prices [Campa and Goldberg, 2005, Burstein and Gopinath, 2015]. Second, border prices respond partially to exchange rate shocks irrespective of the currency they are set [Gopinath et al., 2010, Gopinath and Itskhoki, 2010, Gopinath, 2015].[2]

The empirical approach of this paper is even closer to the literature that exploits large nominal exchange rate changes as a source of identification. The general idea behind this identification strategy is that large exchange rate shocks — or, at least, their timing – are usually exogenous to the local economy. This strategy has been used to study exchange rate pass-through and changes in relative prices [Burstein et al., 2003, 2005, 2007], prices and consumer behavior [Auer et al., 2017, Burstein and Neumeyer, 2010], and distributional issues [Cravino and Levchenko, 2017]. [3]

Finally, it is important to highlight that the channel we study in this paper is not the only one going from exchange rate shocks to households welfare. Besides the distributional consequences of nominal exchange rate shocks that happen through the price of consumption goods, devaluations may also affect nominal wages and employment levels, even though the sign of the effects of a real devaluation on these variables is usually ambiguous from a theoretical point of view [Alejandro, 1963, Krugman and Taylor, 1978, Agénor and Montiel, 2015, Gandolfo, 2016]. Our results should, then, be understood as derived from a partial equilibrium model where nominal wages and employment levels are taken as given. This assumption justifies the short-run nature of the empirical exercises presented in this paper which are restricted to two years after the initial shock. Appendix A presents a simple pricing framework that helps to clarify the main assumptions behind

[2]It is important at this point to clarify some terminology used to refer to different price measures. Consumer or retail prices, measured by Consumer Price Indices (CPI), are prices paid by consumers when buying goods and services. Consumer prices are, then, prices charged by the retail sector. The Producer Price Indices (PPI) measure prices of production and, besides consumption goods, they also include intermediate and investment goods. Border prices or prices "at the dock" are prices of actually traded goods. They can be measured using Import Price Indices (IPI) or Export Price Indices (EPI).

[3]Large exchange rate shocks have also been used to study other topics in international economics, such as trade, quality upgrading and wage inequality [Verhoogen, 2008, Araújo and Paz, 2014], quality and exchange rate pass-through [Goetz and Rodnyansky, 2016], employment, domestic revenue and profitability of exporting firms [Rodnyansky, 2017] to mention a few papers.

the empirical exercise.

The rest of the paper is organized as follows. Section 2 discusses the theoretical framework and price indices definitions. Data and an empirical overview are presented in Section 3. Section 4 brings the main empirical results of the paper, which ends with some concluding remarks.

2 Conceptual Framework and Price Indices Definitions

In this section, we present the conceptual framework and price indices definition following closely the discussion in Cravino and Levchenko [2017].

2.1 Conceptual framework

Assume that the indirect utility of household h, its income and the vector of prices are given by V_t^h, W_t^h and $P_{g,t}$. In this case, the proportional change in welfare given a change in income and the vector of prices can be approximated by

$$\hat{V}_t^h = \hat{W}_t^h - \sum_{g \in G} \omega_g^h \hat{P}_{g,t} \tag{1}$$

where a hat over a variable indicates its cumulative growth rate, g indexes goods and ω_g^h are household-specific expenditure shares. As shown by Cravino and Levchenko [2017], if we sum and subtract $\omega_g \hat{P}_{g,t}$ to the right-hand side, where ω_g is the economy-wide expenditure share on good g, equation (1) can be written as

$$\hat{V}_t^h = \underbrace{\hat{W}_t^h - \sum_{g \in G} \omega_g \hat{P}_{g,t}}_{\text{homothetic-utility}\hat{V}} - \underbrace{\sum_{g \in G} (\omega_g^h - \omega_g) \hat{P}_{g,t}}_{Cov(\hat{P}_{g,t}, \omega_g^h - \omega)} \tag{2}$$

Equation (2) makes explicit the source of the distributional effects of the price changes. The first term captures the change in welfare if households expenditure shares in every good g were the same and their utility homothetic. The distributional effect is captured by the second term which is a covariance between price changes and the relative expenditure shares. Then, if household h relative expenditure shares are higher in goods whose prices increase by a greater extent, household h has a greater decrease in welfare than the average household. As pointed out by Cravino and Levchenko [2017], these equations also show that the results can be interpreted either as heterogeneity in costs of living or in the compensating variation across households.[4] To measure the extent of these heterogeneous changes in the cost of living across households, the authors propose a decomposition of the overall price index in two main sub-indices and a covariance term as follows.

2.2 Price indices definitions

Define the change in the aggregate price index as:

$$\hat{P}_t \equiv \sum_{g \in G} \omega_g \hat{P}_{g,t} \tag{3}$$

where $g \in G$ is a good category and, as before, ω_g is the economy-wide expenditure share on good g. Assume that within each good category, there are v_g varieties. Then, the change in the price index for good category g with V_g varieties is given by:

$$\hat{P}_{g,t} \equiv \frac{1}{V_g} \sum_{v_g \in g} \hat{P}_{v_g,t} \tag{4}$$

If we assume that households have different expenditure shares across and within product categories, we can define the household-specific price index as:

[4] The compensating variation is equal to the change in income required to keep welfare unchanged given a vector of price changes.

$$\hat{P}_t^h \equiv \sum_{g \in G} \omega_g^h \hat{P}_{g,t}^h \tag{5}$$

where ω_g^h is the expenditure share of household h in category g and $\hat{P}_{g,t}^h$ is the change in the price sub-index of good g. As households consume different varieties, this price sub-index varies by household as in:

$$\hat{P}_{g,t}^h \equiv \sum_{v_g} s_{v_g}^h \hat{P}_{v_g,t} \tag{6}$$

where s_{v_g} is the household expenditure share in variety v_g within product category g and $\hat{P}_{v_g,t}$ is the economy-wide change in the price of variety v_g of good g. $\hat{P}_{g,t}^h$ will then vary across households if they consume different varieties within categories.

The *Across* and *Within* price indices can be defined as follows:

$$\hat{P}_{Across,t} \equiv \sum_{g \in G} \omega_g^h \hat{P}_{g,t} \tag{7}$$

$$\hat{P}_{Within,t} \equiv \sum_{g \in G} \omega_g \hat{P}_{g,t}^h \tag{8}$$

Therefore, while equation (7) assumes household-specific expenditure shares and economy-wide price indices for goods g, equation (8) assumes economy-wide expenditure shares and household-specific price indices for varieties v_g.

Using the previous definitions, it is possible to write the change in the price index of household h as:

$$\hat{P}_t^h = \underbrace{\sum_{g\in G} \omega_g^h \hat{P}_{g,t}}_{\hat{P}_{Across,t}} + \underbrace{\sum_{g\in G} \omega_g \hat{P}_{g,t}^h}_{\hat{P}_{Within,t}} + \underbrace{\sum_{g\in G} \left(\omega_g^h - \omega_g\right)\left(\hat{P}_{g,t}^h - \hat{P}_{g,t}\right)}_{\hat{P}_{Cov,t}} - \underbrace{\sum_{g\in G} \omega_g \hat{P}_{g,t}}_{\hat{P}_t} \tag{9}$$

and the difference in price indices of two households at different points of the income distribution as:

$$\Delta\hat{P}_t = \Delta\hat{P}_{Across,t} + \Delta\hat{P}_{Within,t} + \Delta\hat{P}_{Cov,t} \tag{10}$$

where Δ denotes a cross-sectional difference between household h and h'.

In the next sections, we provide estimates for the *Across* and *Within* price indices. However, for some product categories, prices of identical goods cannot be observed continuously over time and an additional hypothesis is required to obtain a *Within* price index representative of the whole economy. In the empirical implementation, Cravino and Levchenko [2017] suggest using a conservative and liberal version of the *Within* price index. In the conservative version is assumed that the relative price of varieties remained constant for the missing generic categories, while the liberal version assumes that the change in relative prices of these missing categories is equal to the weighted average price change of the observed varieties. The conservative and liberal versions are, then, defined by:

$$\hat{P}_{Within-C,t} \equiv \sum_{g\in G_M} \omega_g \hat{P}_{g,t}^h + \sum_{g\in G_U} \omega_g \hat{P}_{g,t} \tag{11}$$

and

$$\hat{P}_{Within-L,t} \equiv \sum_{g\in G_M} \omega_g \hat{P}_{g,t}^h + \sum_{g\in G_U} \omega_g \hat{P}_{g,t} \frac{\sum_{g\in G_M} \omega_g \hat{P}_{g,t}^h}{\sum_{g\in G_M} \omega_g \hat{P}_{g,t}} \tag{12}$$

where G_M is the set of categories for which identical varieties are measured continuously through time and G_U is the set of categories for which identical varieties are not continuously observed.

3 Data and Empirical Overview

Implementing Cravino and Levchenko [2017]'s decomposition requires two types of data: consumer prices and household expenditures. In addition to consumer price indices, the *Within* effect also requires observing the surveyed price quotes of different varieties. Given that these are not public available for IPCA, we use data from IPC-FIPE to quantify the *Within* effect in the City of São Paulo. [5]

3.1 IBGE data

IBGE, the Brazilian national bureau of statistics, produces consumer price indices since 1979 and IPCA is the official measure of overall inflation in Brazil. The weighting structure of the IPCA basket is constructed and updated by IBGE using micro data from consumer expenditure surveys. we use data on total income and total expenditure from the *Pesquisa de Orçamentos Familiares 2002-2003* (henceforth POF 2002-2003) to obtain the consumption pattern of households across product categories.[6] Using information from the POFs, IBGE sets the criteria for a product to be included in the IPCA basket and computes the weighting structure of the overall price index. IBGE, then, surveys the prices of these products and publishes the results following a hierarchical classification that aggregates each product into four categories: group (1 digit), subgroup (2 digits), item (4 digits) and subitem (7 digits). For example, **orange** is a subitem of the item **fruits**, which

[5] There are many different CPIs in Brazil, produced by different institutions and having different targeted populations and regional coverage. In addition to IPCA and IPC-FIPE, IPC-BR from Fundação Getúlio Vargas (FVG) is also among the most traditional CPIs in Brazil. For a summary of the most important methodological differences among IPCA, IPC-FIPE and IPC-Br, see BCB [2004].

[6] Since IBGE started producing CPIs, there were five of such surveys in Brazil: the *Estudo Nacional de Despesa Familiar* (ENDEF) of 1974-1975 and the POFs of 1987-1988, 1995-1996, 2002-2003 and 2008-2009. Besides ENDEF, POF 2002-2003 was the first nationally representative consumer expenditure survey in Brazil. For a historical overview and the main differences among these consumer expenditure surveys, see Diniz et al. [2007].

belongs to the subgroup **food at home** that is part of the group **food and beverages**. The IPCA subindices are then available for 8 groups, 19 subgroups, 52 items and 512 subitems for the period under study.[7]

3.2 FIPE Data

The consumer price index of the City of São Paulo started in January 1939 and its time series is the longest for a consumer price index in Brazil. Its calculation was carried out by the City of São Paulo until 1968, when it was transferred to FIPE, a nonprofit organization created to support the Economics Department of the University of São Paulo.[8] IPC-FIPE measures the cost of living in the City of São Paulo and its consumption basket is constructed using specific consumer expenditure surveys carried out by FIPE. I use data on total income and total expenditure from the *Pesquisa de Orçamentos Familiares 1998-1999* (henceforth POF 1998-1999), the closest to the period under study, to obtain the consumption pattern across product categories of households living in the City of São Paulo. After determining the weighting structure of the index, FIPE surveys the price levels of the products included in the CPI basket and I had access to this proprietary data set at the product-outlet level with information over the period 1998 and 2007. In the FIPE data, I can then observe monthly average price quotes with a unique product-outlet identifier. As in Cravino and Levchenko [2017], we consider each product-outlet information a specific variety. Varieties are grouped by FIPE using a different hierarchical classification from IBGE but this classification also has four levels. In the period under study, there are 7 groups, 29 subgroups, 54 items and 463 subitems.

[7] IBGE updates the weighting structure a few years after each POF, *e.g.*, the IPCA revision after POF 2002-2003 occurred in 2006. Since the stabilization of the economy with *Plano Real*, there were three revisions. Martinez [2014] discusses in detail their differences and provide a compatibilization table from the changes after 1999.

[8] Rizzieri and Carmo [2006] present the history and methodology of the IPC-FIPE from its beginning until the 1994 revision. For the most recent revisions, see Carmo [1999], de Lima et al. [2011] and Chagas et al. [2015].

3.3 Empirical Overview

The empirical exercises performed in the next section are based on two very simple ideas. The first is that relative price changes in the aftermath of the 2002 Brazilian depreciation followed the main stylized facts of the exchange rate pass-through literature, *i.e.*, that the increase in the prices of tradable goods is higher than the prices of nontradable goods after a devaluation[Burstein and Gopinath, 2015]. The second is that household consumption pattern in Brazil follows the pattern predicted by the Engel's Law.

Figure 2 presents price indices normalized to 1 in April 2002, the month before the depreciation. It shows that prices at the dock tracked closely the exchange rate movement in the period, while prices of tradable goods increased by a greater extent than prices of nontradables. In fact, the exchange rate shock created a gap between the price levels of tradable and nontradable goods that started three months after the depreciation and was sustained afterward. It is also important to highlight that this result does not depend on the choice of the consumer price index. Both IPCA and IPC-FIPE showed the same pattern of relative price changes and are also numeric similar, giving us more confidence that the results for the City of São Paulo may be representative of what happened for the country as a whole when computing the *Within* effect.

Figure 2 plots expenditure shares in tradable and nontradable goods by income decile for Brazil[9]. The consumption pattern observed in the figure is clear: the higher the household level of income, the smaller its expenditure share in tradables and the higher its expenditure share in nontradables as expected by the Engel's Law[10].

In summary, the evidence presented in this section suggest that the relative price movements

[9] To classify goods in the consumer expenditure survey as tradable and nontradable, we used the Brazilian Central Bank classification which was made available by Martinez [2014]. Unfortunately, we do not have a similar classification for the consumer expenditure survey of the City of São Paulo.

[10] Hoffmann [2007] presents a more formal statistical analysis of the validity of the Engel's Law in Brazil using data from POF 2002-2003.

after the 2002 depreciation and the households pattern of consumption may have produced important heterogeneity in the cost of living of Brazilian households. The next section corroborates this suggestion and presents empirical estimates for the distributional effects of this devaluation episode by computing the *Across* effect at the level of the country and the *Across*, *Within* and *Combined* effect for the City of São Paulo.

4 Empirical Results

4.1 The Across Effect

Table 1 reports the *Across* price indices, computed as in equation (7), one and two years after the 2002 depreciation for each decile of income. In panel A, the price index is computed at 1 digit, *i.e* nine groups of the IPCA and seven groups of the IPC-FIPE. Panel B reports results computed at 7 digits, *i.e.* 512 subitems of the IPCA and 463 subitems of the IPC-FIPE. In both cases, the results show that there is important heterogeneity in the changes in price level across the distribution of income.

The *Across* price index for Brazil at the 1 digit level changed by 25 percent for households at the first decile compared to the 22 percent for households in the 10th decile. This difference is more striking at 7 digits, when households at the top decile observed an increase in the across price index of 21 percent, while the change was 32 percent for households at the bottom.

The results are qualitatively the same for the City of São Paulo. Even though numerically they are slightly smaller, this was expected as overall inflation was smaller in the City of São Paulo as shown in the column where the actual figures of the IPCA and IPC-FIPE are reported. In the City of São Paulo, the difference in price changes between the first and tenth deciles are 3 percentage points.

Figure 3 presents the evolution of these price indices during the two-year window after and six months before the devaluation. It shows that the gaps in price changes among deciles started three months after the initial shock. More important, the figure shows no differential pre-trends among deciles suggesting that the inflation inequality was indeed driven by the large devaluation.

Figure 4 presents the results when the index is computed at the household level using the lower level of aggregation of the consumer price indices. Similarly to the decile results, the figure shows a negative relationship between household income and the *Across* price index.

Appendix E presents two robustness exercise for the *Across* price index. First, we calculate the *Across* price index by each of the nine metropolitan regions for which IBGE calculates specific consumer price indices. As we can see in table E.1, in all regions the poor households experience a much larger increase in inflation after a large devaluation of the exchange rate. Second, we calculate the *Across* price index using end-of-periods weights to assess if the results change due to differential ability to substitute consumption across categories between poor and rich households. Unfortunately, the next available consumer expenditure survey was only in 2008-2009, a long time after the devaluation. Therefore, results reported in table E.2 should be taken with some caution, but they also show that households in the lower end of the income distribution experienced a much higher rate of inflation following the devaluation than the households in the top.

4.2 The Within Effect

We cannot calculate the *Within* price index for the Brazilian economy because the price quotes used to construct the IPCA are not available. In this section, we use the City of São Paulo as a study case for the *Within* effect. Even though we observe price quotes of each variety in the IPC-FIPE, wedo not have information on household spending by varieties. For this reason, wecalculate price indices for high and low-priced varieties and assume, following the evidence presented in

Cravino and Levchenko [2017] and in Appendix D, that high-priced varieties are consumed by rich households (in 10th decile of the income distribution) while low-priced ones are consumed by poor households (in the 1st decile). Two criteria are used to classify varieties as high or low-priced: first, they are classified as high(low)-priced varieties when their average price in the 12 months before the devaluation is above(below) the median average price of the category; second, they are classified as high(low)-priced varieties when their average price in the 12 months before the devaluation is in the fourth (first) quartile of the distribution of average prices of the category.

As mentioned in section 2, we cannot observe the price quotes of some individual goods continuously over time. This is the case for 201 product categories. For the other 325, we can observe at least two varieties continuously over time and these categories represent 66 percent of the IPC-FIPE.Due to the missing categories, we compute the *Within* price index representative of the whole City of São Paulo using the conservative and liberal versions of the *Within* price index as described in equations (11) and (12), respectively. To recap: in the conservative version we assume that the relative price of the cheap versus expensive varieties remained constant, while in the liberal version we assume that the relative price of the cheap versus expensive varieties was equal to the weighted average price change of the observed categories.

Figure 5 plots the evolution of the *Within* price indices using the two criteria to define high and low-priced varieties. As in the case of the *Across* price index, the figure shows no pre-trends before the devaluation and the price indices start to diverge after the shock. Table 2 reports the results of the price indices one and two years after the devaluation. As we can see, using the median criteria to sort varieties into high and low priced, the price index of low-priced varieties is about 2 to 5 percentage points higher than the price index of high-priced varieties depending on whether we use the conservative of liberal version. Using the quartile definition, we estimate a price difference ranging from 3 to 8 percentage points.

As a robustness exercise, Appendix F reports results for the *Within* effect calculated using a more restrictive definition of individual products to be considered for inclusion in the set of observed categories. In this case, only products whose prices are quoted in a specific measurement unit (like kg or grams) are included in this set. Even though this is a more restrictive criteria, leading to a coverage of 35 percent of the overall CPI, it has the advantage of excluding categories for which prices are quoted using a "sample" of the product that is available when prices are collected. As we can see in the appendix, the results do not change qualitatively, but the estimated price differences between high and low-priced varieties are slightly higher.

4.3 The Combined Effect

This section presents results for the price index that combines both the *Across* and *Within* effects. Due to the categories with missing varieties, we use the same hypothesis to calculate the conservative and liberal version of the price index. The combined price index is given by equation (3) where the spending weights and price index vary by household. we report the results for representatives low-income and high-income households where the former has across-good expenditure shares of a household in the first income decile, while the latter has across-good expenditure shares of a household in the tenth decile. As in the case of the *Wihtin* price index, we assume that households at the bottom consume low-priced varieties and that households at the top consume high-priced varieties.

Figure 6 presents the evolution of the *Combined* price index using the median and quartile criteria to define low and high-priced varieties. The figure shows that the price index of poor households diverge from the the price index of rich households after the devaluation. Again, we cannot identify any pre-trends in the year before the devaluation as the price index of poor and rich households were very close to each other.

Table 3 reports the difference in inflation one and two years after the devaluation. For households at the bottom of the income distribution, we estimate that inflation two years after the devaluation ranged from 28 to 32 percent.For households at the top, inflation in the same period ranged from nearly 20 to 19 percent. Using the more conservative assumptions — conservative version of the price index and varieties split into categories according to the median — inflation two years after the devaluation was 8 percentage points higher for poor households. Using the more liberal assumptions — liberal version of the price index and varieties split into categories according to first and fourth quartiles — the same difference in inflation was 13 percentage points.

Similarly to the case of the *Within* price index, Appendix F presents results of using a more restrictive definition of individual products. Again, the results reported in Table F.2 and Figure F.2 do not change qualitatively and the price differences two years after the devaluation is higher for households at the bottom compared to households at the top.

5 Benchmark, mechanism and confounding factors

To place our results in context, it is interesting to compare them with the findings in Cravino and Levchenko [2017]. Similarly to their study for Mexico, we find that households in the lower end of the income distribution faced higher rates of inflation in the aftermath of the depreciation. Moreover, the more disaggregated the price information used to compute the price indices, the larger the price change differences between households at different points of the income distribution.

Quantitatively, even though the size of the initial devaluation and the overall pass-through was larger in Mexico, the distributional consequences of the devaluation were stronger in Brazil. Cravino and Levchenko [2017, pp. 11] estimate that the change in the across price index was 1.25 times higher for households at the bottom of the income distribution than at the top in the 1994 Mexican devaluation episode. Restricting the analysis to Mexico City, they find that this price change was 1.17 times higher for the first decile. we estimate this difference to be 1.52 and 1.18 for Brazil and City of São Paulo, respectively. For the within price index, Cravino and Levchenko [2017] estimate that the price change was 1.1 to 1.28 times higher for households in the bottom of the income distribution using, respectively, the most conservative and the most liberal assumptions. For the combined effect, these figures were 1.28 and 1.45. For the City of São Paulo, we find that these price differences were 1.11 to 1.4 (conservative to liberal) for the within price index and 1.39 to 1.67 (conservative to liberal) for the combined price index .

Compared to Mexico, two things seem to drive the fact that the distributional impacts are larger in Brazil even with a smaller overall exchange rate pass-through. First, both consumer price indices used in my study are more disaggregated (have more items) than the Mexican CPI. Second, and maybe even more important, income is significantly more concentrated in Brazil leading to larger differences in consumption expenditure shares between poor and rich households. While in the 1994 large devaluation episode in Mexico the 90-10 ratio was 23 and 20 for Mexico and the Mexico City, Table C.1 shows that these figures were 41 for Brazil and 31 for the City of São Paulo in the 2002 Brazilian episode.

Throughout this paper, we have interpreted the inflation inequality in the two years after the 2002 devaluation as a consequence of the devaluation itself. The reason for that, besides the exogeneity of the devaluation discussed in the introduction, is that the mechanism leading to these effects are well understood in the literature of international prices. As shown theoretically and with time series data by Burstein et al. [2005] and with disaggregated data by Cravino and Levchenko [2017], the fact that there is no complete pass-through after the devaluation and that we observe heterogeneous price changes across goods can be explained by heterogeneity in the weight of distribution of costs — *i.e* costs of retail services, marketing, advertising and distribution services — and local goods in retail prices (see Appendix A for details).

However, even though there is evidence on this specific mechanism, one possible objection to our results is that they might be driven by other confounding factors and not the 2002 large devaluation of the Brazilian Real. Although we cannot provide more rigorous tests on this issue, some observations and the timeline of events suggest that other likely explanations do not seem to drive the results. First, our study case of the City of São Paulo and the regional results of IPCA in Appendix E suggest that the inflation inequality we observe does not stem from any type of regional shock, *e.g.* state/municipal fiscal policy or local decisions about regulated prices like public transportation. Second, the timeline of the major events and the effects we find do not suggest that other possible confounders at the national level, which may have affected deferentially the demand for tradables/nontradables and low-priced/high-priced varieties, are driving the results either. For example, the heterogeneous effects on inflation already show up in 2002, when the transition in the federal government had not happened yet. In its turn, the first year of Lula's presidency was very conservative on the macroeconomic front, with high interest rates and with the government delivering a fiscal primary surplus higher than the target. Even though the minimum wage has increased 20% in nominal terms, the increase happened in April 1st of 2003. At that point, only due to the *Across* effect, the inflation faced by the first decile was already 10 percentage points higher for the average household in the first decile compared to the average household in the tenth decile as shown in Table 1. Moreover, social expenditures targeting the poor (Bolsa Familia) started growing especially fast only after 2003 when sharp increases in commodity prices created more fiscal space[Campello, 2016].

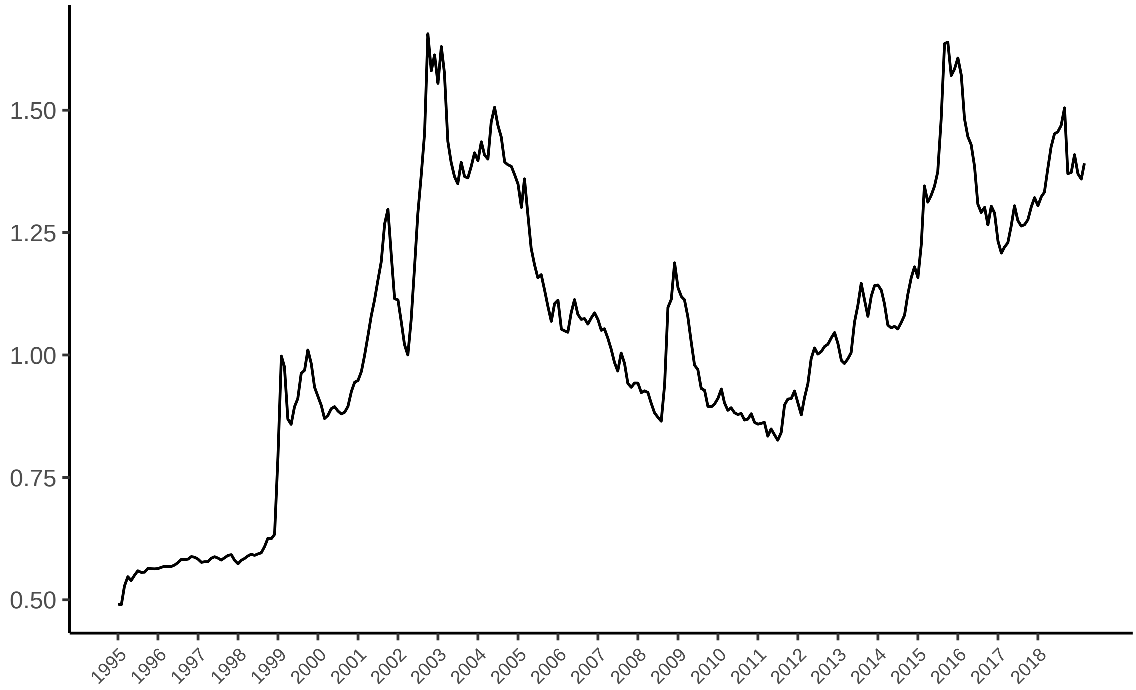
6 Concluding Remarks

This paper has studied the distributional consequences of the 2002 Brazilian large exchange rate shock. The difference in the changes of households cost of living documented in this paper is driven by the relative price changes brought about by the devaluation and differences in consumption pattern among households across different points of the income distribution. Following the methodology first adopted in Cravino and Levchenko [2017], we show that the inflation rate for the average Brazilian households at the bottom decile of the income distribution was 11 percentage points higher than for the average household at the top decile two years after the 2002 devaluation due to the *Across* effect. For the City of São Paulo, this difference was equal to 3 percentage points. My study case of the City of São Paulo also points to important distributional impacts along the *Within* effect dimension with differences in inflation in the range of 2 and 5 percentage points. The *Combined* effect for the City of São Paulo ranges from 8 to 11 percentage points.

Even though the analysis is silent in terms of the evolution of nominal income, it allows us to draw some inference in terms of inequality of real incomes. Given our most conservative estimate for the City of São Paulo, the results imply that the nominal income in the first decile must have increased at least 1.39 times more than the income of the tenth decile just to keep the relative position of the first decile if we consider real income measures. Using only the *Across* effect, we find that this increase would have to be at least 1.52 time higher for an average Brazilian household in the bottom of the income distribution. How the devaluation affected nominal income via the employment and compensation channels requires future research.

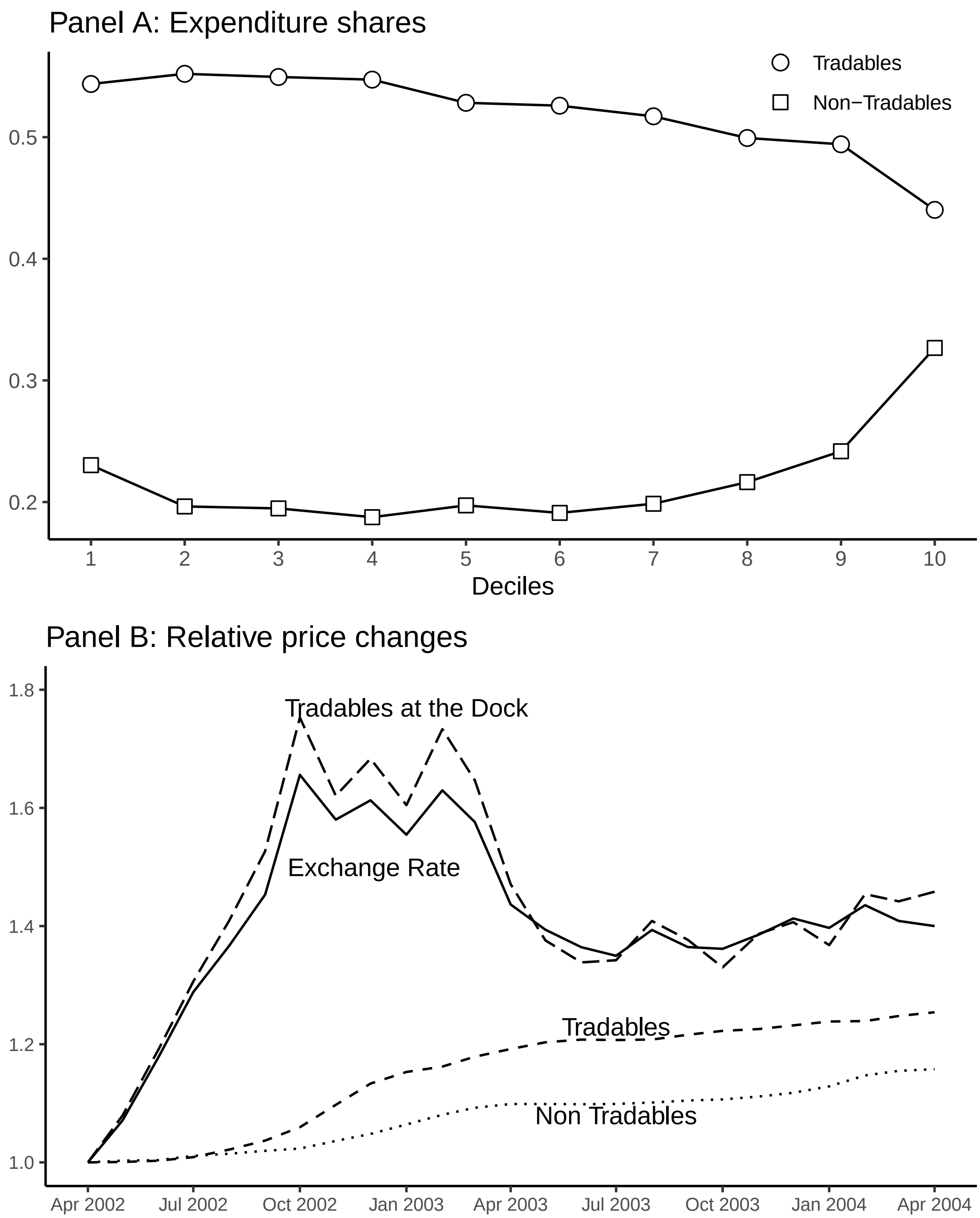
Figures and Tables

Figure 1: Trade-weighted Nominal Exchange Rate (Apr 2002=1)



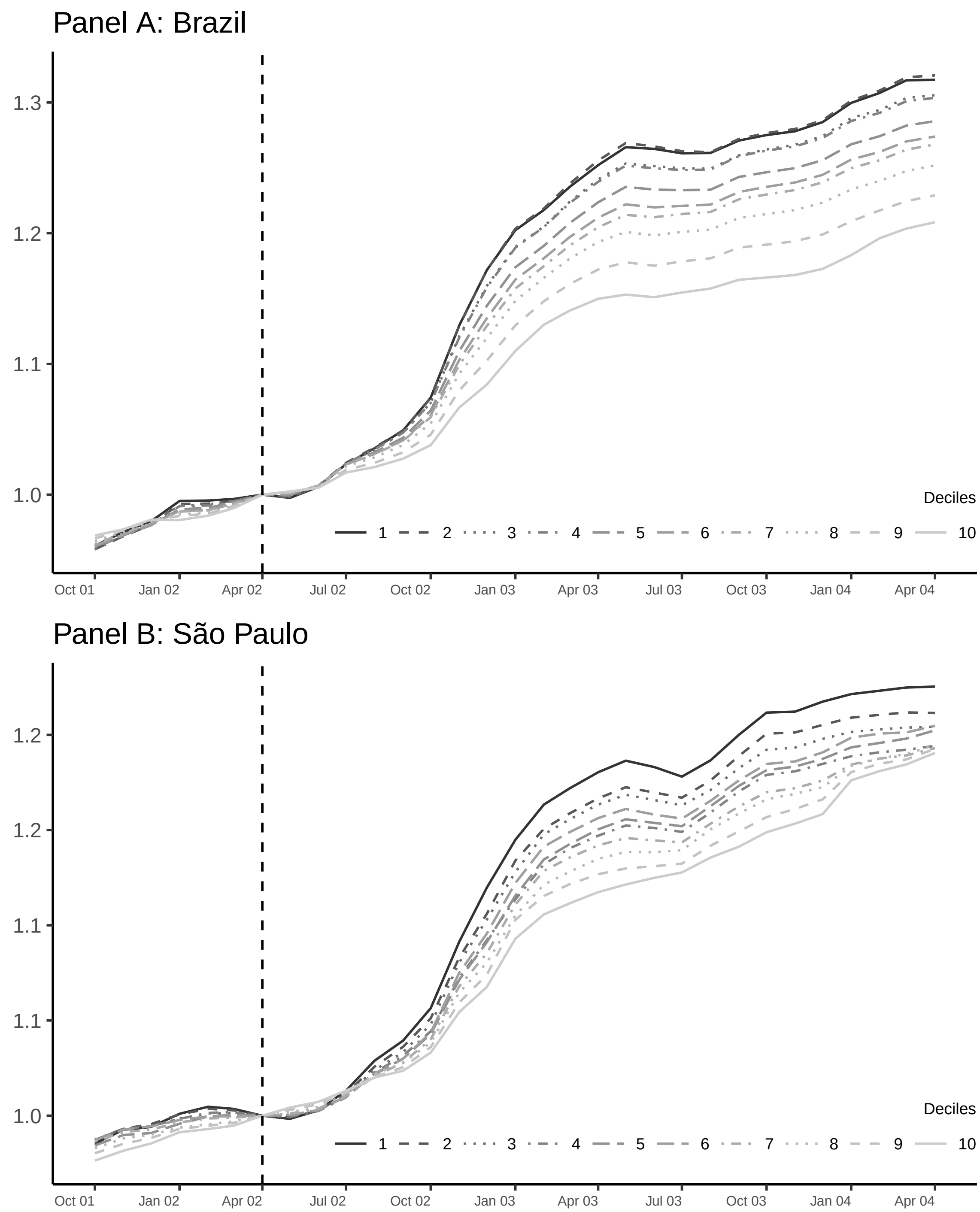
Source: BIS

Figure 2: Expenditure shares by income decile



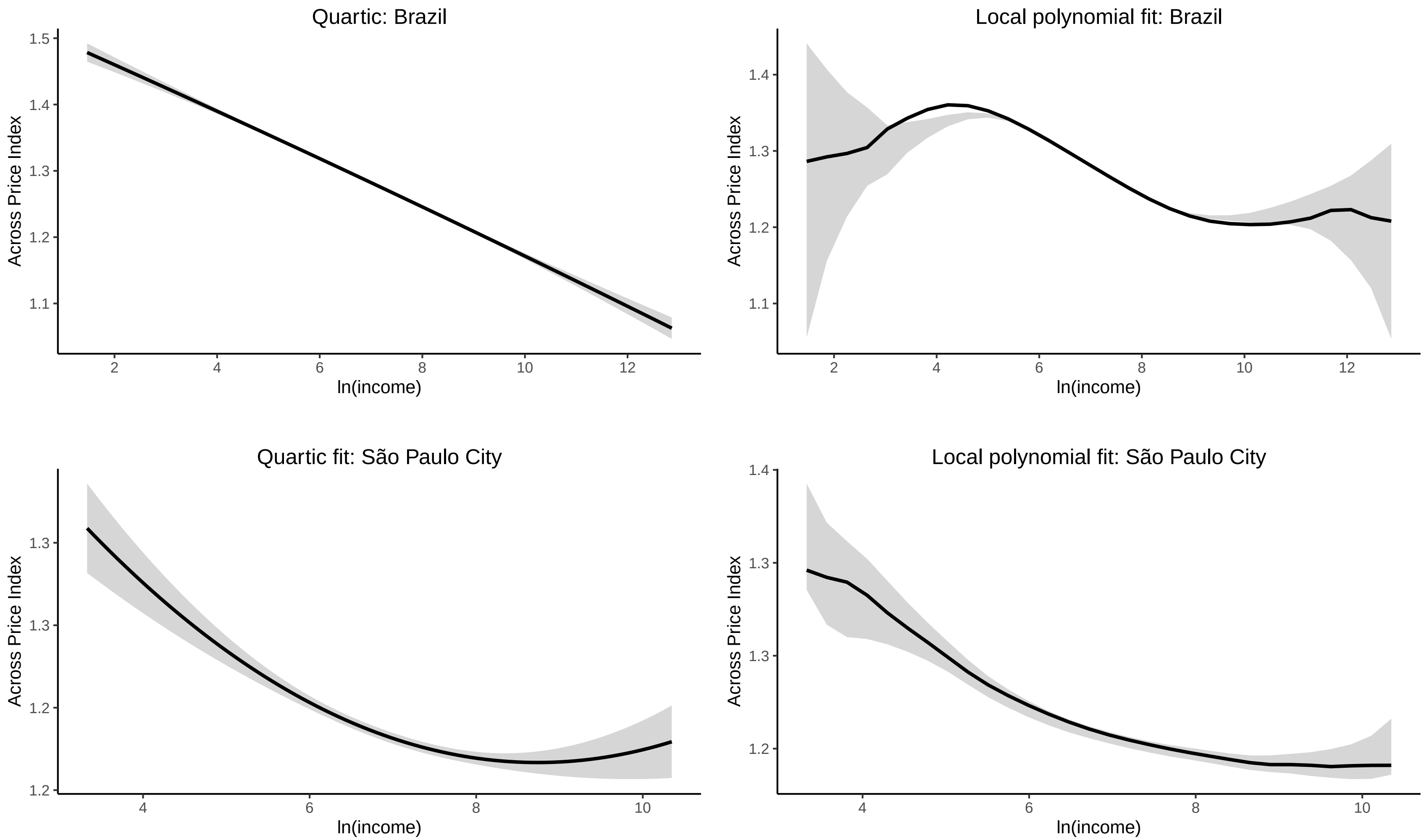
Notes: Expenditure shares of tradables and non-tradables are from POF 2002. Trade-weighted nominal exchange rate is from the BIS, price of tradables at the dock is the Import Price Index from FUNCEX, price of tradables and nontradables are from IBGE.All indices are normalized to 1 in April 2002, the month before the devaluation. Source: Author's calculation.

Figure 3: The evolution of the across price indices by income decile



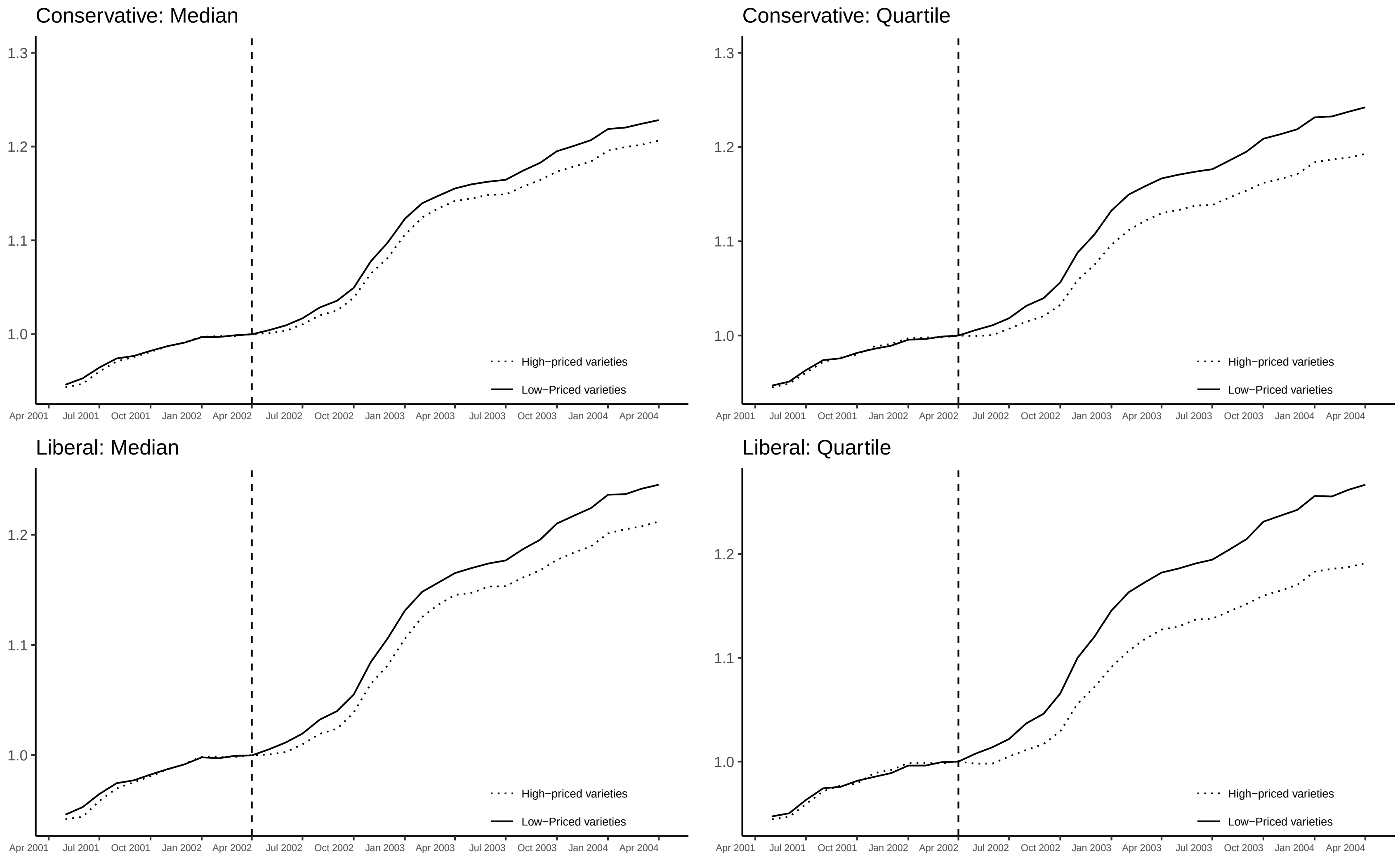
Notes: The across price indices are computed as a weighted average of economy-wide price indexes for each 512 product categories (P_g) and household expenditure shares by income decile (ω_g^h): $\hat{P}_{Across,t} \equiv \sum_{g \in G} \omega_g^h \hat{P}_{g,t}$. The vertical line marks the start of the devaluation episode.

Figure 4: The across price index at the household level



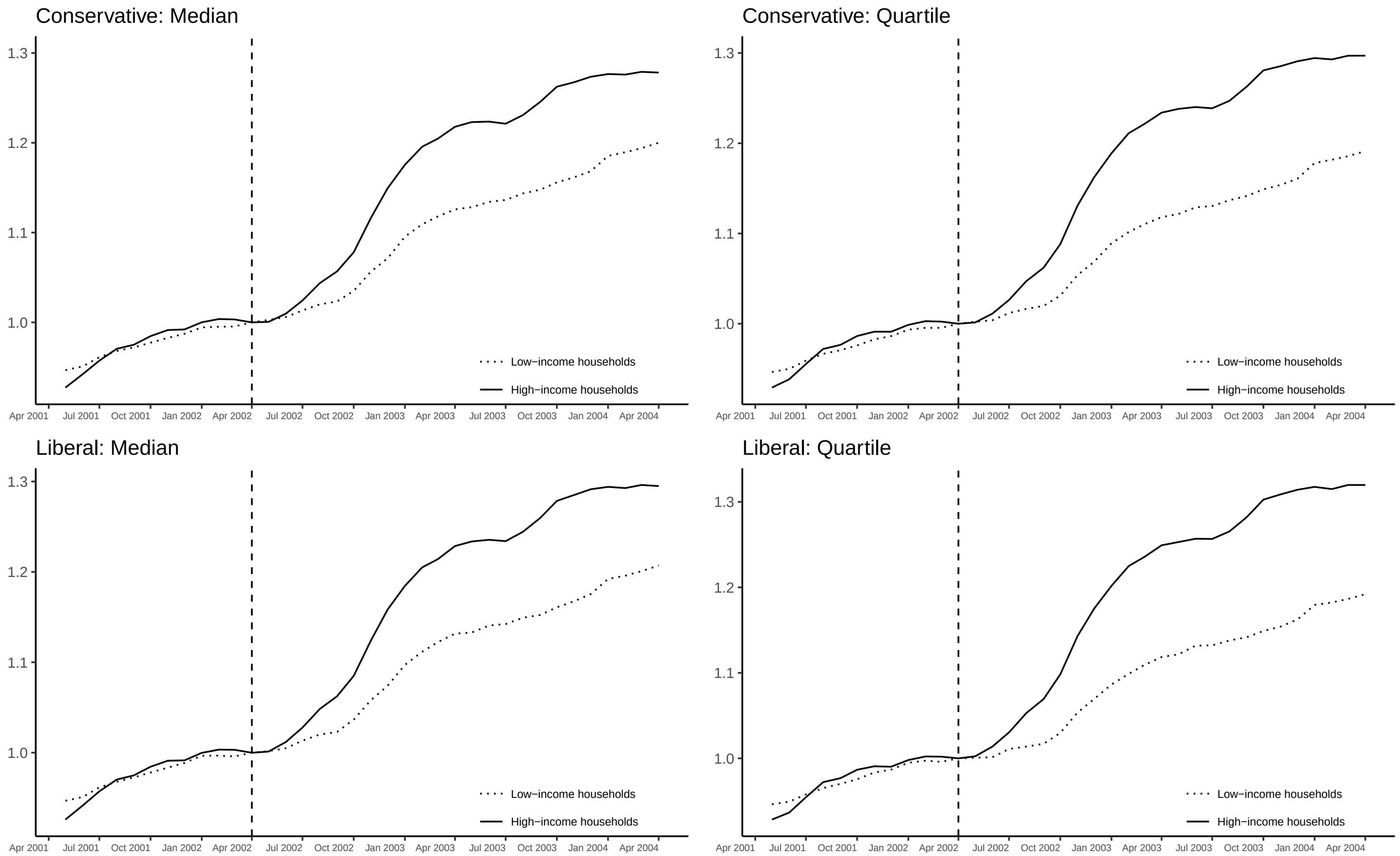
Note: The household-specific across price index is computed as a weighted average of economy-wide price indexes for each product category (P_g) and household-specific expenditure shares(ω_g^h): $\hat{P^h}_{Across,t} \equiv \sum_{g \in G} \omega_g^h \hat{P}_{g,t}$. The household-specific across price index is computed using IPC data at 7-digits (512 subitems).

Figure 5: Within price indices



Note: The household-specific whithin price index is computed as a weighted average of economy-wide expenditure shares (ω_g) and household-specific price indexes for each product category (P_g^h): $\hat{P}_{Within,t} \equiv \sum_{g \in G} \omega_g \hat{P}_{g,t}^h$

Figure 6: Combined price indices



Note: The household-specific whithin price index is computed as a weighted average of economy-wide expenditure shares (ω_g) and household-specific price indexes for each product category (P_g^h): $\hat{P}_{Within,t} \equiv \sum_{g \in G} \omega_g \hat{P}_{g,t}^h$

Table 1: The Across price indices by income decile

	Deciles												
	1	2	3	4	5	6	7	8	9	10	Aggregate	Actual CPI	1st/10th ratio
Panel A: group level													
Brazil													
2002-04-01	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	
2003-04-01	1.184	1.185	1.182	1.181	1.178	1.176	1.174	1.172	1.169	1.161	1.169	1.168	1.144
2004-04-01	1.245	1.244	1.243	1.243	1.239	1.237	1.235	1.232	1.227	1.220	1.228	1.229	1.118
City of São Paulo													
2002-04-01	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	
2003-04-01	1.153	1.148	1.150	1.143	1.148	1.148	1.144	1.141	1.138	1.136	1.141	1.145	1.123
2004-04-01	1.197	1.193	1.194	1.190	1.193	1.194	1.191	1.191	1.190	1.190	1.191	1.192	1.034
Panel B: subitem level													
Brazil													
2002-04-01	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	
2003-04-01	1.252	1.256	1.241	1.239	1.224	1.212	1.205	1.193	1.172	1.150	1.182	1.168	1.682
2004-04-01	1.317	1.321	1.306	1.304	1.286	1.274	1.268	1.252	1.229	1.208	1.242	1.229	1.523
City of São Paulo													
2002-04-01	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	
2003-04-01	1.180	1.167	1.163	1.147	1.150	1.156	1.142	1.135	1.127	1.117	1.135	1.145	1.536
2004-04-01	1.225	1.211	1.204	1.194	1.202	1.205	1.193	1.195	1.193	1.190	1.196	1.192	1.183

Notes: Column Aggregate refers to the across price index using economy-wide weights. Column CPI reports the actual figures from IPCA-IBGE and IPC-FIPE. Column 1st/10th ratio refers to the accumulated inflation ratio between households in the first (poor) and tenth (rich) deciles. The household-specific across price index is computed as a weighted average of economy-wide price indexes for each product category (P_g) and household-specific expenditure shares(ω_g^h): $\hat{P^h}_{Across,t} \equiv \sum_{g \in G} \omega_g^h \hat{P}_{g,t}$. The household-specific across price index is computed using IPC data at 7-digits (512 subitems). Source: Author's calculation.

Table 2: The Within price indices by income decile

	Conservative				Liberal			
	Below Median	Above Median	Quartile 1	Quartile 4	Below Median	Above Median	Quartile 1	Quartile 4
2002-04-01	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
2003-04-01	1.155	1.142	1.167	1.130	1.165	1.145	1.182	1.127
2004-04-01	1.228	1.206	1.242	1.193	1.245	1.212	1.267	1.191

Note: The household-specific whithin price index is computed as a weighted average of economy-wide expenditure shares (ω_g) and household-specific price indexes for each product category (P_g^h): $\hat{P}_{Within,t} \equiv \sum_{g \in G} \omega_g \hat{P}_{g,t}^h$

Table 3: The Combined price indices

	Conservative				Liberal			
	Below Median	Above Median	Quartile 1	Quartile 4	Below Median	Above Median	Quartile 1	Quartile 4
2002-04-01	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
2003-04-01	1.218	1.126	1.234	1.118	1.229	1.132	1.249	1.119
2004-04-01	1.278	1.200	1.297	1.191	1.295	1.207	1.320	1.192

Note: The household-specific whithin price index is computed as a weighted average of economy-wide expenditure shares (ω_g) and household-specific price indexes for each product category (P_g^h): $\hat{P}_{Within,t} \equiv \sum_{g \in G} \omega_g \hat{P}_{g,t}^h$

Online Appendices

A Pricing Framework

In this section, I present a simple pricing framework to help us understand the main sources of heterogeneity in pass-through for consumer prices across different product categories. I focus on presenting reduced-form pricing equations, even though they can be derived from structural models.[11] Moreover, this simple framework is in partial equilibrium in the sense that wages, employment and the exchange rate are taken as given.

Let us assume there are three sectors in the economy: tradable (T), non-tradable (N) and retail (R) sectors. The tradable sector uses imported and local inputs in a constant returns to scale technology, where α is the share of imported inputs used in production. Retailers, in turn, combine tradable goods and distribution services (D) – a non-tradable good – to sell goods to consumers. Both sectors produce differentiated products and operate under monopolistic competition, charging a markup over marginal costs. The non-tradable sector produces a homogenous good.[12]

As discussed before and presented in figure 2 for the case of Brazil, prices at the dock track closely the nominal exchange rate. Then, according to the LOP, prices of imported goods are given by:

$$P^I = E \tag{13}$$

where the price of the foreign good was normalized to 1 and E is the nominal exchange rate (local currency/foreign currency).

Since firms at the tradable sector combine imported and local inputs, prices of tradable goods

[11] For a review of these models, see Burstein and Gopinath [2015]

[12] To avoid clutter, I do not use an index for each product in the following equations, but we should keep in mind that each equation holds for all product categories.

are given by:

$$P^T = \mu^T \left(E^\alpha P^{L^{(1-\alpha)}} \right) \tag{14}$$

where P^T is the price of tradable goods, P^L is the price of local inputs, μ^T is the markup of the tradable producer and α is the share of imported goods in production.

To sell goods to consumers, the retail sector combines tradable goods with distribution services, which is a non-tradable good. Since the non-tradable good is assumed to be homogeneous, $P^D = P^N$ and the retail price is given by:

$$P^R = \mu^R \left(P^{T^\theta} P^{N^{(1-\theta)}} \right) \tag{15}$$

where $1 - \theta$ is the share of distribution services on tradable prices and μ^R is the markup of the retail sector. Plugging in (14) into (15) and log-differentiating, we get:

$$\hat{P}^R = \hat{\mu}^R + \theta\hat{\mu}^T + \theta\alpha\hat{E} + \theta(1-\alpha)\hat{P}^L + (1-\theta)\hat{P^N} \tag{16}$$

Equation (16) highlights the potential mechanisms that make exchange rate pass-through different across across products: retail markups $\hat{\mu}^R$, the share of distribution services in retail prices θ, tradable producer markups $\hat{\mu}^T$ and the share of imported inputs in tradable production α.[13]

If markups ($\hat{\mu}^T$ and $\hat{\mu}^R$) respond to the exchange rate shocks differently across products, the price changes following a devaluation will also vary across product categories. In this case, inflation will be higher for products whose markup rates increase by a greater extent. This mechanism is hard to assess empirically given that data on markup rates at the product level is hard to obtain, but Gopinath et al. [2011] were able to assess how retailers markup respond to the exchange rate.

[13] I assumed throughout that the prices of local inputs are not affected by the nominal exchange rate.

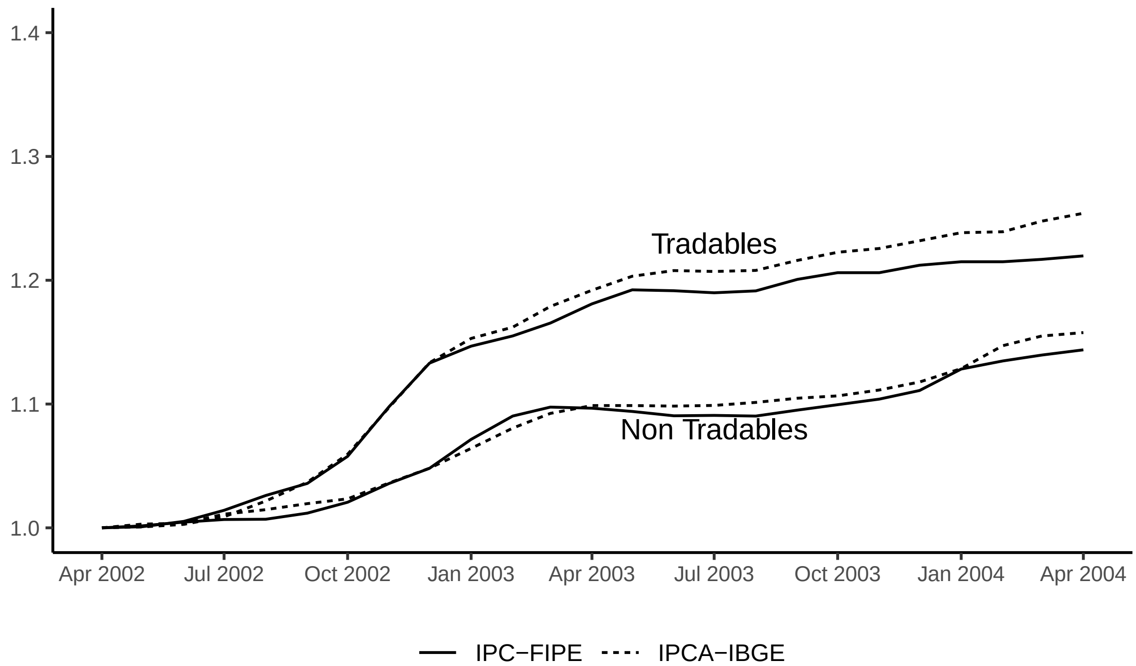
Using a unique data set on prices and wholesale costs from a large retail chain that operates in the United States and Canada, the authors decompose the variation in cross-border retail prices into relative costs and markup components. They show that "almost all of the variation in relative retail prices, in response to exchange rate shocks, is explained by variation in relative costs (net or wholesale) and not by variation in relative markups"[Gopinath et al., 2011, p. 2461]. Therefore, this channel seems less relevant and we can simplify by assuming $\hat{\mu}^R = 0$ for all products.

The role of distribution services in explaining incomplete pass-through to consumer prices was already discussed in the previous section[Burstein et al., 2003, 2007, Burstein and Gopinath, 2015]. Here, the intuition is the same, but with a focus on comparing different products. Since distribution services are non-tradables and the relative price of tradable to non-tradables (then $\hat{P^T} > \hat{P^N}$) increases after a devaluation, products with a smaller share of distribution services $(1-\theta)$ will have a higher inflation rate after the devaluation.

Finally, the import content of each product also affects pass-through to consumer prices. Since the law of one price seems to hold for prices at the dock, local prices of imported goods adjust completely to the exchange rate shock. Therefore, the higher the share of imported goods in a product category (α) the higher its price change after the devaluation.

B IPCA-IBGE *vs* IPC-Fipe

Figure B.1: Comparison between the evolution of IPCA and IPC-Fipe after the devaluation shock



Notes: Price of tradables and nontradables from IPCA and IPC-Fipe. All indices are normalized to 1 in April 2002, the month before the devaluation. Source: Author's calculation using CPI data from IBGE and FIPE.

C Descriptive Statistics

Table C.1: Average Income and expenditure shares across broad consumption categories

	Deciles									
	1	2	3	4	5	6	7	8	9	10
Brazil: IBGE Data										
Average Income	184.83	321.13	436.90	558.93	700.37	886.18	1152.27	1579.58	2441.03	7507.11
Food and Beverages	0.40	0.39	0.37	0.36	0.32	0.30	0.28	0.25	0.20	0.14
Housing	0.22	0.20	0.19	0.18	0.19	0.17	0.16	0.15	0.13	0.10
Household Fur. and App.	0.08	0.07	0.08	0.08	0.07	0.08	0.07	0.07	0.06	0.05
Aparel	0.07	0.08	0.08	0.08	0.08	0.09	0.09	0.09	0.08	0.07
Transportation	0.08	0.10	0.10	0.10	0.14	0.16	0.18	0.21	0.27	0.32
Health	0.08	0.08	0.09	0.09	0.09	0.09	0.09	0.09	0.08	0.08
Individual Expenses	0.04	0.04	0.04	0.05	0.05	0.06	0.06	0.07	0.08	0.11
Education	0.01	0.01	0.01	0.01	0.02	0.02	0.03	0.03	0.05	0.09
Communication	0.02	0.02	0.03	0.03	0.04	0.04	0.05	0.05	0.05	0.04
City of São Paulo: FIPE Data										
Average Income	338.92	668.54	939.61	1200.94	1502.64	1878.76	2427.72	3313.69	4842.16	10421.00
Food and Beverages	0.30	0.26	0.26	0.21	0.21	0.22	0.18	0.16	0.13	0.12
Housing	0.35	0.38	0.36	0.40	0.33	0.31	0.34	0.32	0.32	0.30
Aparel	0.04	0.04	0.04	0.04	0.04	0.05	0.04	0.04	0.04	0.05
Transportation	0.10	0.13	0.15	0.15	0.21	0.19	0.20	0.20	0.22	0.21
Health	0.06	0.05	0.05	0.08	0.07	0.07	0.07	0.10	0.10	0.11
Individual Expenses	0.14	0.13	0.12	0.11	0.11	0.13	0.11	0.11	0.11	0.12
Education	0.00	0.00	0.01	0.01	0.03	0.04	0.04	0.06	0.07	0.10

Note: Panel A shows monthly average income and expenditure shares across the deciles of income distribution using data from IBGE, while Panel B shows the same information using data from FIPE. Monetary values are in Reais of January, 2003. Source: Author's calculation using data from Consumer Expenditure Surveys (POF/IBGE 2002-2003 and POF/FIPE 1998-1999).

D Unit value by income in the City of São Paulo

In the consumer expenditure survey from FIPE (POF 1998-1999), I can observe unit value paid by households for each good. Using these unit prices, I estimate the following model:

$$\ln u_g^h = c + \sum_{g \in G} \alpha_g + \sum_{j=2}^{10} \beta_j I[h \in Dec(j)] + e_g^h \tag{17}$$

where u_g^h is the unit value paid by household h for a good $g \in G$, $I[h \in Dec(j)]$ is an indicator if household h belongs to in income decile j, α_g's are IPC subitem dummies to control for specific characteristics of each product and e_g^h is the residual term.

The results reported in table D.1 show that the higher the household income the higher the price paid for goods within a product category as the decile dummies become increasingly positive and significant for higher deciles. Comparing the top and bottom deciles, the richest households in São Paulo paid on average 0.34 log points higher prices than the poorest households.

Table D.1: Unit value by income in the City of São Paulo

Deciles	Estimate
decile2	0.0153
	(0.013)
decile3	0.0173
	(0.020)
decile4	0.0633
	(0.011)
decile5	0.0683
	(0.011)
decile6	0.0653
	(0.015)
decile7	0.113
	(0.013)
decile8	0.1433
	(0.015)
decile9	0.2193
	(0.019)
decile10	0.3383
	(0.025)
N	216902
Adj.R2	0.78

Notes: Robust standard errors in parentheses.The specification includes product fixed effects. Source: Author's calculation using data from Consumer Expenditure Survey of the City of São Paulo(POF/FIPE 1998-1999)

E Robustness: Across Price Index

Table E.1: The Across price indices by region

	Deciles											
	1	2	3	4	5	6	7	8	9	10	CPI	1st/10th ratio
Bahia												
2002-04-01	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	
2003-04-01	1.243	1.231	1.248	1.228	1.199	1.211	1.198	1.192	1.171	1.139	1.185	1.752
2004-01-01	1.307	1.302	1.317	1.306	1.265	1.285	1.269	1.250	1.220	1.178	1.241	1.727
Ceará												
2002-04-01	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	
2003-04-01	1.260	1.247	1.239	1.219	1.226	1.213	1.199	1.196	1.160	1.150	1.188	1.730
2004-01-01	1.305	1.308	1.297	1.280	1.287	1.274	1.260	1.254	1.222	1.194	1.241	1.573
Minas Gerais												
2002-04-01	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	
2003-04-01	1.234	1.201	1.200	1.207	1.200	1.188	1.189	1.169	1.163	1.123	1.161	1.893
2004-01-01	1.295	1.257	1.258	1.241	1.247	1.240	1.237	1.210	1.205	1.160	1.218	1.848
Pará												
2002-04-01	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	
2003-04-01	1.235	1.219	1.221	1.203	1.208	1.195	1.185	1.184	1.157	1.153	1.174	1.531
2004-01-01	1.292	1.280	1.278	1.259	1.271	1.250	1.253	1.250	1.217	1.207	1.240	1.408
Pernambuco												
2002-04-01	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	
2003-04-01	1.223	1.229	1.216	1.216	1.185	1.198	1.182	1.183	1.164	1.137	1.176	1.622
2004-01-01	1.272	1.281	1.265	1.260	1.249	1.263	1.237	1.237	1.225	1.192	1.231	1.414
Paraná												
2002-04-01	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	
2003-04-01	1.200	1.190	1.189	1.172	1.198	1.164	1.164	1.154	1.156	1.141	1.160	1.421
2004-01-01	1.241	1.224	1.221	1.203	1.223	1.190	1.188	1.173	1.175	1.164	1.193	1.467
Rio de Janeiro												
2002-04-01	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	
2003-04-01	1.219	1.230	1.207	1.214	1.212	1.210	1.189	1.173	1.171	1.159	1.175	1.376
2004-01-01	1.278	1.293	1.270	1.274	1.271	1.263	1.238	1.210	1.213	1.190	1.224	1.466
Rio Grande do Sul												
2002-04-01	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	
2003-04-01	1.234	1.197	1.216	1.185	1.206	1.187	1.166	1.172	1.155	1.165	1.171	1.424
2004-01-01	1.258	1.241	1.254	1.225	1.243	1.221	1.205	1.209	1.194	1.196	1.211	1.319
São Paulo												
2002-04-01	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	
2003-04-01	1.203	1.176	1.187	1.184	1.170	1.162	1.150	1.148	1.133	1.140	1.156	1.455
2004-01-01	1.242	1.214	1.231	1.224	1.205	1.188	1.187	1.181	1.161	1.169	1.190	1.437

Notes: Column Aggregate refers to the across price index using economy-wide weights. Column CPI reports the actual figures from IPCA-IBGE and IPC-FIPE. Column 1st/10th ratio refers to the accumulated inflation ratio between households in the first (poor) and tenth (rich) deciles. Source: Author's calculation.

Table E.2: The Across price indices by income decile using end-of-period weights

	Deciles												
	1	2	3	4	5	6	7	8	9	10	Aggregate	CPI	1st/10th ratio
Panel A: group level													
Brazil													
2002-04-01	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	
2003-04-01	1.177	1.178	1.175	1.175	1.174	1.172	1.170	1.168	1.164	1.154	1.164	1.168	1.150
2004-01-01	1.225	1.225	1.222	1.222	1.221	1.219	1.217	1.214	1.211	1.203	1.212	1.211	1.106
Panel B: subitem level													
Brazil													
2002-04-01	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	
2003-04-01	1.220	1.220	1.209	1.209	1.200	1.197	1.189	1.182	1.175	1.158	1.179	1.168	1.390
2004-01-01	1.275	1.273	1.259	1.258	1.251	1.246	1.239	1.227	1.219	1.202	1.225	1.211	1.363

Notes: Column Aggregate refers to the across price index using economy-wide weights. Column CPI reports the actual figures from IPCA-IBGE and IPC-FIPE. Column 1st/10th ratio refers to the accumulated inflation ratio between households in the first (poor) and tenth (rich) deciles. Source: Author's calculation.

F Robustness: Within and Combined Price Indices

Table F.1: The Within price indices using restricted definition of individual goods

	Conservative				Liberal			
	Below Median	Above Median	Quartile 1	Quartile 4	Below Median	Above Median	Quartile 1	Quartile 4
2002-04-01	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
2003-04-01	1.162	1.140	1.167	1.131	1.207	1.147	1.220	1.123
2004-01-01	1.219	1.191	1.224	1.181	1.278	1.201	1.291	1.175

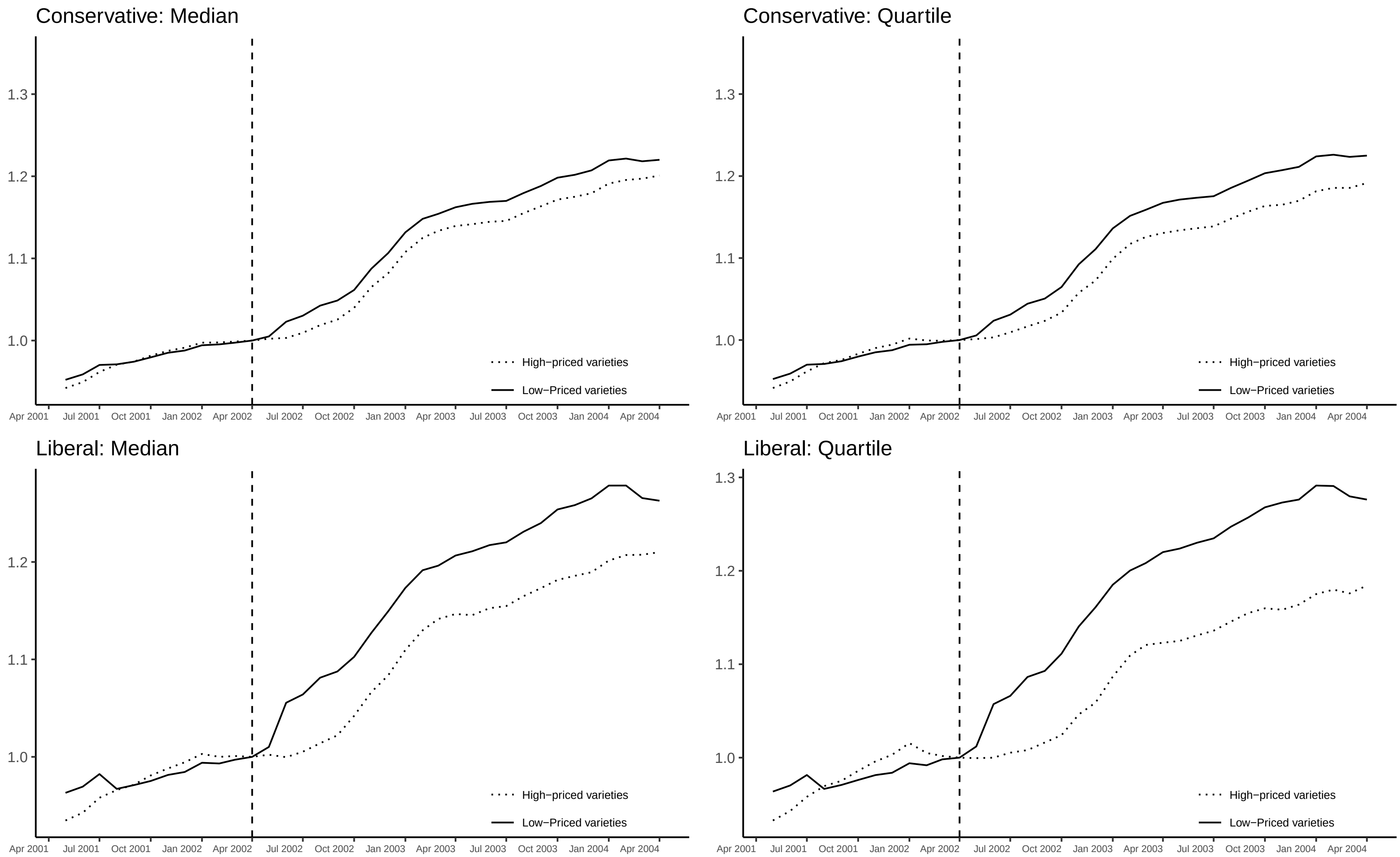
Note: The household-specific whithin price index is computed as a weighted average of economy-wide expenditure shares (ω_g) and household-specific price indexes for each product category (P_g^h): $\hat{P}_{Within,t} \equiv \sum_{g \in G} \omega_g \hat{P}^h_{g,t}$

Table F.2: The Combined price indices using restricted definition of individual goods

	Conservative				Liberal			
	Below Median	Above Median	Quartile 1	Quartile 4	Below Median	Above Median	Quartile 1	Quartile 4
2002-04-01	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
2003-04-01	1.242	1.122	1.253	1.116	1.295	1.131	1.317	1.112
2004-01-01	1.291	1.180	1.303	1.173	1.356	1.188	1.378	1.166

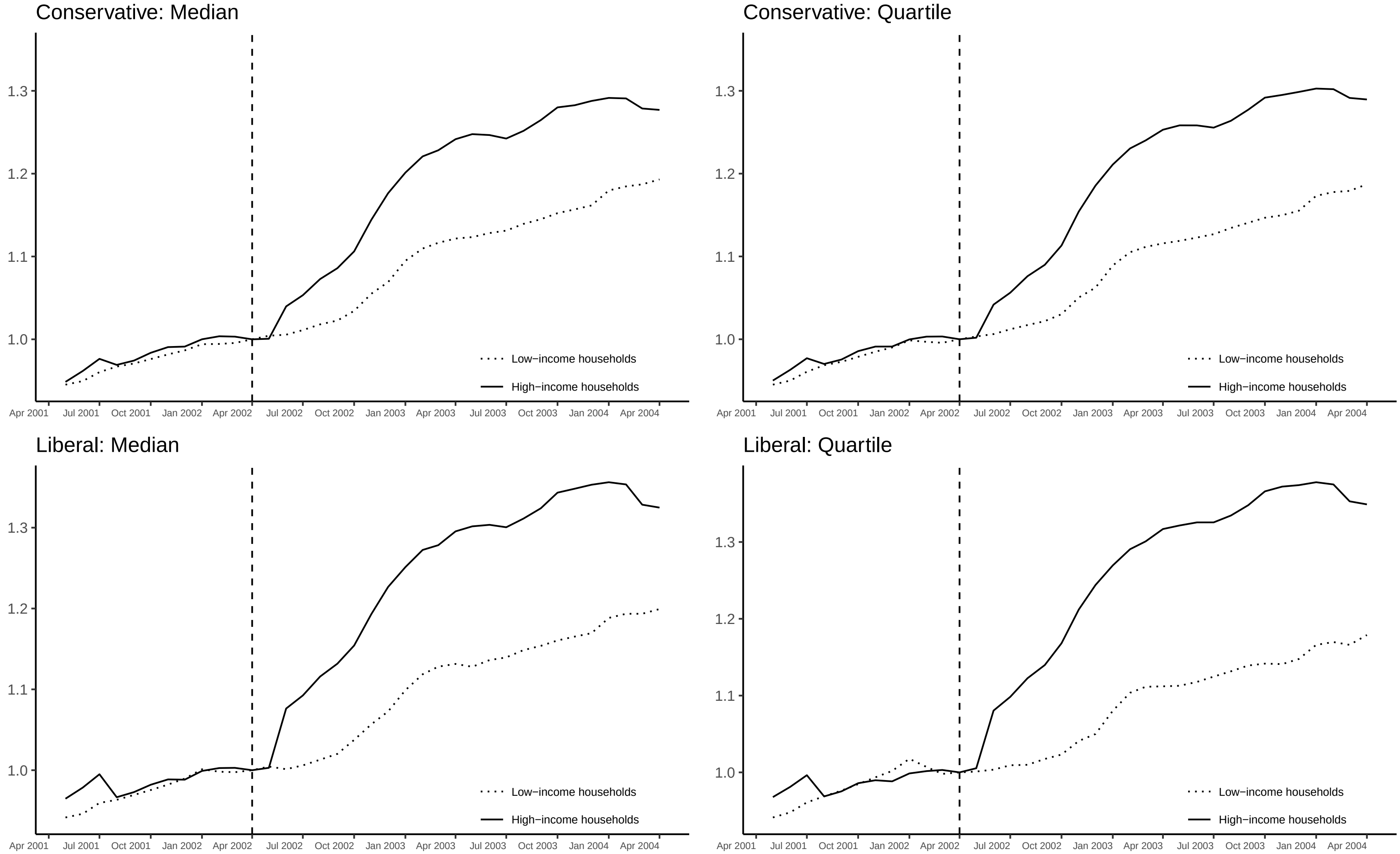
Note: The household-specific whithin price index is computed as a weighted average of economy-wide expenditure shares (ω_g) and household-specific price indexes for each product category (P_g^h): $\hat{P}_{Within,t} \equiv \sum_{g \in G} \omega_g \hat{P}^h_{g,t}$

Figure F.1: Within price indices using restricted definition of individual goods



Note: The household-specific whithin price index is computed as a weighted average of economy-wide expenditure shares (ω_g) and household-specific price indexes for each product category (P_g^h): $\hat{P}_{Within,t} \equiv \sum_{g \in G} \omega_g \hat{P}^h_{g,t}$

Figure F.2: Combined price indices indices using restricted definition of individual goods



Note: The household-specific whithin price index is computed as a weighted average of economy-wide expenditure shares (ω_g) and household-specific price indexes for each product category (P_g^h): $\hat{P}_{Within,t} \equiv \sum_{g \in G} \omega_g \hat{P}_{g,t}^h$

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