# Large Devaluations and the Real Exchange Rate*

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**Abstract**

In this paper we argue that the primary force behind the large drop in real exchange rates that occurs after large devaluations is the slow adjustment in the price of nontradable goods and services. Our empirical analysis uses data from five large devaluation episodes: Argentina (2001), Brazil (1999), Korea (1997), Mexico (1994), and Thailand (1997). We conduct a detailed analysis of the Argentina case using disaggregated CPI data, data from our own survey of prices in Buenos Aires, and scanner data from supermarkets. We assess the robustness of our findings by studying large real-exchange-rate appreciations, medium devaluations, and small exchange-rate movements.

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## 1. Introduction

Large devaluations are generally associated with large declines in the real exchange rate (RER) and concomitant low rates of inflation. In this paper, we argue that the primary force that induces these low rates of inflation is slow adjustment in the price of nontradable goods and services, not slow adjustment in the price of goods that are imported or exported. At both short and long horizons, the rate of passthrough from exchange rates to prices is much lower for nontradable goods than it is for goods that are actually traded.

Our findings are consistent with the implications of a large theoretical literature that emphasizes the importance of nontradable-goods prices in explaining RER movements in developing countries.[1] Our results are also consistent with an empirical literature that argues that inflation is lower than the rate of devaluation because prices were too high to start with (i.e. the currency was "overvalued").[2] We do not take a stand on whether currencies were overvalued before large devaluations. Instead, we focus on the question of which prices change after a large devaluation. Our findings cast doubt on the view that large devaluations are associated with large deviations from relative purchasing power parity (PPP) for imported and exported goods.

To study the sources of movements in the RER we decompose the consumer price index (CPI) into tradable and nontradable goods. Traditional decompositions classify goods as tradables and services as nontradables. The prices of tradable goods are generally measured at the retail level. This approach leads us to conclude that the primary source of RER movements after large devaluations are changes in the prices of tradable goods across countries.

We argue that this inference is misleading. The basic problem is that the retail price of tradable goods comprises two important nontradable components, distribution costs and local goods. We define distribution costs as wholesale and retail services, marketing and advertising, and local transportation services. We define local goods as goods that are produced solely for the domestic market. Thus, the retail price of tradable goods does not accurately reflect the price of pure-traded goods at the dock, i.e., the price of goods that are actually traded, exclusive of distribution costs.

To deal with this problem, we adopt an alternative decomposition that distinguishes

[1] Early theoretical work in this literature includes Meade (1956), Salter (1959), Swan (1960), and Corden (1960). For more recent discussions see Calvo and Vegh (1999) and the references therein.

[2] See Goldfajn and Valdes (1999) and the references therein.

between nontraded goods and pure-traded goods. We base our primary measure of the price of pure-traded goods on import and export prices at the dock. We argue that the main source of RER movements after large devaluations are changes in the price of nontradable goods relative to the price of pure-traded goods.

The core of our empirical analysis is based on data from five large devaluation episodes: Argentina (2001), Brazil (1999), Mexico (1994), Korea (1997), and Thailand (1997). Briefly, our findings are as follows. The rate of inflation for nontradable goods and services is very low in the wake of these devaluations, so the dollar price of nontradable goods and services falls dramatically. The dollar price of tradable goods also falls during these episodes, but the extent of this decline depends critically on whether we measure prices at the retail level or by using the price of imports and exports at the dock. The dollar retail price of tradable goods falls substantially. In sharp contrast, the dollar price of imports and exports at the dock falls by relatively little. So, although relative PPP is a poor description of the behavior of retail-tradable goods prices, it is a reasonable description of the behavior of import and export prices. We corroborate this last finding by using data from four other large devaluation episodes: Indonesia (1997), Malaysia (1997), the Philippines (1997), and Uruguay (2002).

Given these facts, we go on to quantify the main sources of RER movements in our large devaluation episodes. We begin with a series of "price accounting" exercises aimed at understanding why CPI inflation rates are so low after large devaluations, and what accounts for the wedges we observe between import and export prices and retail prices of tradable goods.

In these exercises we take the price of nontradable goods from the data. We consider two alternative assumptions about the prices of pure-traded goods. First, we assume that relative PPP holds for these goods at the dock. Second, we measure the price of pure-traded goods using at-the-dock import and export price indices. We then compute the CPI and ask whether the implied rate of inflation is consistent with the data.

For both measures of pure-traded-goods prices, we find that the answer is yes. Two key assumptions are necessary to reach this conclusion: that the retail sales of tradable goods require nontradable distribution services, and that some of the goods traditionally classified as tradable are actually "local goods." We defend both assumptions on empirical grounds and argue that their combined effect is to substantially raise our estimate of the importance of nontradable goods in the CPI relative to conventional estimates.

Although the rates of inflation implied by our price-accounting exercise are similar to actual rates of inflation, they are not identical. There are two factors that might eliminate the remaining discrepancies. The first factor is a specification error associated with our simplifying assumption that the distribution sector is perfectly competitive. To assess the impact of this assumption, we deduce the time series of markup rates in the distribution sector that are required to reconcile actual and implied rates of inflation. As it turns out, movements in the markup rate are observationally equivalent to measurement error in prices. Under either interpretation, the required movements in the markup are small. In contrast, if we abstract from distribution services and local goods then the required mark-up movements are implausibly large.

The second factor is the measurement error in the CPI that stems from a "flight from quality," which we define as the substitution by households to lower-quality goods in the aftermath of large contractionary devaluations. In practice, CPI price inspectors replace individual goods in the CPI basket to reflect changes in demand and product turnover. Unless these inspectors make appropriate corrections for quality changes, the flight from quality can induce a downward bias in CPI inflation rates. In general, it is difficult to obtain direct evidence of this bias. However, we provide indirect evidence on the importance of this bias by using price data from the Economist Intelligence Unit (EIU).

After discussing our price-accounting exercises, we use a strategy proposed by Engel (1999) to understand the sources of RER movements. We decompose RER movements into fluctuations in the price of pure-traded goods across countries and movements in the price of nontradables relative to pure-traded goods. We corroborate our basic finding that the most important sources of RER movements in the aftermath of large devaluations are movements in the price of nontradables relative to pure-traded goods.

We complement our analysis of the five large devaluation episodes with an in-depth analysis of the Argentinian case. Here, we use four different data sets: disaggregated CPI data, data from our own survey of prices in Buenos Aires, scanner data from Buenos Aires supermarkets, compiled by CCR, an Argentine marketing research firm; and our own survey of product origin which classifies goods in the CCR data set into imported, exported, or local. The general pattern that emerges from these data supports our findings from the aggregate data.

We use the scanner and survey data to provide some direct evidence of flight from quality in Argentina. This evidence complements our results based on the EIU data.

Finally, we use our survey data to study the frequency of price adjustment for individual goods and services. Our main finding is that goods prices change much more frequently than services prices. The median monthly frequency of price changes is 63 percent for goods and zero percent for services. We view this result as significant, because services are the quintessential nontradable product.

We ask if our findings are peculiar to large devaluation episodes. There are two dimensions to be investigated here: RER appreciations compared to depreciations and large devaluations compared to small movements in exchange rates. To investigate the first dimension, we consider two large real-appreciations episodes associated with exchange-rate-based stabilization programs: Argentina (1991) and Mexico (1987). Consistent with our results for large devaluations, we find that in both these episodes, the key source of RER fluctuations is a change in the price of nontradables relative to pure-traded goods.

To investigate the second dimension, we study four medium-sized devaluations: the 1992 devaluations in Finland, Italy, Sweden, and the UK. In addition, we examine small exchange-rate fluctuations that occur at business-cycle frequencies over the period 1971-2001 in ten OECD countries. For medium-size devaluations, we find that movements in the price of nontradable goods relative to pure-traded goods are an important source of RER movements, but less so than in large devaluation episodes. For small exchange-rate fluctuations, we find that changes in the price of nontradable goods relative to pure-traded goods account for a significant fraction of movements in the RER. However, in contrast to large devaluations, the fluctuations in the price of pure-traded goods across countries account for the majority of small movements in the RER. In this sense, our findings are consistent with the results in Engel (1999) and Chari, Kehoe, and McGrattan (2002).

The paper is organized as follows. In Section 2 we provide empirical evidence on the behavior of nominal and real exchange rates, and on the response of different prices to large devaluations. Section 3 presents the results of our price-accounting exercises. Section 4 describes the results of our Engel decompositions. Section 5 provides a detailed analysis of the 2001 Argentinian devaluation. Section 6 discusses large RER appreciation episodes. Section 7 summarizes our results for the medium-size devaluations and small exchange-rate fluctuations. Section 8 concludes. An appendix available upon request provides a detailed summary of the data used in this paper.

## 2. Large Devaluations

In this section we summarize the behavior of various prices and exchange rates in our five large devaluation episodes. Throughout, we define the CPI-based real exchange rate as:

$$RER_t = \frac{P_t}{S_t P_t^*}. \tag{2.1}$$

In equation (2.1) $S_t$ denotes the trade-weighted nominal exchange rate of the home country which we define as units of local currency per unit of trade-weighted foreign currency. The variable $P_t$ denotes the level of the CPI in the home country. $P_t^*$ represents the trade-weighted CPI of foreign countries.

Table 1 presents data on cumulative logarithmic changes, relative to one month prior to the devaluation, in trade-weighted nominal and real exchange rates, and price levels for five large devaluation episodes: Argentina (2001), Brazil (1999), Korea (1997), Mexico (1994), and Thailand (1997).[3] We focus on these large devaluation countries because of data availability issues. In every episode there is a considerable drop in the RER, reflecting the fact that the home-country inflation is much lower than the rate of devaluation.

Since export and import price indices play a significant role in our analysis, we briefly digress to discuss how these indices are constructed.[4] The two most common methods are to build indices based on price data collected by surveying importers and exporters, and unit value indices (UVIs) computed from trade statistics as the ratio of the local currency value of exports or imports to volume (weight or quantity). UVIs are computed for individual good categories and then aggregated. Countries that construct survey-based indices include Argentina (import prices), Korea (both import and export prices), and Mexico (export prices). Countries that use UVI-based import and export indices include Brazil (see Guimarães et al. (1997) and Markwald et al. (1998)) and Thailand. Mexico differs from other countries in that the government constructs its import price index using information on producer and export prices in the U.S. Consequently, we should treat the Mexican import price index with

[3] We compute trade-weighted nominal and real exchange rates using a set of trading partners that represent, on average, 80 percent of exports and imports for each country. For each country, we choose the largest trading partners for which we have price data.

[4] Some studies use the Producer Price Index (PPI) or the Wholesale Price Index (WPI) as a measure of the price of pure-traded goods. We think that these are poor measure of pure traded goods prices for two reasons. First, since the PPI targets prices charged by domestic producers, import prices are generally excluded. Second, the composition, coverage and availability of the PPI and WPI varies widely across countries (see Maitland-Smith (2000)).

caution, because it may be biased towards finding relative PPP by construction. To assess the robustness of inference, we compare our export and import price indices with annual export and import price deflators from the National Income Accounts of each country.

There is a potential bias with UVIs that results from the fact that product composition can shift over time. However, this bias actually works against our inference that relative PPP is a good approximation for pure-traded-goods prices. After large devaluations, the quality of imports is likely to go down, not up. Consequently, the rate of inflation implied by UVI-based import indices should be biased downward, making it appear that relative PPP is a worse approximation.

Table 1 shows that there is substantial comovement between the price of imports and exports and the nominal exchange rate. In Argentina, Brazil, and Mexico this comovement is present at all the horizons we consider. For Korea and Thailand, the comovement is stronger in the first few months after the devaluation. Figure 1 plots the time series for the logarithm of the trade-weighted nominal exchange rate, import and export prices. Figure 1 makes clear that relative PPP is a reasonable description of the behavior of prices of pure-traded goods. There is certainly no indication that import or export prices, measured in units of local currency, are sticky.

One limitation of Table 1 is that it reports evidence only for the five countries for which we have monthly data. To assess the robustness of inference, to our measure of import and export prices and the selection of countries, Table 2 considers results based on annual import and export price deflators. Using these deflators allows us to include four other large devaluation episodes into our analysis: Indonesia (1997), Malaysia (1997), the Philippines (1997), and Uruguay (2002). Consistent with the evidence in Table 1, Table 2 shows that for all countries there is strong comovement between import and export price deflators and the exchange rate.

An important issue is whether movements in the import and export price indices are driven by the non-consumption-good components, i.e. capital goods, intermediate goods, and raw materials. Figure 2 displays the overall import indices and the consumption-goods import price indices for the four countries for which this data is available, Argentina, Brazil, Korea, and Thailand. It is evident that these indices move together very closely.

Table 1 indicates that the retail price of tradable goods moves by much less than the price of imports and exports (see also Figure 1).[5] Table 1 also shows that the price of nontradable goods and services moves by much less than the rate of devaluation. Although the retail prices of tradable goods move more than prices of nontradable goods and services, the differences are small relative to overall movements in the nominal exchange rate.

In principle, the slow response of nontradable-goods prices could reflect the importance of government-controlled prices. Table 1 indicates that with the exception of Argentina, the rate of inflation for public goods is roughly the same as the overall rate of inflation for non-tradables. Even in Argentina, the difference between public-goods inflation and nontradables inflation is small relative to the overall rate of devaluation.

We conclude that there is a stark difference in the behavior of the two alternative measures of tradable prices, import and export prices, and retail prices. Relative PPP is a reasonable description of the behavior of pure-traded-goods prices. However, it is a very poor description of the behavior of tradable-goods retail prices.

## 3. Price Accounting

In principle, there are many possible explanations for the declines in the RER after large devaluations. Suppose that most goods in the CPI bundle are tradable and relative PPP is a poor description of the price of pure-traded goods. Then, the fall in the RER would primarily reflect a big change in the relative price of pure-traded goods across countries. Alternatively, suppose that most goods in the CPI are nontradable and relative PPP is a good description of pure-traded good prices. Then, the fall in the RER primarily reflects a large change in the price of nontradable goods relative to pure-traded goods. Of course, there are many intermediate possibilities. To assess the empirical relevance of the different possibilities, this section discusses our estimate of the weight of nontradables in the CPI. We then describe a series of price-accounting exercises that are helpful in isolating the determinants of CPI inflation and RER movements.

[5] This is consistent with Frankel, Parsley, and Wei's (2004) finding that exchange-rate passthrough is higher for import prices at the dock than for retail prices.They find weaker evidence than we do that relative PPP holds at the dock. This difference may refect the fact that, unlike them, we focus on large devaluation episodes.

### 3.1. The Composition of the CPI Basket

As noted earlier in the paper, traditional decompositions of the CPI classify goods as tradables and services as nontradables. Table 3 reports the results of implementing this decomposition for our five large devaluation countries. According to Table 3 on average, nontradable goods account for roughly 50 percent of the CPI basket. In our view, this decomposition substantially understates the percentage of the CPI basket that is composed of nontradables because it ignores distribution costs for tradable goods and local goods.

We now provide an overview of the potential impact of distribution costs and local goods on the composition of the CPI basket. Recall that we compute the CPI using retail prices. These prices are necessarily different from producer prices, because they reflect distribution costs associated with wholesale and retail services, marketing and advertising, and local transportation services. Burstein, Neves, and Rebelo (2003) show that these costs are large. According to their estimates, the average distribution margin for consumption goods, defined as:

$$\text{Distribution Margin} = \frac{\text{Retail Price - Producer Price}}{\text{Retail Price}},$$

is roughly 50 percent.[6] Distribution services are nontradable in nature, since they are intensive in local land and labor. So Burstein, Neves, and Rebelo's findings imply that half of the retail price of a tradable good reflects nontradable goods and services. Consequently, distribution costs account for approximately 25 percent of the CPI bundle raising the total share of nontradables in the CPI to 75 percent.

Consider the remaining 25 percent of the CPI basket classified as tradable goods. Many of these goods are actually local goods that are produced solely for domestic consumption. For example, yogurt is traditionally classified as a tradable good. However, almost all the yogurt produced in Argentina is sold locally (see Table 8, which provides additional examples). It is difficult to precisely estimate the share of local goods in the CPI. However, the calculations below suggest that local goods could represent as much as 22 percent of tradable goods or 11 percent of consumption. In this case, taking distribution costs and local goods into account reduces the share of pure-traded goods in the CPI basket to 14 percent.

To illustrate the importance of pure-traded goods in consumption we calculate the import

[6] In practice Burstein, Neves, and Rebelo (2003) compute distribution margins as the ratio of gross margin to sales. An alternative measure is the ratio of value added to sales. Value added is equal to the gross margin minus the cost of supplies, materials, fuel, and other energy, and the cost of contract work on materials of the wholesaler. In practice, the difference between these two measures of the distribution margin is small.

content of consumption for our five large devaluation countries.[7] Our calculations use input-output tables, except for Brazil and Thailand for which we use data from the National Income and Products Accounts.

Table 3 reports two measures of the importance of pure-traded goods in consumption. The first measure is the fraction of imported final goods in total consumption exclusive of distribution services. We refer to this measure as the "direct" import content of consumption. The second measure is the direct import content plus the value of imported intermediate inputs used to produce final consumption goods as a fraction of total consumption expenditures. We refer to this measure as the "total" import content of consumption.

Table 3 shows that, for all of our large devaluation countries, the importance of pure-traded goods in consumption is small.[8] The average direct import content of consumption in these countries is 5 percent, while the average total import content of consumption is 14 percent.[9]

We would like to estimate the fraction of exportable goods in consumption. Unfortunately, we cannot use input-output matrices to construct these estimates, because they do not contain information on the fraction of exportable goods that is consumed domestically. In light of this, we use two bounds for the importance of pure tradable goods in consumption. The lower bound, which abstracts from exportables, is equal to the total import content of consumption. The upper bound, which abstracts from local goods, is equal to the conventional estimate of nontradable goods plus distribution services.

### 3.2. Price-Accounting Results

We think of the CPI as a geometric average of the retail price of tradable goods ($P_t^T$) and the price of nontradable goods and services ($P_t^N$):

$$P_t = (P_t^T)^{1-\omega}(P_t^N)^{\omega}. \tag{3.1}$$

In equation (3.1), $\omega$ is the weight of nontradable goods in the CPI, as traditionally defined. We take the view that tradable goods include both goods that are actually traded (imports/exports) and local goods. We assume that the price of tradable goods is given by:

$$P_t^T = (P_t^I)^{1-\theta}(P_t^L)^{\theta}, \tag{3.2}$$

[7] Unfortunately, we were not able to obtain data for the other four countries included in Table 3.

[8] For Brazil we measure the direct and total import content in final demand.

[9] Investment goods generally have a higher import content than consumption goods. See Burstein, Neves, and Rebelo (2004).

where $P_t^I$ is the retail price of traded goods, $P_t^L$ the retail price of local goods, and $\theta$ denotes the share of local goods in tradable goods.

As in Burstein, Neves, and Rebelo (2003), we assume that selling one unit of traded or local goods requires nontradable distribution services, and that the price of distribution services is the same as the price of nontradable goods. We assume that the technology used to transform traded goods and local goods into retail tradable goods is Cobb-Douglas. We denote the weight of distribution services in this production technology by $\phi$. For simplicity, we suppose that this weight is the same for traded and local goods. Perfect competition in the distribution sector implies that the retail price of traded and local goods is given by:

$$P_t^I = (\bar{P}_t^I)^{1-\phi}(P_t^N)^{\phi}, \quad (3.3)$$

$$P_t^L = (\bar{P}_t^L)^{1-\phi}(P_t^N)^{\phi}, \quad (3.4)$$

respectively.

In equation (3.3) $\bar{P}_t^I$ denotes the price of pure-traded goods. In equation (3.4) $\bar{P}_t^L$ is the price of a local good exclusive of its distribution component.

Finally, we assume that the price of local goods is the same as the price of nontradables:

$$\bar{P}_t^L = P_t^N. \quad (3.5)$$

Equations (3.1)-(3.5) imply that $P_t$ is given by:

$$P_t = (\bar{P}_t^I)^{1-\alpha}(P_t^N)^{\alpha}, \quad (3.6)$$

where

$$\alpha = 1 - (1-\theta)(1-\phi)(1-\omega), \quad (3.7)$$

is the total weight of nontradable goods in the CPI basket.

In our price-accounting exercises we take the rate of change in $P_t^N$ directly from the data. We consider two measures of $\bar{P}_t^I$. In case 1, we assume that relative PPP holds for the price of pure-traded goods ($\bar{P}_t^I$):

$$\bar{P}_t^I = kS_t\bar{P}_t^{I*},$$

where $k > 0$ is an arbitrary constant. In this case, we measure the foreign price of pure-traded goods ($\bar{P}_t^{I*}$) using a simple geometric average of foreign import and export prices. We compute foreign import and export prices as trade-weighted geometric averages of the import and export price indices of the trading partners for the country in question. In case 2 we do not impose relative PPP. Instead, we measure $\bar{P}_t^I$ using an equally weighted geometric average of the import and export price indices for the country in question.

We consider four alternative assumptions about $\alpha$: that all goods are traded, that some goods are nontradable, but there are no distribution costs or local goods; that there are nontradable goods and distribution costs but no local goods; and that there are nontradable goods, distribution costs, and local goods. For each set of assumptions we use equation (3.6) to compute the implied rate of CPI inflation. We then compare the implied rate with the actual inflation rate one year after the devaluation.[10]

**Assumption A: All Goods Are Traded** Suppose that all goods are traded so that $\omega = \alpha = \phi = 0$. Table 4 shows that for both measures of $\bar{P}_t^I$, the implied rate of inflation is much higher than the actual rate of inflation.

**Assumption B: Nontradable Goods but No Distribution Costs or Local Goods** Suppose that there are nontradable goods but no distribution costs ($\phi = 0$), and no local goods ($\theta = 0$) so that $\alpha = \omega$. We set $\omega$ to the conventional measure of the weight of nontradable goods in the CPI basket reported in Table 3. We note that the assumption of local goods is isomorphic to the assumption that there are no local goods, but their price moves one-to-one with the price of pure-traded goods ($\bar{P}_t^I$). Table 4 indicates that for all countries and both measures of $\bar{P}_t^I$, the rate of inflation implied by the price-accounting exercises is much larger than the actual rate of inflation.

**Assumption C: Nontradable Goods and Distribution Costs but no Local Goods** We introduce distribution costs and assume a 50 percent distribution margin ($\phi = 0.5$). We continue to set $\omega$ to the values reported in Table 3. The resulting value of $1 - \alpha$ provides an upper bound on the importance of pure-traded goods, since it completely abstracts from local goods ($\theta = 0$). Table 4 indicates that, for all countries and both measures of $\bar{P}_t^I$, the rates of inflation implied by the price-accounting exercises fall substantially, relative to the case of $\phi = 0$.

[10] We do not include Thailand in our analysis because we do not have data on $P_t^N$.

**Assumption D: Nontradable Goods, Distribution Costs, and Local Goods** We set $1-\alpha$ to the total import weight of consumption obtained from the input-output tables (see Table 3). This case provides a lower bound on the importance of pure-traded goods, because it abstracts from exportables and assumes that the price of local goods moves like the price of nontradables.

Table 4 indicates that the rates of inflation implied by the price-accounting exercise are similar to the actual rates of inflation. In Brazil these two rates coincide, but in Argentina the implied rate of inflation is actually lower than the actual inflation rate.

Assumption D overstates the extent to which we can replicate actual rates of inflation, because it corresponds to a lower bound value for the importance of traded goods. At the same time, assumption C understates the extent to which we can replicate actual rates of inflation. Recall that under this assumption there are no local goods, or, equivalently, the price of these goods rises at the same rate as the retail price of imported goods. Presumably, the truth lies somewhere between assumptions C and D.

One piece of evidence on this point comes from Argentina, the only country for which we have data on the retail prices of local goods. We will see in section 5 that the rate of inflation in the retail price of local goods is lower than the rate of change in the retail price of imported goods, but higher than the rate of change in the price of nontradables. So a conservative assessment of our results is that the implied rates of inflation emerging from the price-accounting exercises are still somewhat higher than actual rates of inflation.

**Markups and Measurement Error** One factor that might reduce the discrepancy between actual and implied rates of inflation is specification error in the model of the retail tradable sector summarized by equation (3.3). There, we assume that retail tradable goods are produced by perfectly competitive producers who combine distribution services with pure tradable goods. Equation (3.3) is an identity that does not perfectly describe the behavior of the retail prices of traded goods. This limitation raises the question: how large is the difference between actual and predicted retail prices of traded goods?

To answer this questions we modify equation (3.3) so that the actual and predicted retail prices of tradables are, by construction, the same. Suppose that retail prices are given by:

$$\begin{aligned} P_t^I &= \mu_t (\bar{P}_t^I)^{1-\phi} (P_t^N)^{\phi}, \\ P_t^L &= \mu_t P_t^N. \end{aligned}$$

Then the retail price of tradable goods is given by:

$$P_t^T = \mu_t[(\bar{P}_t^I)^{(1-\phi)(1-\theta)}(P_t^N)^{1-(1-\phi)(1-\theta)}]. \tag{3.8}$$

One interpretation of $\mu_t$ is that it represents measurement error in the different price indices. A more interesting possibility is that retail firms are not perfectly competitive. In this case, $\mu_t$ corresponds to the time $t$ markup. For expositional purposes we adopt the latter interpretation.

To quantify the difference between actual and predicted retail prices, we compute the values of $\mu_t$ required for equation (3.8) to perfectly fit the time series on $P_t^T$. Since we take $P_t^N$ from the data, these values of $\mu_t$ also imply that the predicted rates of inflation coincide at each point in time with actual rates of inflation.

Figure 3 shows the time series for $\mu_t$ under assumptions B, C, and D. We measure $\bar{P}_t^I$ using an equally weighted geometric average of the import and export price indices for the country in question. We look first at our results under assumption D (nontradables, local goods, and distribution costs). Here, the variations in $\mu_t$ are relatively small. They are always lower than 10 percent in Brazil and Mexico and lower than 20 percent in Argentina and Korea. To put these numbers in perspective, suppose that the pre-devaluation gross markup is $\mu = 1.25$. This assumption implies that in Brazil and Mexico $\mu_t$ never falls below 1.13. In Korea $\mu_t$ never falls below 1.02, but in the Argentinian case the implied markup rises somewhat.

Next, we consider our results under assumption C (nontradables and distribution costs, but no local goods). Movements in $\mu_t$ are smaller than 20 percent for all countries. We note that in this case, the markup in Argentina no longer rises but declines by a modest amount.

When we examine our results under assumption B (nontradables but no distribution costs or local goods) we see that movements in $\mu_t$ are much larger. For example, the maximal deviation exceeds 60 percent for Argentina and is over 40 percent for the other three countries. So, if the pre-devaluation markup is 1.25, then the gross markup falls below 0.69 in Argentina and 0.84 for the other countries. This big fall in $\mu_t$ means that retailers would have been selling products at a loss for long periods of time. To avoid this implication while maintaining the assumption that there are no distribution costs or local goods, we would have to assume that pre-devaluation markups were extremely high: higher than 1.85 in Argentina and 1.5 in the other countries.

### 3.3. Flight From Quality

Another factor that might reduce the discrepancy between actual and implied rates of inflation is measurement error that stems from a flight from quality. By a flight from quality we mean that households substitute towards lower-quality goods in the aftermath of large contractionary devaluations.[11] In fact, all the large devaluations in our sample are contractionary: in the first year after the devaluation real GDP contracts by 12, 1, 7, 6, and 11 percent in Argentina, Brazil, Korea, Mexico, and Thailand, respectively.

Flight from quality can lead to a downward bias in the official inflation rate. In principle, the CPI measures the price of a fixed basket of goods, so it should not be affected by a flight from quality. But in practice, the individual goods in the CPI basket are periodically replaced to reflect changes in demand and product turnover. When an item is replaced CPI price inspectors must decompose the price difference between incoming and outgoing goods into a pure-price effect and a quality-difference effect. This decomposition can impart significant biases in the CPI (see e.g. Klenow (2003)). These biases are likely to be become worse after large devaluations, because there are sizable shifts in consumption patterns. In addition, there are marked rises in product destruction rates that increase the number of products that must be replaced in the CPI basket.

It is generally difficult to quantify the bias induced by flight from quality. Here, we provide indirect evidence on this bias using data from the EIU.

By surveying prices in different countries the EIU computes cost-of-living indices that firms use to calculate compensation for workers who are relocated to a different country. Two virtues of this data set are that the EIU tries to keep constant the quality of the products surveyed and tends to exclude local goods.

Using EIU data, we study the behavior of prices in our five devaluation countries, focusing on the largest city in each country (Buenos Aires, São Paulo, Mexico City, Seoul, and Bangkok). The EIU collects prices in September of each year, in both low- and high-price outlets.

We group EIU items into four categories: clothing, durables, food, and other miscellaneous goods. We then compute a price index for each category in each country. The weight we give to an individual item (e.g., yogurt, natural, 150 grams) in a category (e.g., food)

[11] There is substantial anectodal evidence that large contractionary devaluations are accompanied by flight from quality. See, for example, Cho and Advincula (1998) for a discussion of how Korean department stores accommodated the switch in demand from imported goods to cheaper local substitutes after the 1997 crisis.

is equal to the weight the item receives in the U.S. CPI.[12] To calculate an overall rate of inflation, we assign to each category the weight that it receives in the U.S. CPI basket. We also use these weights to compute a partial CPI inflation rate as an average of the official inflation rates for the four categories used in computing the EIU inflation rate. We then compare the two inflation rates to assess the importance of the flight from quality. Although the EIU inflation rate is an imperfect measure, it provides some useful information about the magnitude of measurement error associated with the flight from quality.

For each country, Table 5 reports the partial CPI inflation rate and two EIU inflation rates. We compute these two EIU inflation measures using data collected in low- and high-price outlets, respectively. For Mexico we have institutional information that there were very few unplanned substitutions of items in the CPI basket.[13] This information suggests that the flight from quality does not have a big impact on the Mexican CPI. Interestingly, the EIU inflation rate tracks the official CPI inflation quite closely for Mexico. This fact gives us some confidence that the EIU inflation rates, as we compute them, are useful.

For all other countries in our sample, the partial CPI inflation rate is lower than both EIU inflation rates. The differences are particularly notable for Brazil, Korea, and Thailand.

Our results suggest that flight from quality probably induced a systematic downward bias in inflation rates after large devaluations. But it is difficult to be precise about the quantitative importance of this bias.

## 4. Engel Decompositions

In this section we use an approach proposed by Engel (1999) to study the source of RER movements. We assume that equation (3.1) defines the domestic CPI and that the foreign CPI ($P_t^*$) is given by:

$$P_t^* = (P_t^{T*})^{1-\omega}(P_t^{N*})^{\omega}.$$

For exposition purposes only we assume that $\omega$, which represents the share of tradable goods in the CPI basket, is the same in both countries. We can decompose the RER, which we defined in equation (2.1) as:

[12] We use these weights because of data limitations. See the appendix for details.

[13] Banco de Mexico updated the list of goods used to compute the Mexican CPI in February 1995. This update had been planned for months and was unrelated to the devaluation. Using several issues of the Diario Oficial de la Federacion for 1995, we concluded that between February and July only 233 goods out of 5494 were added to the CPI basket for Mexico City. Only a fraction of the 233 new goods were introduced to reflect changes in consumption patterns.

$$\log(RER_t) = \log(RER_t^T) + \log(RER_t^N). \qquad (4.1)$$

The first component, $\log(RER^T)$, measures the extent to which the price of tradable goods is different across countries:

$$\log(RER_t^T) = \log[P_t^T/(S_t P_t^{T*})].$$

The second component, $\log(RER_t^N)$, measures movements in the price of nontradables, relative to tradables, across countries:

$$\log(RER_t^N) = \omega\left[\log(P_t^N/P_t^T) - \log(P_t^{N*}/P_t^{T*})\right].$$

Table 6 and Figure 4 report for our five episodes changes in different measures of the RER.[14] When we measure $P_t^T$ using retail prices changes in $\log(RER_t^T)$ account for most of the movement in $\log(RER_t)$.

Earlier we argued that retail prices are not good measures of the price of pure-traded goods, because they embody a large nontradable component in the form of distribution costs and local goods.[15] We now incorporate these factors into our analysis. Using equation (3.6) and (2.1) the RER can be expressed as:

$$\log(RER_t) = \log(\overline{RER}_t^T) + \log(\overline{RER}_t^N). \qquad (4.2)$$

Here, $\log(\overline{RER}_t^T)$, is the difference across countries in the price of pure-traded goods:

$$\log(\overline{RER}_t^T) = \log[\bar{P}_t^I/(S_t\bar{P}_t^{I*})].$$

Also, $\log(\overline{RER}_t^N)$ is the difference across countries in the price of nontradables, relative to traded prices measured at the dock:[16]

$$\log(\overline{RER}_t^N) = \alpha\left[\log(P_t^N/\bar{P}_t^I) - \log(P_t^{N*}/\bar{P}_t^{I*})\right].$$

Table 6 and Figure 4 report changes in $\log(\overline{RER}_t^T)$ in the aftermath of our five large devaluation episodes. We measure $\bar{P}_t^I$ using an equally weighted geometric average of import and

[14] We do not have data on $P^{T*}$ for the trading partners of each country. We proxy for $P^{T*}$ using the CPI of the relevant countries.

[15] Betts and Kehoe (2004) find that different measures of tradable good prices have different implications for decompositions of movements in the RER. Their preferred measure of the RER is based on gross output deflators. Unfortunately, these are available only for a small set of countries and only at an annual frequency.

[16] For expositional purposes only we assume that $\alpha$ (as defined in equation (3.7)) is the same across countries.

export price indices. We also report results for the case in which we measure $\bar{P}_t^I$ using just the import price index.

We note that movements in $\log(\overline{RER}_t^T)$ account for a much smaller fraction of the changes in $\log(RER_t)$ than movements in $\log(RER_t^T)$. We conclude that when RERs are constructed using at-the-dock prices of pure-traded goods they do not fall by a substantial amount after large devaluations .

Once we allow for time-varying markups, equation (3.8) implies that the Engel decomposition takes the form:[17]

$$\log(RER_t) = \log(\overline{RER}_t^T) + (1-\omega)\log(\mu_t) + \log(\overline{RER}_t^N).$$

We note that this equation implies that our previous calculations about the importance of $\overline{RER}_t^T$ in the Engel decomposition are unaffected by the presence of time-varying markups.

Viewed as a whole, and consistent with our price-accounting exercises, the results in this section provide strong evidence in favor of the view that, in our large devaluation episodes, movements in the relative price of pure-traded goods across countries is not an important source of RER movements after large devaluations.

## 5. A Closer Look at the Data: Argentina's 2001 Devaluation

We complement the evidence presented above with an in-depth look at an episode for which we have more detailed data, Argentina's 2001 devaluation.[18] Our information comes from four different data sets: disaggregated CPI data from INDEC (Instituto Nacional de Estadística y Censos, the Argentinian National Statistical Agency); data from our own survey of prices in Buenos Aires; scanner data compiled by CCR, an Argentine marketing research firm; and our own survey of product origin that classifies goods in the CCR data set into imported, exported, or local.

### 5.1. Disaggregated CPI and Scanner Data

Our data show that the rate of increase in retail prices is higher for goods that have a higher market share of imported and exportable goods. Table 7, obtained from INDEC, describes the behavior of various price indices for the period December 2001 to December 2002. The

[17] For simplicity we abstract from markups in foreign countries.

[18] Argentina devalued its official exchange rate in January 2002, but banks were closed in the last few days of December 2001.

same patterns of price behavior emphasized in the previous section emerge clearly here. During the period under consideration, the logarithm of the Peso/U.S. dollar exchange rate rises by roughly 124 percent. Consistent with the notion that relative PPP is a reasonable description of the price of pure-traded goods, the price of imports rises by 111 percent. Consistent with the importance of distribution costs, the retail price of imported goods rises by far less (83 percent). The retail price of tradable goods, which includes both imported and local goods, rises by only 52 percent.

The table also shows that the retail price of tradable goods with the lowest market share of importables and exportables rises the least. For example, the retail price of local goods rises by only 42 percent.[19]

Table 7 is consistent with the notion that the price of nontradable goods and services is not substantially affected by the devaluation. Indeed, the price of these goods rises by only 13 percent. We conclude that the higher is the pure-traded content of the good, the better does relative PPP describe the behavior of a good's price .

We now examine our second source of evidence on the relation between inflation and the market share of imported and exportable goods across different good categories. This evidence comes from two sources. First, we obtained scanner data on prices and market shares of individual products at the SKU (stock keeping unit) level from CCR. The data covers 24 supermarket product categories for the period January 1999 to June 2002. For each product category, we have information on a very large number of individual products (e.g. 1,042 different types of breakfast cereal).

Second, we conducted our own survey of product origin for a subset of individual items in 21 product categories in the CCR data set. This subset represents approximately 70 percent of the total market share for each of the 21 product categories. The survey took place in October 2002 in several Buenos Aires supermarkets. Product labels of the goods that we surveyed indicate whether the good was imported, exported, or neither. Using this information, we classified each product as being imported, exportable, or local. Using CCR data on market shares of individual products, we computed the shares of imported and exportables for each product category (e.g. beer, bread, etc.). We obtained the rate of inflation for each product category from INDEC for the period December 2001 to June 2002.

Table 8 reports the shares of imported and exportables for each product category and the

[19] Local goods are typically not branded. Crucini, Telmer, and Zachariadis (2005) find, using European data, that PPP is a better approximation for branded goods than for non-branded goods.

corresponding rate of inflation. Our key finding is that there is a strong positive correlation (0.69) between the rate of inflation of a product category and the market share of imported and exportable goods in that product category.

### 5.2. Our Survey of Prices in Buenos Aires

We now turn to a data set that allows us to assess how often the retail prices of tradable and nontradable goods are adjusted. This data set is based on a survey of prices in Buenos Aires that we conducted between March 27 and December 24, 2002. Our data appendix contains a complete description of the goods and services include in the survey.

We collected prices for 58 goods in eight supermarkets at weekly frequency. For each good we gathered information on different items. An item is a type of brand and size of a good collected in a given supermarket (e.g. cooking oil, Cocinero brand, 1.5 liter bottle, in Disco supermarket). We have prices on 518 items. We also collected data on ten services in one or two different outlets. In total, we have prices on 17 service items. All of the goods that we consider would be classified as tradable under a standard classification. The services in our survey are all clearly nontradable in nature.

We compute the frequency of price changes for each individual item. Frequency is defined as the number of periods in which a price change occurs relative to the previous period, as a fraction of the total number of periods in which the item is available.[20] For example, suppose that we have weekly data on the price of an item for an eight-month period. If the price of the item changes in only two weeks during that period, then the frequency of price change is 2/(8x4) = 1/16. If the item changes price every week, then the frequency of price adjustment is one.

Figure 5 presents a histogram showing the frequency of price changes for the goods and services in our sample. We note that 65 percent of the services surveyed never change prices during the sample period. In contrast, fewer than 2 percent of the goods surveyed keep their prices constant throughout the sample.[21]

Table 9 reports the median frequency of price changes and the median time between

[20] In practice, for a given good or service, we compute the frequency of price changes as an average of the frequency of price changes in different supermarkets or locations.

[21] When we use a daily-frequency version of our survey data, we find that most price adjustments occur after a stock-out. The probability of a price change, conditional on the good not being on the shelf on the previous day, is 33 percent. This evidence is consistent with Rotemberg's (2003) argument that retailers worry about customer anger associated with price changes.

price changes. We compute the latter as the median of the inverse of the frequency of price changes for individual items.[22] Our main finding is that goods prices are adjusted much more frequently than are services prices. The median weekly frequency of price changes is 30 percent for goods and zero percent for services.[23] These frequencies imply that the median time between price changes is 5.3 weeks for goods and infinity for services.[24] The low frequency of price adjustments for nontradable services is not driven by the fact that the government controls some of these prices: the median weekly frequency of price changes for services whose price is not administered by the government is still very low–1.7 percent.

We compare our results with those reported by Bils and Klenow (2004) for the U.S. and by Lach and Tsiddon (1992) and Baharada and Eden (2004) for Israel. To make this comparison we aggregate our weekly data to a monthly frequency and then compute the frequency of price changes.

Bils and Klenow (2004) estimate that the median monthly frequency of price changes for the period 1995 to 1997 is 30 percent for goods and 21 percent for services. Lach and Tsiddon (1992) estimate that the average frequency of price changes during the period 1978–1979 and 1981–1982 is 41 percent. The average monthly rate of inflation in Israel is 4.3 percent in 1978-1979 and 6.3 percent in 1981–1982. Baharada and Eden (2004) consider the 1991-92 period when inflation is lower (0.8 percent per month). They find that the average frequency of price changes is 24 percent. In our data set the median monthly frequency of price changes is 67 percent for goods and zero percent for services. Our finding that service prices change less frequently than goods prices is consistent with Bils and Klenow's results (2004). Our results indicate that goods prices adjusted much more rapidly in Argentina than in the U.S. and Israel. In contrast, service prices adjusted much more slowly in Argentina than in the U.S.

[22] Our results understate the frequency of price adjustment for goods because they only take into account changes in prices that were reflected in price labels. This excludes price changes associated with supermarket-wide discounts.

[23] Our data starts in March and the devaluation occurred in the beginning of the year. CPI inflation between December 2001 and March 2002 was 9.2 percent for the overall CPI and 2.8 percent for services. Inflation in Argentina for the period when we conducted our survey (March-December 2002) was 25.1 percent, 10.1 percent, and 36.3 percent for the overall CPI, nontradable goods, and tradable goods, respectively.

[24] For services, all the price changes are positive. In contrast, for goods, 59 percent of the price changes are positive.

### 5.3. Flight from Quality in Argentina

We use our scanner data to provide evidence of the flight from quality in Argentina. We calculate the fraction of individual products at the SKU level that were "destroyed," i.e., disappeared from supermarket shelves. For each of 24 product categories, the first five columns of Table 10 report the fraction of SKUs that were destroyed in the six months prior to June 2000, December 2000, June 2001, December 2001, and June 2002. The median fraction of SKUs across all product categories that disappeared rose from 16 percent in June 2001 to 26 percent in June 2002.

Next, we calculate the weighted average price of SKUs whose markets share fall by more than 2 percent in any given period. We also compute the average price of SKUs whose market share rises by more than 2 percent. The last three columns of Table 10 report the ratio of these two average prices for each of the 24 goods categories in our sample. The median of this ratio across product categories rose from 1.1 in the year preceding June 2000 to 1.3 in the year preceding June 2002. To the extent that price is correlated with quality this change in the median is clear evidence of a flight from quality: the products that lose market share have significantly higher prices than do those products that gain market share.

Additional evidence on flight from quality in Argentina comes from CCR, which classifies brands into different categories ordered by decreasing quality: premium, first brands, new first brands, supermarket brands, and low-price brands. Table 11 reports the price of goods in each category relative to the price of goods in all categories for the year 2001. The table also contains the market shares of each category for 2001, 2002, and 2003.

Two key facts are worth noting. First, the average price of premium and first brands is roughly 43 percent higher than is the average price of lower-quality brands. This fact is consistent with the notion that price is correlated with quality. Second, after the devaluation there is a clear decline in the market share of premium and first brands, from 71 percent in 2001 to 63 percent in 2003. This decline is consistent with an ongoing flight from quality. Using consumption data collected by LatinPanel, which includes 3,000 Argentine households, McKenzie and Schargrodsky (2004) find results similar to those in our Table 12.

Further evidence of flight from quality is provided by an AC Nielsen survey of Argentinian consumers conducted in April 2002 (see *Wall Street Journal*, May 28, 2002). According to this survey, 88 percent of consumers reported that they changed the types of products that they purchased. Of those consumers, 85 percent switched to cheaper brands, 69 percent stopped buying certain products, and 45 percent were buying smaller packages.

Viewed overall, our results strongly support the view that there was flight from quality in the aftermath of the Argentinian devaluation. To the extent that CPI inspectors do not perfectly account for changes in the quality of products being purchased, a flight from quality will impart a negative bias to reported inflation rates. Presumably, the high rate of SKU destruction observed after the devaluation makes it much more difficult to correct for quality changes.

In summary, the findings of our Argentina case study are consistent with the results in section 2. In addition, we show that at-the-dock prices of imported goods rise by more than the analogue retail prices; the rate of increase in retail prices is higher for goods that have a higher market share of imported and exportable goods; the frequency of price adjustment is much larger for tradables than for nontradables. Our case study also provides direct evidence of flight from quality.

## 6. Large RER Appreciations

To assess the robustness of our results on the sources of RER fluctuations, we analyze large RER appreciations. We examine two episodes in which exchange-rate-based stabilization programs lead to economic expansions that are associated with large appreciations in the RER. We select these episodes because of data availability considerations.

In the first episode, Argentina maintained a fixed exchange rate with the U.S. dollar from April 1991 to December 2001 as part of the Convertibility Plan. The real exchange rate peaked in January 1995. Real GDP grew at an average annual rate of roughly 6.5 percent between 1991 and 1995.

The second episode is Mexico's exchange-rate-based stabilization, which began in late 1987. The U.S. dollar-peso exchange rate was initially fixed, then devalued according to a crawling peg, and was finally allowed to float within a narrow band. Between March 1988 and November 1994, Mexico successfully stabilized its nominal exchange rate. The peso devalued by roughly 5 percent per year. During this period there was a cumulative RER appreciation of 31 percent. In Mexico, the real exchange rate peaked in January 1994. Real GDP grew at an average annual rate of 3.8 percent between 1988 and 1994.

Table 12 summarizes the behavior of prices and exchange rates in our two large appreciation episodes. The RERs are measured relative to the US dollar. We note that the

CPI-based RER appreciated by 28 percent in Argentina and 46 percent in Mexico. This appreciation was accompanied by a rise in the dollar retail price of tradables (31 and 76 percent in Argentina and Mexico, respectively). These facts imply that, when we measure the price of tradable goods using retail prices, most of the movement in the RER is accounted for by changes in the prices of tradable goods (see decomposition (4.1)). In particular, the percentages of movements in the RER accounted for by changes in the prices of tradable goods are 89 and 58 percent in Argentina and Mexico, respectively.

In contrast, movements in pure-traded goods, which we measure using an equally weighted geometric average of import and export price indices, account for a relatively small fraction of movements in the RER: 21 percent in Argentina and -4 percent in Mexico.[25] This result reflects the fact that consistent with our previous evidence, relative PPP is a reasonable description of the behavior of import and export prices. The change in the dollar price of pure-traded goods was only -2 percent in Mexico and 6 percent in Argentina.

# 7. Medium-Size Devaluations and Small Exchange-Rate Fluctuations

Here, we examine the behavior of the RER in medium-size devaluations and small exchange-rate fluctuations. Unfortunately, for data availability reasons, we cannot hold constant the set of countries that we study. The set of medium-size devaluation episodes for which we have reliable data are the 1992 devaluations in Finland, Italy, Sweden, and the UK.[26] The average rate of devaluation in the first half year after the onset of these episodes is 20 percent. The corresponding figure for our large devaluation episodes is 62 percent.

Consistent with Engel (1999), we also study exchange-rate fluctuations by using quarterly data from ten OECD countries: Canada, Denmark, Finland, Germany, Italy, Japan, the Netherlands, Sweden, UK, and the U.S. over the period 1971-2001.

## 7.1. Medium-Size Devaluations

Table 13 presents data on cumulative logarithmic changes in trade-weighted nominal and real exchange rates and price levels for four medium-size devaluation episodes. There are several

[25] These results are consistent with Mendoza (2000), who finds that movements in the relative price of nontradable goods, especially housing, accounted for a large fraction of movements in the CPI-based RER during the Mexican exchange-rate-based stabilization episode.

[26] During 1993, real GDP fell by -1.2 percent, -2 percent, and 0.9 percent in Finland and Sweden and Italy, respectively. The UK experienced a mild expansion, with real GDP growing by 2.3 percent in 1993.

notable features of Table 13. First, in all cases, the rate of inflation is much lower than the rate of depreciation. Second, the retail prices of tradable goods move by significantly less than do import and export prices. Third, there is a substantial rise in import and export prices. Although there is substantial passthrough from exchange rates to import and export prices, relative PPP is a worse approximation than it is in our large devaluation episodes. This finding is consistent with findings in Campa and Goldberg (2004). Using different methods, these authors conclude that on average across OECD countries, import prices in local currencies reflect 46 percent of exchange-rate fluctuations in the short run, and nearly 64 percent over the long run.[27]

Table 14 summarizes the results of the Engel decomposition for our four medium-size devaluation episodes. Consistent with our large devaluation results, we find that when we use retail prices to measure $P^T$, changes in $\log(RER_t^T)$ account for most of the movements in $\log(RER_t)$. In contrast, changes in $\log(\overline{RER_t}^T)$ account for a much smaller fraction of the change in $\log(RER_t)$.

We conclude that using retail tradable goods prices leads one to overstate the fraction of the decline in the RER that is due to changes in the price of pure-traded goods across countries. While this overstatement is substantial, it is not as severe as it is in our large devaluation episodes.

### 7.2. Small Exchange-Rate Fluctuations

Authors such as Engel (1999) and Chari, Kehoe, and McGrattan (2002) conclude that, for small exchange-rate fluctuations, changes in $\log(RER_t^T)$ dominate movements in $\log(RER_t)$. We assess the sensitivity of these authors' findings to the use of at-the-dock prices in the analysis. For all ten countries in our sample we proceed as follows. We begin by HP filtering $\log(RER_t)$, $\log(\overline{RER_t}^T)$ and the nominal exchange rate. This filter isolates relatively small exchange-rate movements that occur at business-cycle frequencies. Using the HP-filtered data, we construct two statistics: the correlation between both $\log(RER_t)$ and $\log(\overline{RER_t}^T)$ with the nominal exchange rate; and the ratio of the standard deviation of our $RER$ measures to the standard deviation of the nominal exchange rate.

Table 15 in the working paper version of this paper (Burstein, Eichenbaum and Rebelo (2004)) reports results for both trade-weighted exchange rates and bilateral exchange rates

[27] See Obstfeld and Rogoff (2000) for additional evidence that in industrialized countries there is significant, albeit incomplete, passthrough from exchange rates to import prices.

with the U.S. dollar. Consistent with results in Mussa (1986), we find there is a very high correlation between the nominal exchange rate and $\log(RER_t)$: the average correlation between these two series across our ten countries is 93 percent. The volatility of these two series is roughly the same. Authors such as Chari, Kehoe, and McGrattan (2002) argue that they can obtain similar results if they replace $\log(RER_t)$ with $\log(RER_t^T)$. These observations lie at the heart of the view that sticky tradable goods prices are an important source of RER movements.

Next, we examine our results when we work with $\log(\overline{RER}_t^T)$. We find that $\log(\overline{RER}_t^T)$ is much less volatile than $\log(RER_t)$. However, there is substantial heterogeneity across countries in the ratio of the standard deviation of $\log(\overline{RER}_t^T)$ to the standard deviation of $\log(RER_t)$. To relate this statistic to the Engel decomposition (4.2), we compute the variance on both sides of that equation by abstracting from the covariance between $\log(\overline{RER}_t^T)$ and $\log(\overline{RER}_t^N)$.[28] We find that movements in $\log(\overline{RER}_t^T)$ account for 63 percent of the standard deviation in $\log(RER_t)$. We also find that $\log(\overline{RER}_t^T)$ is much less correlated with the nominal exchange rate than $\log(RER_t)$. The average correlation with the nominal exchange is 93 percent for $\log(RER_t)$ and 66 percent for $\log(\overline{RER}_t^T)$.

We conclude that changes in the price of nontradable goods relative to pure-traded goods account for a significant fraction of movements in the RER. But fluctuations in the price of pure-traded goods across countries account for the majority of small movements in the RER.

## 8. Conclusion

In this paper we argue that the primary force behind the large fall in real exchange rates that occurs after large devaluations is the slow adjustment in the price of nontradable goods and services. It is not the failure of relative PPP for goods that are actually traded.

We do not address the question of why the rate of inflation for nontradable goods is so much lower than the rate of devaluation. An important task for future research is to develop quantitative general equilibrium models that can account for this phenomenon.

[28] We cannot compute this covariance term because, for most of the countries in our sample, the time series for the price of nontradable goods is too short.

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**Table 1**
**Prices and Exchange Rates in Large Devaluations**
Cumulative Logarithmic Change

| | **Argentina - December 2001** | | | | **Brazil - December 1998** | | | |
|---|---|---|---|---|---|---|---|---|
| | *3 months* | *6 months* | *12 months* | *24 months* | *3 months* | *6 months* | *12 months* | *24 months* |
| US$ nominal exchange rate | 86.9 | 128.2 | 123.5 | 107.4 | 45.3 | 38.2 | 42.4 | 48.7 |
| Trade-weighted nominal exchange rate | 86.6 | 124.7 | 110.6 | 108.3 | 43.2 | 34.6 | 39.6 | 41.0 |
| Import prices (at the dock) | 68.1 | 111.4 | 111.3 | 99.3 | 44.3 | 36.7 | 43.1 | 49.5 |
| Export prices (at the dock) | n.a. | n.a. | n.a. | n.a. | 37.4 | 26.7 | 32.7 | 43.3 |
| Consumer price index | 9.2 | 26.6 | 34.3 | 37.9 | 2.8 | 3.9 | 8.6 | 14.4 |
| Nontradable prices | 2.8 | 8.3 | 13.0 | 18.3 | 1.4 | 2.2 | 5.1 | 9.7 |
| Retail price of tradables | 15.2 | 41.6 | 51.5 | 53.8 | 4.4 | 5.7 | 11.4 | 16.8 |
| Public goods prices | 0.8 | 4.5 | 4.7 | 7.5 | 2.2 | 2.9 | 8.1 | n.a. |
| CPI-based real exchange rate (trade weighted) | -78.5 | -100.2 | -82.2 | -81.7 | -40.5 | -31.5 | -32.7 | -30.7 |

| | **Korea - September 1997** | | | | **Mexico - November 1994** | | | |
|---|---|---|---|---|---|---|---|---|
| | *3 months* | *6 months* | *12 months* | *24 months* | *3 months* | *6 months* | *12 months* | *24 months* |
| US$ nominal exchange rate | 49.0 | 49.3 | 41.2 | 27.6 | 50.2 | 54.9 | 80.0 | 83.3 |
| Trade-weighted nominal exchange rate | 46.3 | 46.6 | 37.3 | 30.8 | 50.2 | 56.1 | 80.4 | 82.9 |
| Import prices (at the dock) | 28.7 | 38.8 | 21.5 | 19.7 | 52.5 | 59.1 | 84.0 | 86.9 |
| Export prices (at the dock) | 32.4 | 44.8 | 22.5 | 11.0 | 51.6 | 57.9 | 79.6 | 87.1 |
| Consumer price index | 2.6 | 6.5 | 6.6 | 7.4 | 8.7 | 26.2 | 39.5 | 64.0 |
| Nontradable prices | 2.1 | 5.0 | 5.1 | 4.8 | 6.7 | 21.6 | 31.6 | 53.6 |
| Retail price of tradables | 3.0 | 8.0 | 8.2 | 10.2 | 10.0 | 29.6 | 45.6 | 72.1 |
| Public goods prices | 1.0 | 7.1 | 7.5 | n.a. | 3.6 | 20.7 | 29.2 | 53.1 |
| CPI-based real exchange rate (trade weighted) | -43.3 | -39.4 | -30.4 | -24.6 | -42.0 | -31.5 | -42.7 | -24.3 |

| | **Thailand - June 1997** | | | |
|---|---|---|---|---|
| | *3 months* | *6 months* | *12 months* | *24 months* |
| US$ nominal exchange rate | 34.2 | 56.3 | 49.7 | 35.8 |
| Trade-weighted nominal exchange rate | 30.5 | 46.2 | 35.9 | 28.6 |
| Import prices (at the dock) | 30.1 | 50.3 | 40.4 | 20.4 |
| Export prices (at the dock) | 31.4 | 47.5 | 32.3 | 17.6 |
| Consumer price index | 3.7 | 5.3 | 10.1 | 8.9 |
| Nontradable prices | n.a. | n.a. | n.a. | n.a. |
| Retail price of tradables | n.a. | n.a. | n.a. | n.a. |
| Public goods prices | n.a. | n.a | n.a. | n.a. |
| CPI-based real exchange rate (trade weighted) | -27.4 | -41.1 | -26.2 | -20.7 |

Source: National Statistic Agencies, and International Financial Statistics (IFS). For details see data appendix available upon request.

**Table 2**
**Prices, Deflators, and Exchange Rates in Large Devaluations**
Cumulative Logarithmic Change

| | **Argentina** | | | | **Brazil** | | |
|---|---|---|---|---|---|---|---|
| | *2001* | *2002* | *2003* | | *1998* | *1999* | *2000* |
| US$ nominal exchange rate | 0.0 | 112.0 | 106.5 | | 0.0 | 47.0 | 47.9 |
| Trade-weighted nominal exchange rate | n.a. | n.a. | n.a. | | n.a. | n.a. | n.a. |
| Consumer price index | 0.0 | 23.0 | 35.6 | | 0.0 | 8.0 | 14.0 |
| Deflators | | | | | | | |
| Imports | 0.0 | 107.4 | 104.3 | | 0.0 | 48.8 | 51.0 |
| Exports | 0.0 | 103.6 | 102.5 | | 0.0 | 34.7 | 41.2 |

| | **Korea** | | | | **Mexico** | | |
|---|---|---|---|---|---|---|---|
| | *1996* | *1997* | *1998* | *1999* | *1994* | *1995* | *1996* |
| US$ nominal exchange rate | 0.0 | 16.8 | 55.5 | 39.1 | 0.0 | 64.3 | 81.2 |
| Trade-weighted nominal exchange rate | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. |
| Consumer price index | 0.0 | 4.3 | 11.6 | 12.4 | 0.0 | 30.0 | 59.6 |
| Deflators | | | | | | | |
| Imports | 0.0 | 11.0 | 35.4 | 16.2 | 0.0 | 66.9 | 86.1 |
| Exports | 0.0 | 4.9 | 25.6 | 3.1 | 0.0 | 58.6 | 79.1 |

| | **Thailand** | | | |
|---|---|---|---|---|
| | *1996* | *1997* | *1998* | *1999* |
| US$ nominal exchange rate | 0.0 | 21.3 | 49.0 | 40.0 |
| Trade-weighted nominal exchange rate | n.a. | n.a. | n.a. | n.a. |
| Consumer price index | 0.0 | 5.4 | 13.2 | 13.5 |
| Deflators | | | | |
| Imports | 0.0 | 16.9 | 31.0 | 27.4 |
| Exports | 0.0 | 15.8 | 26.0 | 16.6 |

| | **Indonesia** | | | | **Malaysia** | | | |
|---|---|---|---|---|---|---|---|---|
| | *1996* | *1997* | *1998* | *1999* | *1996* | *1997* | *1998* | *1999* |
| US$ nominal exchange rate | 0.0 | 21.7 | 145.3 | 121.0 | 0.0 | 11.2 | 44.5 | 41.2 |
| Trade-weighted nominal exchange rate | n.a. | n.a. | n.a. | n.a. | 0.0 | 2.8 | 29.1 | 28.0 |
| Consumer price index | 0.0 | 6.5 | 52.0 | 70.5 | 0.0 | 2.6 | 7.8 | 10.5 |
| Deflators | | | | | | | | |
| Imports | 0.0 | 8.8 | 99.3 | 120.0 | 0.0 | 7.2 | 30.0 | 28.6 |
| Exports | 0.0 | 16.5 | 112.2 | 124.5 | 0.0 | 7.0 | 28.6 | 26.9 |

| | **Philippines** | | | | **Uruguay** | | |
|---|---|---|---|---|---|---|---|
| | *1996* | *1997* | *1998* | *1999* | *2001* | *2002* | *2003* |
| US$ nominal exchange rate | 0.0 | 11.7 | 44.5 | 39.9 | 0.0 | 46.7 | 75.0 |
| Trade-weighted nominal exchange rate | 0.0 | 3.6 | 31.1 | 28.5 | 0.0 | 31.1 | 72.3 |
| Consumer price index | 0.0 | 5.7 | 15.0 | 21.5 | 0.0 | 13.1 | 30.8 |
| Deflators | | | | | | | |
| Imports | 0.0 | 16.9 | 41.3 | 41.6 | 0.0 | 38.0 | 70.6 |
| Exports | 0.0 | 14.2 | 53.5 | 59.7 | 0.0 | 34.3 | 65.0 |

Source: Statistical Division of United Nations, and International Financial Statistics (IFS) from IMF.
Trade-weighted nominal exchange rate is NEER from INS reported in IFS.
We compute import and export price deflators using annual UN Statistical Division NIPA data.
We compute Brazil's import and export price deflators using quarterly NIPA data from IBGE for the last quarter of each year.

**Table 3**
**Share of Tradables in CPI, and Import Content of Consumption**

| | Argentina | Brazil | Korea | Mexico | Thailand |
|---|---|---|---|---|---|
| **Share of Tradables in CPI** | 53.0 | 59.3 | 48.0 | 53.5 | 43.3 |
| **Import Content in Consumption** | | | | | |
| Direct import content | 4.3 | 2.3 * | 6.6 | 4.7 | 7.8 * |
| Total import content | 10.5 | 8.9 ** | 20.6 | 10.9 | 20.7 * |

| | Finland | Italy | Sweden | UK | US |
|---|---|---|---|---|---|
| **Share of Tradables in CPI** | 58.7 | 65.8 | 48.0 | 69.0 | 42.9 |
| **Import Content in Consumption** | | | | | |
| Direct import content | 13.1 | 6.6 | 13.6 | 12.0 | 4.7 |
| Total import content | 24.0 | 16.2 | 25.3 | 20.9 | 9.1 |

* Imported final consumption goods / private consumption, from National Income and Product Accounts (NIPA).
** Total imports / final demand, from NIPA.
*** Imports of final consumption and of intermediate inputs for consumption / private consumption, from NIPA and trade accounts.

Source: National Statistic Agencies, OECD Input-Output Tables.

**Table 4**
**Price Accounting for Large Devaluations**
**Inflation One Year after Devaluation**

| | **Argentina** | **Brazil** | **Korea** | **Mexico** |
|---|---|---|---|---|
| Case I: $\bar{P}^I$ = Exchange Rate x Simple Geometric Average of Foreign Import and Export Prices | | | | |
| Assumption A: All goods traded | 128.4 | 42.0 | 34.4 | 83.3 |
| Assumption B: Nontradables, no distribution, no local goods | 74.2 | 27.0 | 19.2 | 59.3 |
| Assumption C: Nontradables, distribution, no local goods | 43.6 | 16.1 | 12.1 | 45.4 |
| Assumption D: Nontradables, distribution, local goods | 25.1 | 8.4 | 11.1 | 37.2 |
| Actual CPI inflation | 34.3 | 8.6 | 6.6 | 39.5 |
| Case II: $\bar{P}^I$ = Simple Geometric Average of Import and Export Prices | | | | |
| Assumption A: All goods traded | 111.3 | 37.9 | 22.0 | 81.8 |
| Assumption B: Nontradables, no distribution, no local goods | 65.1 | 24.5 | 13.2 | 58.4 |
| Assumption C: Nontradables, distribution, no local goods | 39.0 | 14.8 | 9.2 | 45.0 |
| Assumption D: Nontradables, distribution, local goods | 23.3 | 8.0 | 8.6 | 37.0 |
| Actual CPI inflation | 34.3 | 8.6 | 6.6 | 39.5 |

**Table 5**
**CPI and Economist Intelligence Unit (EIU) Inflation Rates**

| | Partial CPI Inflation | EIU Inflation Low price outlet | EIU Inflation High price outlet |
|---|---|---|---|
| One-year inflation rate, starting in September | | | |
| Argentina, 2001 | 54.1 | 68.4 | 68.8 |
| Brazil, 1998 | 7.2 | 15.2 | 14.6 |
| Korea, 1997 | 5.1 | 23.4 | 14.4 |
| Mexico, 1994 | 44.0 | 49.0 | 44.0 |
| Two-year inflation rate, starting in September | | | |
| Argentina, 2001 | 53.4 | 75.1 | 71.9 |
| Brazil, 1998 | 14.1 | 19.4 | 16.1 |
| Korea, 1997 | 5.4 | 30.8 | 20.9 |
| Mexico, 1994 | 70.8 | 72.0 | 69.3 |

Partial CPI inflation is a weighted average of clothing, durables, food, and housing non-durables.

Source: Economist Intelligence Unit and National Statistical Agencies.

**Table 6**
**How Much of the Decline in the RER Is Due to the Decline in the Price of Tradable Goods ?**
Percent as a Fraction of Change in CPI-based-RER

| | Argentina - December 2001 | | | | Brazil - December 1998 | | | |
|---|---|---|---|---|---|---|---|---|
| | *3 months* | *6 months* | *12 months* | *24 months* | *3 months* | *6 months* | *12 months* | *24 months* |
| Retail prices | 92.4 | 85.0 | 79.1 | 80.5 | 96.1 | 94.4 | 91.4 | 92.0 |
| Simple geometric average of import and export prices | 22.4 | 19.7 | 20.8 | 26.5 | 5.2 | 10.4 | 12.7 | -1.2 |
| Import prices | 21.8 | 19.1 | 22.5 | 26.5 | -3.4 | -3.7 | 2.5 | -1.4 |
| | **Korea - September 1997** | | | | **Mexico - November 1994** | | | |
| | *3 months* | *6 months* | *12 months* | *24 months* | *3 months* | *6 months* | *12 months* | *24 months* |
| Retail prices | 99.0 | 96.1 | 94.8 | 88.7 | 96.9 | 89.2 | 85.7 | 66.8 |
| Simple geometric average of import and export prices | 38.4 | 7.1 | 40.8 | 35.8 | -0.9 | 1.7 | 3.6 | -3.1 |
| Import prices | 42.5 | 11.3 | 36.9 | 18.8 | -3.2 | -1.2 | -3.8 | -0.7 |
| | **Thailand - June 1997** | | | | | | | |
| | *3 months* | *6 months* | *12 months* | *24 months* | | | | |
| Retail prices | n.a. | n.a. | n.a. | n.a. | | | | |
| Simple geometric average of import and export prices | 2.8 | 3.2 | 6.5 | 26.6 | | | | |
| Import prices | 3.7 | -1.5 | -16.9 | 12.9 | | | | |

**Table 7**
**Prices and Exchange Rates in Argentina**
Cumulative Logarithmic Change
December 2001 - December 2002

| | **Price change** percent | **Share in CPI** percent |
|---|---|---|
| US$ nominal exchange rate | 123.5 | |
| Trade-weighted nominal exchange rate | 110.6 | |
| Import prices (at the dock) | 111.3 | |
| Producer prices | 78.0 | |
| Consumer price index | 34.3 | 100.0 |
| Nontradables | 13.0 | 47.0 |
| Tradables | 51.5 | 53.0 |
| **Disaggregated Tradables in CPI** | | |
| Imported | 83.2 | 3.0 |
| Exportables | 62.6 | 8.6 |
| Mixed origin | 71.7 | 5.8 |
| With imported inputs | 49.6 | 10.0 |
| With exportable inputs | 44.8 | 9.6 |
| Local goods | 41.8 | 16.1 |
| **Disaggregated Nontradables in CPI** | | |
| Public services | 4.7 | |
| Private services | 14.6 | |

Source: INDEC.

**Table 8**
**Inflation and Market Share of Imports and Exportables in Argentina**

| **Product Category** | **Inflation** (log percent) Dec 01 - June 02 | **Market Share** Imported + Exportables Oct-02 |
|---|---|---|
| Beer | 32.4 | 12.7 |
| Bread | 33.4 | 52.7 |
| Cereals | 40.3 | 55.7 |
| Cleaning liquids | 50.4 | 86.2 |
| Coffee | 45.1 | 55.8 |
| Deodorant | 50.0 | 86.4 |
| Detergents for clothes | 67.1 | 66.0 |
| Diapers | 83.3 | 72.4 |
| Dish detergents | 50.1 | 32.1 |
| Female protection | 67.0 | 85.7 |
| Hamburgers | 17.9 | 0.7 |
| Insect killer | 53.3 | 77.7 |
| Juice | 50.0 | 11.5 |
| Mayonnaise | 64.5 | 95.4 |
| Milk | 41.9 | 0.2 |
| Paper towels | 52.4 | 50.8 |
| Shampoo | 47.3 | 71.4 |
| Soap | 46.0 | 70.1 |
| Soda | 31.5 | 3.9 |
| Toothpaste | 67.0 | 68.3 |
| Yogurt | 27.7 | 4.1 |

Correlation coefficient: 0.69.

Source: CCR, INDEC, and our own survey.

**Table 9**
**Frequency of Price Adjustment in Buenos Aires**
March 27 - December 24, 2002

| | **Goods** | **Services** |
|---|---|---|
| **Weekly** | | |
| Number of products | 58 | 10 |
| Median frequency of price adjustment (%) | 30.0 | 0.0 |
| Median time between price change | 5.3 | $[39, \infty)$ |
| **Monthly** | | |
| Number of products | 58 | 10 |
| Median frequency of price adjustment (%) | 66.5 | 0.0 |
| Median time between price change | 1.7 | $[9, \infty)$ |

Source: Our own price survey.

**Table 10: Prices, Market Shares, and Product Destruction in Argentina**

| Product Category | Product destruction: Percentage of SKUs destroyed in previous 6 months | | | | | Average price of SKUs whose market share fell by > 2% between June t , t+1 / Average price of SKUs whose market share increased by > 2% between June t , t+1 | | |
|---|---|---|---|---|---|---|---|---|
| | June 2000 | Dec. 2000 | June 2001 | Dec. 2001 | June 2002 | June 2000 June 1999 | June 2001 June 2000 | June 2002 June 2001 |
| Beer | 19 | 15 | 26 | 17 | 32 | 0.91 | 0.86 | 1.24 |
| Bread | 13 | 11 | 13 | 15 | 20 | 1.01 | 1.34 | 1.08 |
| Cereals | 12 | 11 | 14 | 14 | 17 | 1.27 | 0.96 | 1.78 |
| Cleaning products | 15 | 11 | 15 | 15 | 26 | 1.08 | 0.78 | 1.30 |
| Clothes detergents | 22 | 18 | 19 | 18 | 25 | 1.00 | 1.00 | 1.31 |
| Coffee | 11 | 11 | 10 | 16 | 17 | 1.10 | 1.08 | 0.99 |
| Cooking oil | 13 | 7 | 10 | 17 | 25 | 0.97 | 0.91 | 1.04 |
| Deodorants | 11 | 9 | 10 | 11 | 28 | 0.92 | 0.91 | 1.27 |
| Diapers | 15 | 13 | 20 | 27 | 44 | 1.09 | 1.08 | 1.76 |
| Dish detergents | 19 | 10 | 16 | 16 | 28 | 0.74 | 1.57 | 1.59 |
| Feminine protection | 14 | 9 | 9 | 11 | 21 | 0.87 | 1.21 | 1.28 |
| Hamburgers | 15 | 12 | 20 | 13 | 17 | 1.24 | 1.11 | 1.16 |
| Ice cream | 18 | 14 | 21 | 14 | 22 | 1.25 | 0.96 | 1.48 |
| Insects killers | 16 | 5 | 15 | 7 | 23 | 0.89 | 1.01 | 1.14 |
| Juice | 13 | 16 | 17 | 16 | 37 | 0.68 | 1.64 | 2.15 |
| Mayonnaise | 13 | 14 | 15 | 15 | 32 | 1.11 | 0.89 | 1.06 |
| Milk | 12 | 10 | 18 | 18 | 24 | 1.05 | 1.11 | 0.98 |
| Paper towels | 25 | 22 | 16 | 15 | 31 | 0.95 | 1.07 | 1.28 |
| Shampoo | 18 | 15 | 19 | 17 | 37 | 1.05 | 1.10 | 2.16 |
| Soap | 19 | 11 | 18 | 14 | 27 | 1.22 | 1.00 | 1.39 |
| Soft drinks | 21 | 16 | 25 | 26 | 38 | 1.06 | 1.10 | 0.88 |
| Toothpaste | 12 | 10 | 9 | 10 | 25 | 1.03 | 1.14 | 1.35 |
| Wine | 12 | 9 | 11 | 14 | 15 | 1.21 | 0.72 | 1.13 |
| Yogurt | 16 | 11 | 19 | 16 | 28 | 1.26 | 1.45 | 1.31 |
| Average | 16 | 12 | 16 | 16 | 27 | 1.04 | 1.08 | 1.34 |
| Median | 15 | 11 | 16 | 15 | 26 | 1.05 | 1.08 | 1.28 |

Source: CCR.

**Table 11: Flight From Quality in Argentina**

| | Price of category/ Average price across categories, in 2001 | Market Share 2001 | Market Share 2002 | Market Share 2003 |
|---|---|---|---|---|
| Premium brands | 1.5 | 13.7 | 10.7 | 10.4 |
| First brands | 1.1 | 57.3 | 53.2 | 52.7 |
| New first brands | 0.8 | 6.4 | 10.0 | 9.6 |
| Supermarket brands | 0.8 | 6.5 | 7.8 | 9.5 |
| Low price brands | 0.8 | 16.0 | 18.3 | 17.8 |
| Premium and first brands | 1.2 | 71.0 | 63.9 | 63.1 |
| New first, supermarket, and low price brands | 0.8 | 28.9 | 36.1 | 36.9 |

Source: CCR.

**Table 12**
**Real Exchange Rate Appreciations in Exchange-Rate-Based Stabilizations**
Cumulative Logarithmic Change

| **Mexico , March 1988 - January 1994** | | **Argentina , April 1991 - January 1995** | |
|---|---|---|---|
| US$ nominal exchange rate | 30.9 | US$ nominal exchange rate | 0.0 |
| Import prices (at the dock) | 43.0 | Import prices (at the dock) | 10.9 |
| Export prices (at the dock) | 32.8 | Export prices (at the dock) | n.a. |
| | | | |
| Consumer price index | 100.1 | Consumer price index | 38.1 |
| Retail price of tradables | 76.2 | Retail price of tradables | 31.1 |
| Nontradable prices excluding housing | 103.4 | Nontradable prices | 56.7 |
| Housing | 183.6 | | |
| | | | |
| CPI-based RER | 46.3 | CPI-based RER | 27.6 |
| CPI (excluding housing) - based RER | 32.8 | CPI (excluding housing) - based RER | n.a. |
| Retail price of tradables - based RER | 26.9 | Retail price of tradables - based RER | 24.5 |
| Simple geometric average of import and export price - based RER | -1.7 | Simple geometric average of import and export price - based RER | 5.8 |

Source: National statistical agencies. For details see data appendix.

**Table 13**
**Prices and Exchange Rates in Medium-Sized Devaluations**
Cumulative Logarithmic Change

| | **Finland - August 1992** | | | | **Italy - August 1992** | | | |
|---|---|---|---|---|---|---|---|---|
| | *3 months* | *6 months* | *12 months* | *24 months* | *3 months* | *6 months* | *12 months* | *24 months* |
| US$ nominal exchange rate | 23.8 | 38.2 | 38.2 | 25.6 | 21.3 | 34.0 | 37.6 | 36.1 |
| Trade-weighted nominal exchange rate | 12.3 | 20.0 | 18.0 | 10.8 | 11.4 | 20.7 | 21.1 | 26.4 |
| Import prices (at the dock) | 9.3 | 10.9 | 12.9 | 12.4 | 9.4 | 14.3 | 12.6 | 17.4 |
| Export prices (at the dock) | 4.8 | 6.6 | 7.9 | 11.0 | 5.8 | 12.2 | 13.3 | 16.0 |
| Consumer price index | 0.9 | 2.0 | 2.0 | 3.9 | 1.3 | 2.4 | 4.4 | 8.1 |
| Nontradable prices | 0.5 | 0.9 | 1.0 | 3.0 | 1.2 | 2.3 | 4.3 | 7.8 |
| Retail price of tradables | 1.6 | 3.7 | 4.8 | 7.1 | 1.7 | 2.8 | 5.2 | 9.3 |
| CPI-based real exchange rate (trade weighted) | -12.0 | -20.1 | -19.0 | -12.3 | -10.6 | -20.0 | -19.5 | -23.4 |

| | **Sweden - September 1992** | | | | **UK - August 1992** | | | |
|---|---|---|---|---|---|---|---|---|
| | *3 months* | *6 months* | *12 months* | *15 months* | *3 months* | *6 months* | *12 months* | *15 months* |
| US$ nominal exchange rate | 24.9 | 36.6 | 40.2 | 34.0 | 23.9 | 29.9 | 26.2 | 22.9 |
| Trade-weighted nominal exchange rate | 15.2 | 22.1 | 27.9 | 26.5 | 15.6 | 17.8 | 11.3 | 13.4 |
| Import prices (at the dock) | 6.3 | 14.2 | 16.3 | 20.7 | 7.2 | 12.3 | 12.9 | 18.5 |
| Export prices (at the dock) | 4.2 | 10.3 | 11.1 | 17.1 | 1.7 | 11.1 | 12.5 | 15.4 |
| Consumer price index | 0.1 | 3.5 | 4.1 | 6.7 | 0.6 | -0.1 | 1.7 | 4.1 |
| Nontradable prices | -0.2 | 4.1 | 4.3 | 7.4 | 0.9 | 1.8 | 4.8 | 8.0 |
| Retail price of tradables | 1.2 | 4.9 | 6.2 | 8.5 | 0.6 | 0.3 | 1.8 | 3.1 |
| CPI-based real exchange rate (trade weighted) | -15.4 | -20.3 | -26.3 | -24.5 | -15.7 | -19.6 | -12.3 | -14.3 |

Source: National Statistic Agencies, and International Financial Statistics (IFS). For details see data appendix available upon request.

**Table 14**
**How Much of the Decline in the RER Is Due to the Decline in the Price of Tradable Goods ?**
Percent as a Fraction of Change in CPI-based-RER

| | Finland - August 1992 | | | | Italy - September 1992 | | | |
|---|---|---|---|---|---|---|---|---|
| | *3 months* | *6 months* | *12 months* | *24 months* | *3 months* | *6 months* | *12 months* | *24 months* |
| Retail prices | 93.9 | 91.4 | 85.3 | 74.2 | 96.9 | 97.8 | 96.2 | 94.9 |
| Simple geometric average of import and export prices | 50.4 | 73.7 | 60.1 | 41.4 | 37.9 | 40.4 | 47.1 | 48.6 |
| Import prices | 38.4 | 64.8 | 47.3 | 38.1 | 25.0 | 34.4 | 48.6 | 45.5 |

| | Sweden - August 1992 | | | | UK - August 1992 | | | |
|---|---|---|---|---|---|---|---|---|
| | *3 months* | *6 months* | *12 months* | *15 months* | *3 months* | *6 months* | *12 months* | *15 months* |
| Retail prices | 93.0 | 92.7 | 92.3 | 92.5 | 99.6 | 98.0 | 99.2 | 107.2 |
| Simple geometric average of import and export prices | 73.3 | 63.7 | 61.9 | 45.2 | 74.5 | 34.8 | -4.5 | -11.4 |
| Import prices | 69.1 | 55.0 | 49.0 | 36.1 | 59.3 | 31.4 | -7.9 | -23.4 |

Figure 1: Exchange Rates and Prices in Large Devaluations

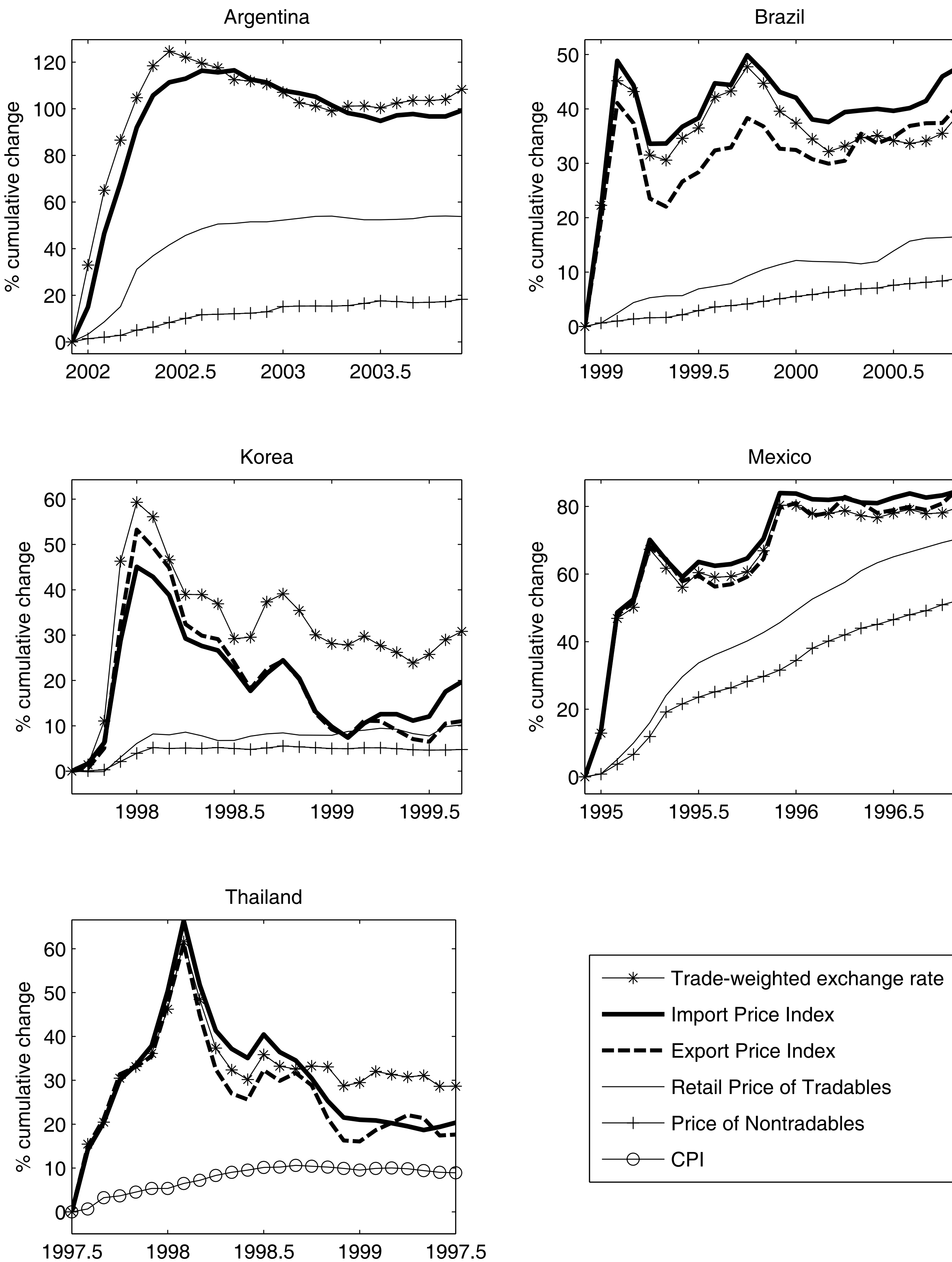

Figure 2: Total Import Prices and Consumer Import Prices in Large Devaluations

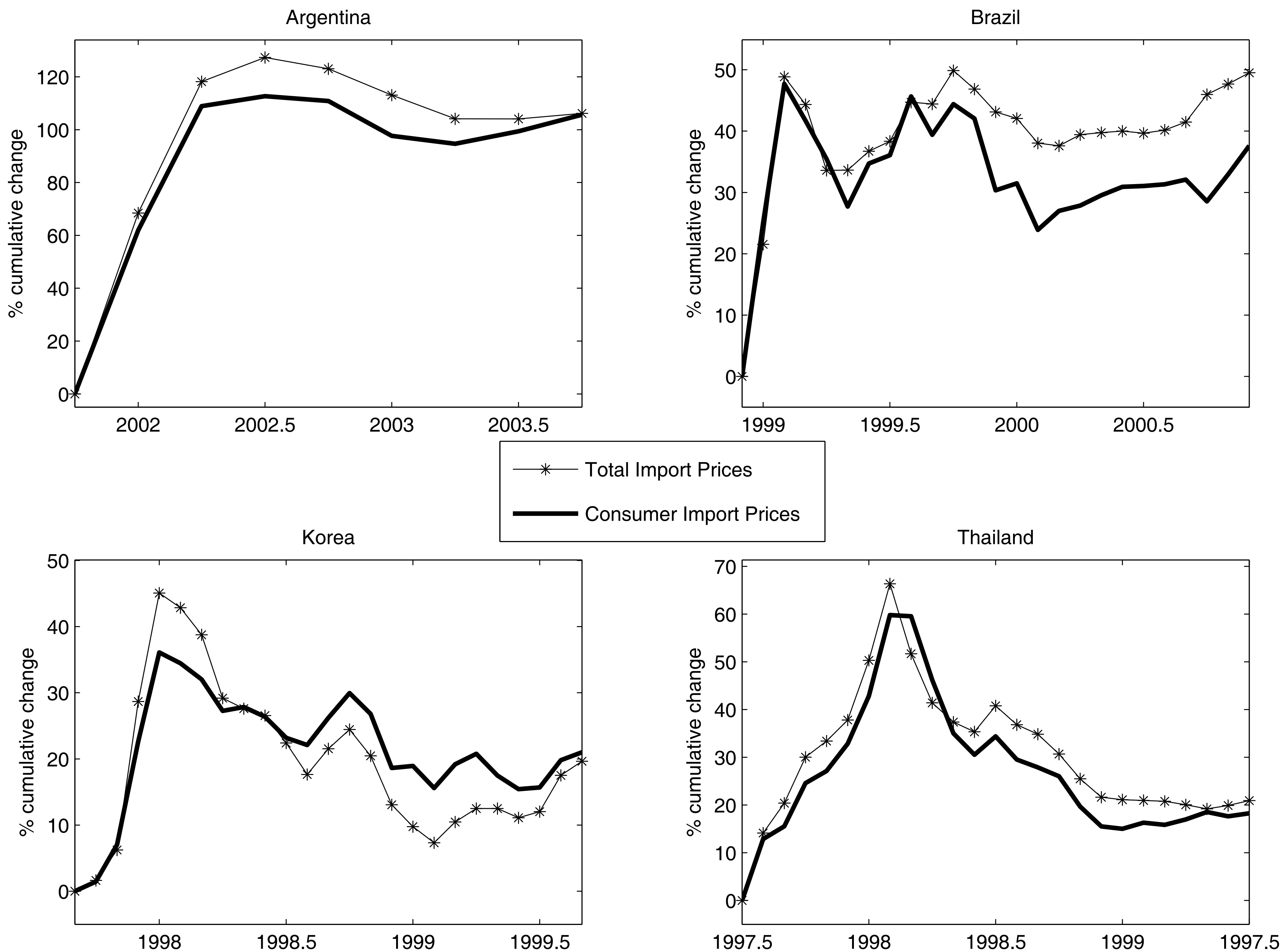

Figure 3: Price Accounting, Change in Gross Markup ($\mu$)

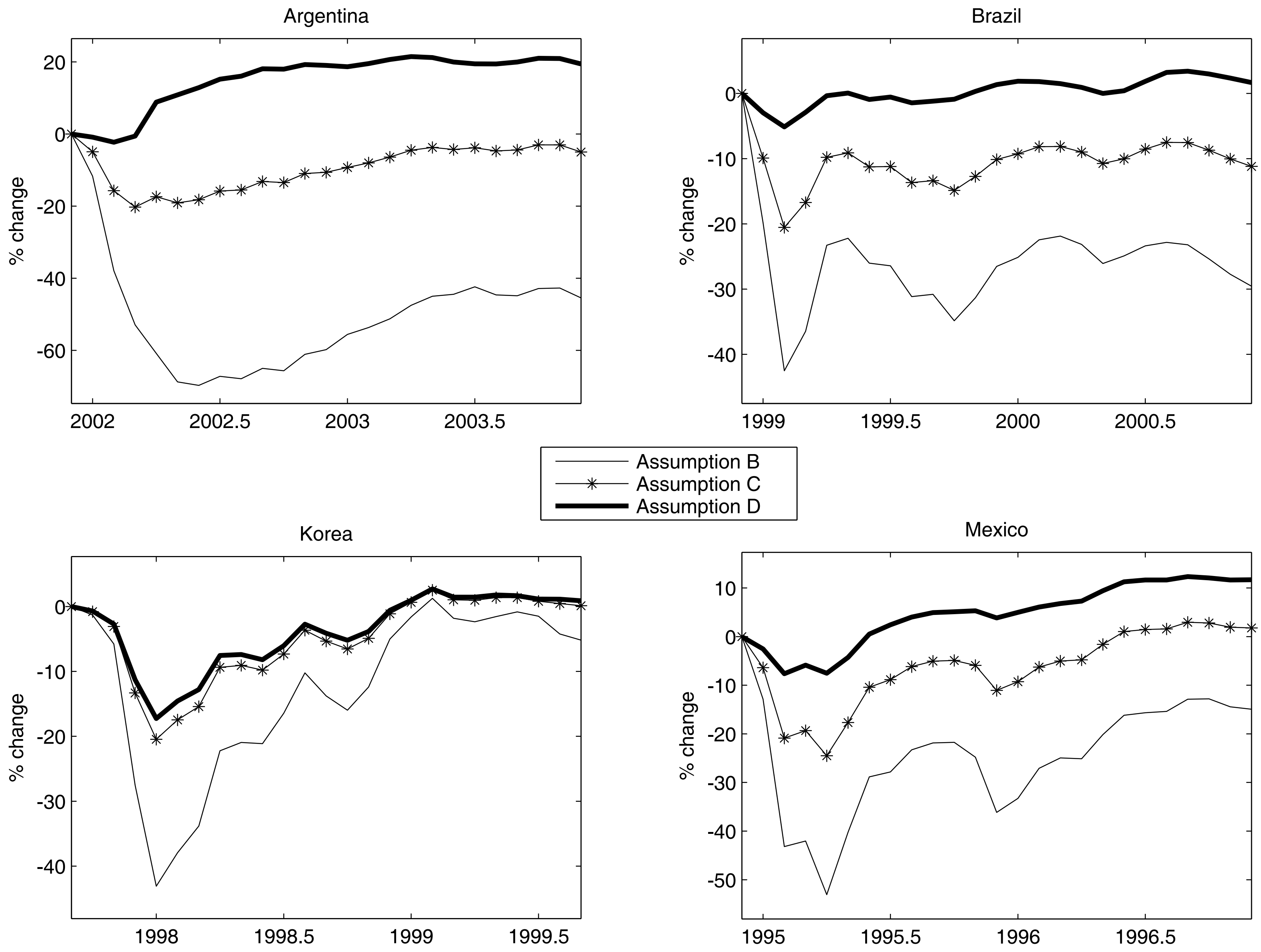

Figure 4: Real Exchange Rate Changes in Large Devaluations

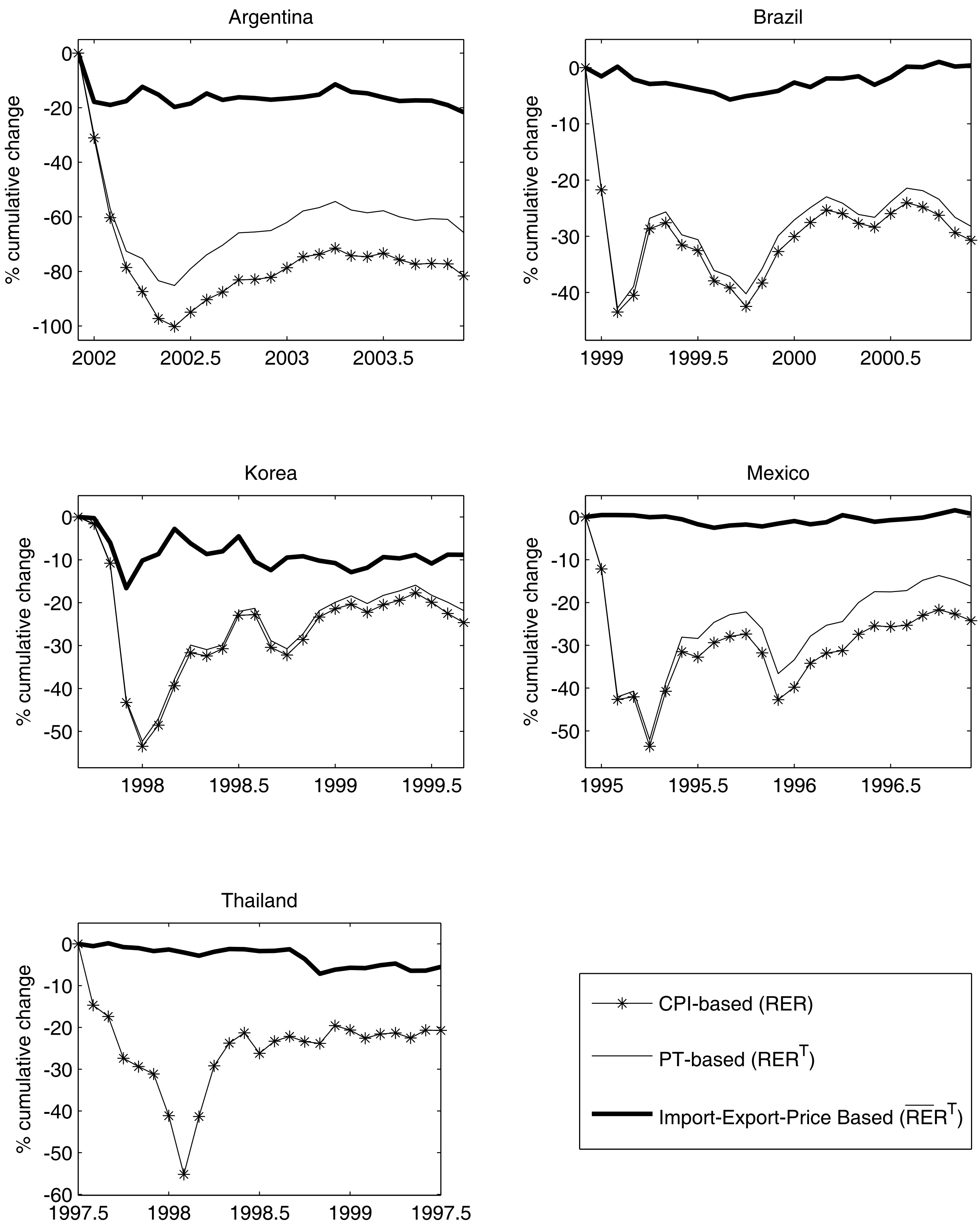

**Figure 5**
**Histogram, Frequency of Price Changes**