How Important Are Nontradable Goods Prices As Sources of Cyclical Fluctuations in Real Exchange Rates?

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Abstract

They account for roughly 50 percent of the cyclical moments in real exchange rates.

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1. Introduction

A classic question in international macroeconomics is whether fluctuations in the real exchange rate \((RER^{\text{cpi}})\) constructed using the consumer price index (CPI) are primarily associated with movements in the relative price of tradable goods across countries or with fluctuations in the relative price of nontradable to tradable goods. Authors such as Engel (1999) and Chari, Kehoe, and McGrattan (2002) conclude that fluctuations in the real exchange rates (RER) of developed economies are almost exclusively driven by changes in the relative price of tradable goods across countries. Their evidence suggests it is not important to distinguish between tradable and nontradable goods to understand cyclical RER fluctuations.

We argue that fluctuations in the relative price of nontradable to tradable goods are actually an important source of movements in \(RER^{\text{cpi}}\). We reach this conclusion using an approach proposed by Engel (1999). This approach decomposes the variance of \(RER^{\text{cpi}}\) into the variance of the relative price of tradable goods across countries, the variance in the relative price of nontradable to tradable goods, and a covariance term. To implement this decomposition we must take a stand on how to measure the price of tradable goods. A standard approach in the literature is to measure this price using retail prices. Unfortunately, retail prices are heavily contaminated by the cost of nontradable distribution services such as retailing, wholesaling, and transportation (see Burstein, Neves, and Rebelo (2003)). One approach to dealing with the distribution cost issue is to measure tradable goods prices using the producer price index (PPI). But a problem with the PPI is that it generally excludes import prices (IMF(2004)) and, for roughly one third of OECD countries, it also excludes export prices (Maitland-Smith (2000)). For this reason, we focus on the price of pure-traded goods at the dock, i.e. the price of goods that are actually traded exclusive of distribution.
costs.\textsuperscript{1} We measure the relative price of pure-traded goods across countries using a weighted average of import and export price indices. We use quarterly data for 11 OECD countries for the period 1971 to 2002. Our key finding is that, for the median country, variations in the price of nontradable goods relative to the price of pure-traded goods account for over 50 percent of movements in $RER^{cpi}$.\textsuperscript{2}

Our conclusion about the importance of movements in the relative price of nontradable goods depends critically on our measure of the price of tradable goods. To substantiate this statement we use U.S. data to decompose the variance of $RER^{cpi}$ using two alternative measures of the price of tradable goods: the retail price of tradable goods and a weighted average of import and export prices. The first price measure implies that the relative price of nontradable to tradable goods accounts for virtually none of the variance of $RER^{cpi}$. In sharp contrast, the second price measure implies that the relative price of nontradable to tradable goods accounts for at least 55 percent of the variance of $RER^{cpi}$. Using the retail price of tradable goods leads one to overstate the fraction of cyclical RER fluctuations that are due to changes in the prices of pure-traded goods across countries.

Viewed overall, our results suggest that a successful theory of RER fluctuations cannot abstract from changes across countries in the price of nontradable goods relative to the price of pure-traded goods. At the same time, our results are consistent with the view that there are significant fluctuations in the relative price of pure-traded goods across countries. These fluctuations could reflect a

\textsuperscript{1}In addition to including distribution costs, CPI-based retail prices differ from import and export prices because the former includes “local goods.” These are goods that are produced solely for the domestic market and are not traded.

\textsuperscript{2}Betts and Kehoe (2005) also argue that movements in nontraded goods prices are important in explaining RER fluctuations. Their analysis is based on RERs constructed using gross output deflators. These deflators are available only at an annual frequency, and they do not include the price of imported final goods.
variety of factors such as sticky prices and endogenous changes in real markups. In addition, countries import and export different baskets of goods. So changes in the relative prices of these goods lead to changes in the relative price of traded baskets and in the measured RER. Assessing the plausibility of these alternative hypotheses is an important objective of ongoing research. Our point here is that a convincing theory of RER fluctuations cannot be based solely on fluctuations in the relative price of pure-traded goods across countries.

The remainder of this paper is organized as follows. Section 2 describes the method that we use to decompose RER\textsuperscript{cpi} movements. We report our empirical results in Section 3. Section 4 concludes.

2. Decomposing the Source of RER Fluctuations

We define the CPI-based RER as:

$$RER\textsuperscript{cpi}_t = \frac{P_t}{S_t P^*_t}.$$  \hspace{1cm} (2.1)

Here $S_t$ denotes the trade-weighted nominal exchange rate of the home country defined as units of local currency per unit of trade-weighted foreign currency. The variables $P_t$ and $P^*_t$ denote the level of the CPI in the home country and the trade-weighted CPI of foreign countries, respectively.

To study the sources of RER movements we follow an approach proposed by Engel (1999). To implement this approach, we assume that $P_t$ is computed as a geometric average of the price of tradable goods ($P^T_t$) and the price of nontradable ($P^N_t$) goods:

$$P_t = (P^T_t)^{1-\omega}(P^N_t)^{\omega}.$$  

Similarly, we assume that the foreign CPI is given by:

$$P^*_t = (P^T^*_t)^{1-\omega^*}(P^N^*_t)^{\omega^*}.$$
where $P_T^*$ and $P_N^*$ denote the foreign price of tradable and nontradable goods, respectively. The variables $\omega$ and $\omega^*$ represent the share of tradable goods in the domestic and foreign CPI baskets.

We denote the logarithm of $RE_{t}^{c pi}$, $RE_{t}^{T}$, and $RE_{t}^{N}$ by $rer_{t}^{c pi}$, $rer_{t}^{T}$, and $rer_{t}^{N}$, respectively. We decompose $rer_{t}^{c pi}$ as:

$$rer_{t}^{c pi} = rer_{t}^{T} + rer_{t}^{N}. \quad (2.2)$$

The first component, $rer_{t}^{T}$, is an index of the extent to which the price of tradable goods is different across countries:

$$rer_{t}^{T} = \log[P_T^t/(S_t P_T^*)].$$

The second component, $rer_{t}^{N}$, reflects the difference between the price of nontradable goods relative to tradable goods at home and abroad:

$$rer_{t}^{N} = \omega \log(P_N^t/P_T^t) - \omega^* \log(P_N^*/P_T^*).$$

Using (2.2) we can decompose the variance of $rer_{t}^{c pi}$ as:

$$\text{var}(rer_{t}^{c pi}) = \text{var}(rer_{t}^{T}) + \text{var}(rer_{t}^{N}) + 2 \text{cov}(rer_{t}^{T}, rer_{t}^{N}). \quad (2.3)$$

To implement this decomposition we construct empirical measures of $rer_{t}^{c pi}$ and $rer_{t}^{T}$. We then compute $rer_{t}^{N}$ as a residual, using the identity (2.2). Using these measures we estimate the individual elements of equation (2.3). We compute a lower bound, $L^N$, on the importance of movements in $rer_{t}^{N}$ by attributing the covariance term to fluctuations in the price of tradable (nontradable) goods when the covariance is positive (negative):
\( L^N = \begin{cases} 
\frac{\text{var}(\text{rer}^N_t)}{\text{var}(\text{rer}^cpi^N_t)} & \text{if } \text{cov}(\text{rer}^T_t, \text{rer}_N^N) > 0, \\
\frac{\text{var}(\text{rer}^N_t)}{\text{var}(\text{rer}^cpi^N_t)} + \frac{2\text{cov}(\text{rer}^T_t, \text{rer}_N^N)}{\text{var}(\text{rer}^cpi^N_t)} & \text{if } \text{cov}(\text{rer}^T_t, \text{rer}_N^N) < 0.
\end{cases} \) (2.4)

We compute an upper bound, \( U^N \), on the importance of movements in \( \text{rer}^N \) by attributing the covariance term to fluctuations in the price of nontradable (tradable) goods when the covariance is positive (negative):

\[ U^N = \begin{cases} 
\frac{\text{var}(\text{rer}^N_t)}{\text{var}(\text{rer}^cpi^N_t)} + \frac{2\text{cov}(\text{rer}^T_t, \text{rer}_N^N)}{\text{var}(\text{rer}^cpi^N_t)} & \text{if } \text{cov}(\text{rer}^T_t, \text{rer}_N^N) > 0, \\
\frac{\text{var}(\text{rer}^N_t)}{\text{var}(\text{rer}^cpi^N_t)} & \text{if } \text{cov}(\text{rer}^T_t, \text{rer}_N^N) < 0.
\end{cases} \] (2.5)

A key empirical question in implementing (2.2) is: how should we measure \( P^T_t \)? The most common approach in the literature is to measure \( P^T_t \) using CPI-based retail prices of tradable goods. In contrast, we measure the price of tradable goods using the price of pure-traded goods at the dock. Specifically, we use an equally weighted geometric average of import and export price indices.\(^3\) These indices have two important advantages relative to retail prices and the PPI. First, import and export indices measure the prices of goods that are actually traded. Second, these indices are much less contaminated by nontradable components such as distribution costs.

We use quarterly data covering the period 1971.Q1 to 2002.Q3 for 11 countries: Australia, Canada, Denmark, Finland, Germany, Italy, Japan, the Netherlands, Sweden, UK, and the U.S. All price series (nominal exchange rate, consumer price...

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\(^3\)We used import and export price indices when possible, and unit values when price indices are not available. When import price indices were available, and export price indices were not, we assumed that the export price index is equal to the import price index. This is the case for Denmark.
index, import and export price indices) are obtained from the IMF’s International Financial Statistics. We measure $S_t$, $P^*_t$ and $P^{T*}_t$ as trade-weighed averages of the individual country price series.\footnote{The trade share of country $i$ from country $j$ is $0.5 \, \text{exports}^i_j / \text{exports}^i + 0.5 \, \text{imports}^i_j / \text{imports}^i$, where exports$^i_j$ and imports$^i_j$ denote total exports and imports of country $i$, respectively, exports$^i$ denotes exports of country $i$ to country $j$, respectively, and imports$^i_j$ denotes imports of country $i$ from country $j$, respectively. For each country, we obtain import and export data from the IMF’s Direction of Trade Statistics. Export and import shares are computed as simple averages using annual data from 1980 to 2002. For each country we choose the set of 20 countries with which this country has the highest trade share. We then eliminated those countries for which we do not have import and export price indices. The remaining 17 countries are: Australia, Canada, Denmark, Finland, Germany, Greece, Italy, Japan, Korea, Mexico, Netherlands, Spain, Sweden, Switzerland, UK, US, and Venezuela. For the median country, our trade weights account for 57 percent of total imports and exports.} To isolate cyclical frequencies we detrend the logarithm of all our time series with the Hodrick-Prescott filter using a standard value of 1600 for the smoothing parameter.

Despite their advantages, there are three caveats about import and export price indices that are worth noting. First, some of the import and export prices can reflect transfer prices within multinational corporations instead of market transactions. Second, import and export indices include investment, intermediate goods, and raw materials as well as consumption goods.\footnote{See Burstein, Eichenbaum and Rebelo (2005) for a discussion of the second caveat.} Finally, for Denmark, Italy and Germany, import and export price indices are based on 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). A potential problem with UVIs is that they are affected by shifts over time in product composition.

3. Empirical Results

Figure 1 displays the time series on $\log(S_t)$, $rer^\text{cpi}_t$, and $rer^T_t$ for 11 countries. We normalize the level of these variables to zero in the beginning of the sample. Notice that $rer^\text{cpi}_t$ and $rer^T_t$ behave quite differently. These differences are particularly

\begin{itemize}
  \item [4]The trade share of country $i$ from country $j$ is $0.5 \, \text{exports}^i_j / \text{exports}^i + 0.5 \, \text{imports}^i_j / \text{imports}^i$, where exports$^i_j$ and imports$^i_j$ denote total exports and imports of country $i$, respectively, exports$^i$ denotes exports of country $i$ to country $j$, respectively, and imports$^i_j$ denotes imports of country $i$ from country $j$, respectively. For each country, we obtain import and export data from the IMF’s Direction of Trade Statistics. Export and import shares are computed as simple averages using annual data from 1980 to 2002. For each country we choose the set of 20 countries with which this country has the highest trade share. We then eliminated those countries for which we do not have import and export price indices. The remaining 17 countries are: Australia, Canada, Denmark, Finland, Germany, Greece, Italy, Japan, Korea, Mexico, Netherlands, Spain, Sweden, Switzerland, UK, US, and Venezuela. For the median country, our trade weights account for 57 percent of total imports and exports.
\end{itemize}
pronounced for Australia, Italy, Japan, the Netherlands, and Sweden.

The first panel of Table 1 displays summary statistics of the data. We compute three statistics for both \( \text{rer}_t^{cpi} \) and \( \text{rer}_t^T \): the standard deviation, the correlation with \( \log(S_t) \), and the elasticity with respect to \( \log(S_t) \). The latter is the slope of a linear regression of the logarithm of either \( \text{rer}_t^{cpi} \) or \( \text{rer}_t^T \) on \( \log(S_t) \). These elasticities do not have a causal or structural interpretation. However, they are a convenient way to summarize the quantitative relation between \( \text{rer}_t^{cpi} \), \( \text{rer}_t^T \) and nominal exchange rates.

Consistent with results in Mussa (1986) we find that there is a very strong correlation between the logarithm of the nominal exchange rate and \( \text{rer}_t^{cpi} \). The median correlation between these two series is \(-0.96\). The volatility of these series is also very similar. The median value of the ratio of the standard deviations of \( \text{rer}_t^{cpi} \) and \( \log(S_t) \) is 1.03. Next, we consider the elasticity of the \( \text{rer}_t^{cpi} \) and \( \text{rer}_t^T \) with respect to \( \log(S_t) \). The median value of this elasticity is \(-0.99\). Viewed overall our summary statistics suggest a very tight relation between \( \text{rer}_t^{cpi} \) and \( \log(S_t) \). One widely held interpretation of this tight relation is that it reflects the pervasiveness of sticky prices, with no distinction being made between tradable and nontradable goods.

Next we consider our summary statistics for \( \text{rer}_t^T \). The median correlation between \( \text{rer}_t^T \) and \( \log(S_t) \) is \(-0.69\), while the median value of the ratio of the standard deviations of these two series is 0.62. Finally, the elasticity of \( \text{rer}_t^T \) with respect to \( \log(S_t) \) is only \(-0.41\). Clearly, the relation between \( \text{rer}_t^T \) and \( \log(S_t) \) is substantially weaker than the relation between \( \text{rer}_t^{cpi} \) and \( \log(S_t) \).

We now examine the role of tradable and nontradable goods prices in accounting for movements in the RER. The last two columns of Table 1 report the lower and upper bounds for the importance of movements in nontradable goods prices as sources \( \text{rer}_t^{cpi} \) fluctuations, defined in (2.4) and (2.5). The median values of
these bounds are 52 and 68 percent. We redid our calculations measuring the price of pure-traded goods using only the price of imported goods. Here we find that the median values of $L^N$ and $L^U$ are 49 and 82 percent, respectively. We infer that movements in the price of nontradable relative to tradable goods are clearly important, accounting for more than half of the fluctuations in the $r_{t}^{cpi}$.

This finding stands in sharp contrast with the results in the literature obtained using retail prices to measure $P_t^T$ and $P_t^{T*}$ (see Engel (1999) and Chari, Kehoe, and McGrattan (2002)). We illustrate this contrast by estimating lower and upper bounds defined in (2.4) and (2.5) for the U.S. using two alternative measures of tradable goods prices.

In the first case we measure $P_t^T$ using an equally weighted geometric average of U.S. import and export price indices. We measure $P_t^{T*}$ using a trade-weighted, equally-weighted geometric average of import and export price indices for the following U.S. trading partners: Australia, Canada, Germany, Italy, Japan, Korea, Mexico, the Netherlands, Spain, Switzerland, UK, and Venezuela. Together these countries account for 64 percent of U.S. imports and exports for the period 1980 to 2001.

In the second case we measure $P_t^{T*}$ using the retail price of tradable goods in the U.S. We average monthly data on the retail price of tradable goods obtained from the Bureau of Labor Statistics to produce a quarterly time series. We construct $P_t^{T*}$ as a trade-weighted average of the U.S. trading partners consumer prices. For Canada, Italy, Japan, and Mexico we use the retail prices of tradable goods. These countries account for 43 percent of U.S. trade during the period 1980 to 2001. Due to data limitations, for Australia, Germany, Korea, the Netherlands, Spain, Switzerland, the UK, and Venezuela we measure the price of tradable goods using the CPI. In all cases the data pertains to the period 1975.Q1 to 2002.Q3. The sample period, which differs from that of the data used to construct Table
1, was dictated by the availability of retail prices of tradable goods for some U.S. trading partners. We report our results in Table 2.

Consistent with the results in Table 1, when \( P_t^T \) is measured using import and export prices, fluctuations in nontradable goods prices account for well over 50 percent of movements in \( rer_t^{cpi} \). In sharp contrast, when \( P_t^T \) is measured using retail prices, these fluctuations account for 5 percent or less of the movements in \( rer_t^{cpi} \).

Viewed overall, our results make clear that the conventional view regarding the unimportance of movements in nontradable goods prices as sources of cyclical RER fluctuations depends critically on the questionable assumption that the price of tradable goods can be accurately measured using retail prices. Measuring the price of tradable goods using retail prices understates the importance of movements in the relative price of nontradable goods as a source of cyclical RER fluctuations.

4. Conclusion

Burstein, Eichenbaum, and Rebelo (2005) argue that in the aftermath of large devaluation episodes, changes in the RER are overwhelmingly driven by movements in the price of nontradable goods relative to the price of pure-traded goods. This paper analyses the source of RER fluctuations at cyclical frequencies. We find that more than half of these fluctuations are accounted for by movements in the price of nontradable goods relative to the price of pure-traded goods. The remaining half are due to movements in the relative price of traded goods across countries. Understanding the sources of these latter movements has been the focus of an important literature. Our findings suggest that equal attention should be paid to modeling movements in the relative price of nontradable to pure-traded goods.
References


**TABLE 1**

<table>
<thead>
<tr>
<th>Country</th>
<th>std(S)</th>
<th>std(RER\textsuperscript{cpi})/std(S)</th>
<th>std(RER\textsuperscript{T})/std(S)</th>
<th>Correlations with S</th>
<th>Elasticity of RER to S</th>
<th>Bounds on Importance of Nontradables</th>
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<td></td>
<td></td>
<td></td>
<td>RER\textsuperscript{cpi}</td>
<td>RER\textsuperscript{T}</td>
<td>Lower Bound</td>
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<td>Median</td>
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### TABLE 2


<table>
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<td>0.71</td>
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<td>PT measured using Retail Prices</td>
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