

The Measurement of Real Effective Exchange Rates:

A Survey and Applications to East Asia

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Abstract: The theoretical bases for different definitions of the real exchange rate are discussed. Alternative means of calculating “effective” exchange rates are presented. Some of the empirical characteristics of these series are examined in the context of several Pacific Rim countries. The use of real effective exchange rates is presented in several context, including (i) evaluating exchange rate overvaluation, (ii) relating real exchange rates to productivity differentials, (iii) estimating the relative price responsiveness of trade flows, and (iv) assessing the impact of competitive devaluation.

Keywords: real effective exchange rate, overvaluation, competitiveness, stationarity, cointegration

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1. Introduction

Economists and policymakers often refer to *the* exchange rate as a key macroeconomic variable. As a relative price, the exchange rate plays a crucial role in theoretical models and open economy and transactions between countries. However, the link between the theoretical concept of the exchange rate and the empirical application is not a straightforward one. This paper lays out the chief concerns the analyst must confront when determining which empirical measure of the exchange rate to use.

This question has taken on heightened importance in recent years, as the scope of international transactions has expanded and more and more economic activity is either directly or indirectly affected by economic activity in other countries. While it is commonplace to think of such transactions as being primarily in the domain of trade in goods and, increasingly, services, this presumption is probably not completely justified. Part of the process that is popularly known as “globalization” entails increasing trade in assets, so one would also like to know what, if any, relative price is relevant for capital flows or stocks.

I examine the question of the appropriate “real effective exchange rate” to use in the following manner. First, I discuss in what cases a particular definition of the real exchange rate is appropriate. Second, the issue of selecting the criteria determining the “effective” aspect is taken up. This question essentially reduces to one of what weights one should put upon each interacting partner country. Then, I compare the behavior of differing real exchange rate indices along different dimensions, such as the use of price deflators, and differing weighting schemes. Finally, the utility of these real effective exchange rates is demonstrated by way of several applications to current policy issues.

The central message of this paper is that the appropriate definition and calculation of the exchange rate depends upon a complicated interplay of the theoretical model of interest, and data availability.

2. Real Exchange Rates

2.1 An Accounting Framework

Often the focus of exchange rate modeling is on the real, or inflation adjusted, exchange rate. Even when the one is examining real exchange rates, there are a number of definitions one

can appeal to. This assertion can be best illustrated by using the following decomposition. Suppose the price index is a geometric average of traded and nontraded good prices.

$$\begin{aligned} p_t &= \alpha p_t^N + (1 - \alpha) p_t^T \\ p_t^* &= \alpha^* p_t^{N*} + (1 - \alpha^*) p_t^{T*} \end{aligned} \quad (1)$$

Where the * denotes the foreign country, and lowercase letters denote logged values of corresponding uppercase letters. Now define the real exchange rate as

$$q_t \equiv s_t - p_t + p_t^* \quad (2)$$

where s is the log exchange rate defined in units of home currency per unit of foreign. Then substituting (1) into (2) and re-arranging yields:

$$q_t \equiv (s_t - p_t^T + p_t^{T*}) - \alpha(p_t^N - p_t^T) + \alpha^*(p_t^{N*} - p_t^{T*}) \quad (3)$$

Equation (3) is a useful decomposition. It indicates that the real exchange rate can be expressed as the sum of three components: (i) the relative price of tradables, (ii) the relative price of nontradables in terms of tradables in the home country, and (iii) the corresponding relative price in the foreign country. For the case where the weights of nontradables in the aggregate price index are identical, the second and third terms can be collapsed into a intercountry relative price of nontradables, viz.:

$$q_t \equiv (s_t - p_t^T + p_t^{T*}) - \alpha(\hat{p}_t^N - \hat{p}_t^T) \quad (4)$$

Where the circumflex denotes the intercountry log difference.

If one assumes the law of one price holds for *all* goods, and consumption baskets are identical, then all the terms are zero, and PPP holds (since there are no nontradables by

definition). That is, the real exchange rate is a constant – not a very interesting condition, from either a theoretical or practical standpoint.

If instead PPP holds only for tradable goods, then only the second term in equation (4) can be non-zero, and the relative tradables-nontradables price is the determining factor in the value of the real exchange rate. Another possibility is that all goods are tradable, but not perfectly substitutable; then one has an imperfect substitutes model. Both terms on the right hand side of equation (4) can take on non-zero values. In either of these cases, there are a large number of variables that could influence each relative price. And of course, there is nothing to rule out both relative price channels as being operative. In popular discussion, all three definitions of “the real exchange rate” are used, sometimes leading to considerable confusion.

2.2 Which Real Exchange Rate?

Most models of the real exchange rate can be categorized according to which specific relative price serves as the object of focus. If the relative price of nontradables is key, then the resulting models have been termed “dependent economy” or “Scandinavian”.¹ The home economy is small relative to the world economy, so the tradable price is pinned down by the rest-of-the-world supply of traded goods. Hence, the “real exchange rate” in this case is (p^N/p^T) , set to achieve internal balance, i.e., the equilibrium in the supply and demand of nontraded and traded goods (see Hinkle and Nsengiyumva, 1999). More generally, the relative price of nontradables move to achieve internal balance in both countries:²

¹ As the discussant Suiwah Leung has pointed out, the dependent economy model is sometimes referred to as the Salter (1959) and Swan (1960) model. Another tradables/nontradables framework is sometimes referred to as the Scandinavian model. In that case, productivity and the nominal exchange rate determine the nominal wage rate and hence the price level. In this context, the real exchange rate is a function of productivity (Krueger, 1983: 157). The two sets of models both focus on the relative nontradables price, but differ in their focus on the source of shifts in this relative price.

² Usually, emphasis is on the domestic relative price of nontradable goods either for simplicity in modeling, or because the variation in this relative price at home dwarfs that of the rest-of-the world.

$$q_t^I = -\alpha(\hat{p}_t^N - \hat{p}_t^T) \quad (5)$$

As Engel (1999) has pointed out, it is typically not appropriate to assume that traded goods prices are equalized, especially at short horizons, but perhaps at even long horizons. For many countries, it may be that the variation in the relative price on nontradables is fairly small. In that case, the relevant exchange rate might well be adequately represented by:

$$q_t^2 = q_t^T \equiv (s_t - p_t^T + p_t^{T*}) \quad (6)$$

This definition is most appropriate when considering the relative price that achieves external balance in trade in goods and services. This variable is also what macroeconomic policymakers allude to as price competitiveness -- a weaker domestic currency (in real terms) means that it is easier to sell domestic goods abroad. Of course, it is also true that a higher q^T is equivalent to a worse tradeoff in terms of number of the domestic units required to obtain a single foreign unit.

A related concept is cost competitiveness (Marsh and Tokarick, 1996). To see how this variable is related to the preceding one, consider a markup model of pricing:

$$p_t^T = \log \left[(1 + \mu) \left(\frac{W_t}{A_t} \right) \right] \quad (7)$$

where μ is percentage markup, W is the nominal wage rate, A is the labor productivity per hour. W/A is therefore unit labor cost. Re-expressing (6) using equation (7), and assuming that markups are constant yields:

$$q_t^3 = [s_t - (w_t - a_t) + (w_t^* - a_t^*)] \quad (8)$$

In this case, the real exchange rate is the nominal rate adjusted by wages and productivity levels, and in some ways more closely resembles the measure of competitiveness as used in popular discussion. As productivity levels rise, the real exchange rate rises (depreciates), *ceteris paribus*. This definition of the real exchange rate also fits in with a Ricardian model of trade (Golub, 1994).

The discussion up to this point has been couched in terms of a two country world. This is a convenient simplification in that it allows one to abstract from third country effects. The home country's exports are the imports of the foreign country, and vice versa. However, in the real world, a typical country exports to a number of countries, so it is possible to consider exports competing with another country's exports. In this case, one may be interested in competitiveness in third markets. As soon as one allows for this possibility, then one can meaningfully discuss the relative price of home versus foreign exports. In this case, one would define the real exchange rate as:

$$q_t^4 = s_t - p_t^X + p_t^{X*} \quad (8)$$

2.3 Empirical Comparisons

In deciding which measure of the real exchange rate is the most appropriate, one is often faced between a set of trade-offs. The first is between the theoretically implied measures and the real world counterparts. The second one is between using the most appropriate measure conceptually, and the most readily available data.

In practice, one only has a choice of a few price deflators. At the monthly frequency, they include the consumer price index (CPI), the producer price index (PPI) or wholesale price index (WPI), or export price index. At lower frequencies, such as quarterly, the set of deflators increases somewhat, to include the GDP deflator, and price indices for the components of GDP, such as the personal consumption expenditure (PCE) deflator.

Typically, the CPI is thought of as weighting fairly heavily nontraded goods such as consumer services.³ Similarly, the GDP deflator and the CPI will include weight in proportion to

³ In addition, CPI's sometime include factor prices for nontradable assets, such as rent.

their importance in the aggregate economy expenditures on nontradables. In contrast, the PPI and WPI exclude retail sales services that are likely to be nontraded.

If one were primarily concerned about issues of internal balance,⁴ then some measure of the relative price of nontradables would be useful, i.e., $(p^N - p^T)$. The most readily accessible data for this purpose is the ratio of the CPI to the PPI. There are a number of deficiencies with this measure, however. The first is that the CPI is an imperfect measure of nontradables prices. If the CPI corresponds to equation (1), and the PPI accurately reflects the price of tradables, then the log ratio of the CPI to the PPI is

$$cpi_t - ppi_t = \alpha(p_t^N - p_t^T) \quad (9)$$

That is, the greater the share of nontradables in the aggregate index (the CPI here), the closer the CPI/PPI ratio approximates the measure of interest. On the other hand, if nontradables are weighted by only one half, then the elasticity of the CPI/PPI ratio with respect to the underlying relative price of nontradables is one-half. In the two country case, calculation of the real exchange rate using CPI's will in theory yield the correct measure of intercountry relative prices.⁵ However, it is unclear of what interest the ratio of the relative nontradables price in one country relative to another is, as it primarily relates to the condition of internal balance in the two countries. Hence, the decision to calculate of the CPI deflated real exchange rate is almost always driven by expediency and data availability rather than an interest in this variable directly (although the financial crisis-early warning system literature constitutes one exception).

For purposes of calculating the relative price of goods and services that are tradable, the preferred measure is the exchange rate deflated by PPIs or WPIs. One drawback of using these

⁴ Although the relative price of nontradables could also move to attain both internal and external equilibrium if traded goods prices are equalized in common currency terms, as in Edwards (1989).

⁵ In practice, there are a number of reasons why this measure will not equal the theoretically implied object of interest. First, CPIs are not calculated using geometric averaging, as is assumed in equation (1). Second, the PPI is likely to include some nontradable goods and services. Third, the PPI does not include the same goods as are included in the CPI.

indices is that there is considerably more variation in how these price series are constructed across countries, than for the corresponding CPIs. This is of particular concern because variation in the real exchange rate can occur even if the law of one price holds for individual goods if the weights differ between countries. To see this, consider if there are two traded goods, 1 and 2, with weights λ and $(1-\lambda)$ respectively. Then,

$$\begin{aligned}\tilde{p}_t^T &= \lambda p_t^1 + (1-\lambda) p_t^2 \\ \tilde{p}_t^{T*} &= \lambda^* p_t^{1*} + (1-\lambda^*) p_t^{2*}\end{aligned}\tag{10}$$

Assuming the law of one price holds for each good, and inflation rates for goods 1 and 2 differ, tradable goods inflation is given by

$$\Delta \tilde{q}_t^T = (\lambda^* - \lambda)(\Delta p_t^{1*} - \Delta p_t^{2*})\tag{11}$$

Equation (11) indicates that differences in individual goods inflation rates will cause variation in the measured real exchange rate if the weights differ. This calculation assumes the weights are constant; a revision in the weights in one or both countries would also show up as a change in the real exchange rate even if goods inflation rates are equal.

This critique applies with even more strength when discussing exchange rates deflated by export price indices. In discussions of industrialized economies, when the export baskets consist largely of manufactured goods, such relative prices might have some meaning. However, when one compares the prices of an export basket of the U.S. against that of, say, Malaysia, it is likely that the sets of goods are quite different, and the variable hence measures an object of limited relevance.

A second potential drawback is that PPI's and WPI's may include a large component of imported intermediate goods, such that the resulting real exchange rates are not a good measure of competitiveness.

In Figures 1-10, the CPI, PPI and export price index deflated real exchange rates are shown for a set of Pacific Rim countries, all expressed against the US dollar (in units of US\$ per

unit of home currency). Hence, treating the non-US economy as the home economy, these series are equivalent to $-q$ in the preceding equations.⁶

There are a number of interesting stylized facts to be gleaned from these figures. First, CPI deflated real exchange rates typically exhibit a more pronounced upward trend (or a less pronounced downward trend) than the corresponding PPI deflated rate. The way the real exchange rate is defined here, the local currency is typically appreciating against the U.S. currency. This pattern is often explained as the outcome of the Balassa-Samuelson model, wherein more rapid productivity growth in the tradable sector than in the nontradable sector results in a rise in the relative price of nontradables. Chinn (2000b) demonstrates that indeed productivity differentials are responsible for some of these trends in East Asian real exchange rates, although not all.⁷

In contrast the PPI deflated real exchange rate exhibits a less pronounced trend, in general. That is, over long periods of time, there appears to be less of a tendency for the PPI deflated rate to move upward. That being said, it is definitely true that PPI and CPI deflated exchange rates covary substantially at the monthly or even quarterly frequency. As for export price deflated real exchange rates, they exhibit considerable variation, so that it is difficult to discern any particular trends.

In a study of East Asian real exchange rates, Chinn (2000a) found that very few of these real exchange rates were trend stationary over the 1975.01-1996.12 period, using a Horvath-Watson (1995) test for cointegration with known cointegrating coefficients. Interestingly, I found that the greatest evidence for stationarity was detected for CPI deflated real exchange rates, expressed against the US\$ -- Hong Kong, Indonesia, Korea, Thailand, and Taiwan. Much fewer instances were found for yen based rates, either using the CPI or the PPI.

⁶ Note that there are two CPI deflated series for China. The first one uses the official exchange rate, while the second one incorporates the fact that some proportion of transactions preceding the 1994 unification of exchange rates were occurring at the swap market rate. See the discussion in Fernald, Edison and Loungani (1999). No long span of PPI or WPI data were available for China.

⁷ For a dissenting view on the role of the relative price of nontradables in East Asian exchange rates, see Isard and Symanski (1996) and Parsley (2001).

3. Real Exchange Rates in a Multi-Country World

3.1 The Determination of Weights

Academic treatments of the real exchange rate typically abstract from how to measure real exchange rates when countries engage in transactions with a number of partners. By far the most common means of calculating an “effective” real exchange rate is to weight the currencies by trade weights. This simple statement hides a number of complications. First, does one use export weights, import weights, or both? Second, what does one do about third markets – that is how does one measure real exchange rates when one wishes to measure relative prices between home country and foreign goods in a third foreign country? Third, how does one account for time variation in trade weights?

To formalize the discussion, consider a geometrically weighted average of bilateral real exchange rates.⁸ Using our previous notation, where

$$q_t^{RER1} \equiv \sum_{j=1}^n w_j q_t^j \quad (12)$$

where q^j denotes the log real exchange rate relative to country j . This can be re-expressed in levels

$$Q_t^{RER1} \equiv \prod_{j=1}^n (Q_t^j)^{w_j} \quad (12')$$

There are two questions to be addressed at this point. The first is the nature of the real exchange rate (CPI, PPI, export price index). The second is the one alluded to earlier – how to calculate w_j .

⁸ I have sidestepped a number of issues by ignoring arithmetically averaged indices. Such indices have the drawback that changes in the index will differ in percentage terms, depending upon whether the exchange rates are expressed in units of foreign currency per domestic, or vice versa.

The simplest approach is to use weights based upon bilateral trade volumes (the sum of exports and imports, expressed as a proportion of total exports and imports). One problem with this approach is that there is no theoretically implied manner in which to account for changing trade flows.

Trade weighting can take on a more complicated form to allow for competition in third markets. Specifically, the U.S. Federal Reserve Board and the IMF construct their real effective exchange rate attempting to capture third market effects.

To see how this is accounting is accomplished consider the following stylized model based upon the IMF's methodology. There is only one type of good, but it is differentiated by country of source. The degree of substitutability of this good is the same, regardless of what type of the country the good comes from. This Armington (1969) assumption is a common feature of effective exchange rate indices. The weight to be used in equation (12) can then be expressed as:

$$w_j = (\text{imports of } i / \text{imports and exports of } i) \times (\text{share of } i \text{ imports from } j) \\ + (\text{exports of } i / \text{imports and exports of } i) \times (\text{overall export weight})$$

where

$$\text{overall export weight} = \beta \times (\text{share of exports of } i \text{ to } j \text{ out of total } i \text{ exports}) + (1-\beta) \times (\text{third market weight})$$

The third market weight is equal to the weighted average over all third-country markets of country j 's import share divided by a weighted average of the combined import share of all of country i 's competitors, with the weights being the shares of country i 's exports to the various markets.⁹

Hence, effective exchange rates that take into account the substitutability between goods sourced from different countries can be calculated from trade data in principle. However, the appropriateness of these measures relies upon a constant elasticity of substitution (CES) function for utility. This selection of utility function is driven by tractability – nothing guarantees that utility is CES in form, and nothing guarantees that a widget exported from the Euro area is equally substitutable with a widget from Malaysia. Spilembergo and Vamvakidis (2000)

⁹ A detailed derivation is contained in Zanetto and Desruelle (1997).

investigate whether the CES assumption over all countries is plausible, and find that it is helpful to distinguish between OECD and non-OECD countries in constructing effective exchange rate indices.

An even more ideal measure of the effective exchange rate would attempt to use estimated measures of the elasticities. However, such calculations are beyond the data capabilities of most statistical agencies (but see Section 4.4).¹⁰

3.2 Allowing for Time Variation in Weights

Once one has settled on the theoretically interesting weighting scheme, one confronts the matter of allowing for time variation. Clearly, trade flows change over time, so in principle the corresponding trade weights should change. The more rapid the evolution of trade patterns, the more likely it is that a fixed weight index will misrepresent the impact of exchange rate changes.

One can either allow the weights to change over time continuously or discretely and infrequently, with the choice depending in large part upon the tradeoff between convenience and accuracy. The IMF takes the latter approach, while the Fed adopts the latter. The Federal Reserve calculates its dollar index as:

$$R_t^{FRB} \equiv R_{t-1}^{FRB} \prod_{j=1}^n (R_t^j / R_{t-1}^j)^{w_{j,t}} \quad (13)$$

(where $R \equiv 1/Q$ is the value of domestic currency). The weight $w_{j,t}$ evolves on an annual basis (Leahy, 1998).

Ellis (2001) describes in greater detail the various methods for allowing time variation in the weights. The ideal method would involve a Tornqvist index. However, such indices require next period's weights, so calculation of such indices would not be possible in real time. Given the slow moving nature of trade flows, chained Laspeyres (base year weighted) indices are probably a good approximation to the ideal indices.

¹⁰ An instance of this approach is the now defunct Multilateral Effective Exchange Rate Model (MERM) (Black, 1976; Artus and McGuirk, 1981).

3.3 Empirical Comparisons

In Figure 11, the CPI deflated indices reported by the IMF and the Federal Reserve Board for the value of the U.S. dollar are displayed. Despite the fact that the country coverage is slightly different in this “major currencies” index (Leahy, 1998), the indices track each quite well. Of course, they are not exactly identical. The adjusted R^2 from a regression of the log difference of the IMF series on the log differenced FRB series is 0.95, while the slope coefficient is 0.87.¹¹

What appears to be of more importance for the United States dollar is the choice of price index. The IMF calculates two real exchange rate series for the U.S. – the CPI deflated and unit labor cost deflated, depicted in Figure 12 (the JP Morgan PPI deflated series could be included, but follows very closely the CPI deflated series, and so is omitted for clarity). Because the U.S. experienced substantially more rapid productivity growth than its trading partners, the dollar experiences real depreciation (in unit labor cost terms) from March 1985 until early 1995, while the CPI deflated series shows a leveling off in 1990. While both series show a dollar appreciation starting in 1995, they tell remarkably different stories about the relative cost positions of U.S. firms. In particular, after accounting for productivity changes, the dollar at the end of 2001 is less than 20% weaker than its 1985 peak using the CPI deflated rate, while the unit labor deflated series is 40% weaker. In other words, a radically different picture of the strength of the currency is obtained depending upon the variable used. Figure 13 depicts the CPI, PPI and unit labor cost deflated indices for Japan.

Unfortunately, unit labor costs are not always available on a timely or consistent basis. Hence, in general trade weighted indices are usually constructed using either CPI's or PPI's. Figures 14-23 depict the trade weighted real exchange rates for several Pacific Rim economies. It is difficult to discern any clear pattern amongst all these series, although it is same to say that most do not appear to be mean stationary. Visually, there appear to be deterministic time trends

¹¹ There are also two other U.S. dollar indices calculated by the Atlanta Fed and the Dallas Fed; see Acree (1999) for a discussion. The Dallas Fed series has been discontinued.

in some of the series, although we know from the econometric literature on real exchange rates that such ocular regressions may lead to misleading inferences.

3.4 Alternative definitions

Recently, some analysts have suggested calculating measures of the effective exchange rate that use weights not based upon trade flows. Makin and Robson (1999) calculate several series for Australia, including (1) a current account credit+debits weighted index; (2) a capital inflows+outflows index; (3) an external liabilities weighted index; (4) an external liabilities weighted by currency of denomination index. All of these are considered in either nominal or real terms. The authors find that each of these series tends to have their own trends, although they all tend to move together at high frequencies.

While it is interesting to consider alternative weighting schemes, the theoretical justification for each of these measures is not known. For instance, it makes sense to generate weights on the basis of trade flows, since one has a presumption that trade flows depend upon relative prices. However, for capital flows, the important relative price is an intertemporal one (the rate of return over time), rather than a relative price of goods. Similarly, weighting by debt stocks does not necessarily make sense since they do not respond to relative prices of currencies. The easiest way to see this is to consider the case when foreign debt is denominated in domestic currency terms. An exchange rate depreciation has no impact upon the value of the debt in nominal domestic currency terms.

On the other hand, a case might be made for a debt-weighted measure, where the weights are determined by borrowing in different currencies, as in Makin and Robson formula:

$$w_j = \frac{B_j}{\sum_{k=1}^n B_k} \quad (14)$$

where B_i is the value of bonds denominated in *currency i*, but valued in domestic currency terms.

Then changes in the debt-weighted index

$$S_t^{ERS} \equiv \prod_{j=1}^n (S_t^j)^{w_j} \quad (15)$$

would indicate movements in the (nominal) debt burden. It is a bit trickier to consider the “real” analogue to this nominal debt-weighted index. If one considers a representative agent in the home country considering her debt, then it makes sense to deflate by the home country’s consumer price index. On the other hand, considering representative agents is consistent with purchasing power parity, in which case, exchange rate movements offset one for one movements in prices.¹²

4. Selected Applications

As is apparent from the preceding discussion, there are numerous measures of effective exchange rates. There is no simple answer to the question of which one is the best. Rather, the selection of the effective exchange rate measure depends upon the economic issue being analyzed.¹³ That can best be demonstrated by recounting several recent analyses incorporating effective exchange rate measures.

4.1 As a Factor in Determining Currency Crises: Overvaluation

One recent use real exchange rates has been as an indicator of incipient currency crises. Goldfajn and Valdes (1999) document that most medium to large real appreciations are reversed by nominal devaluations/depreciations. Exploring this avenue, Chinn (2000a) considers East Asian exchange rate overvaluation from the perspective of purchasing power parity. Contrary to the views taken in many of the papers on the subject circulating after the crisis,¹⁴ I argue that

¹² See Dornbusch (1980) for a discussion of how price and exchange rate changes fit into an evaluation of welfare effects when foreign currency debt is involved.

¹³ A case could be made for using the variable that “works” best on empirical grounds, although this argument would seem to have a “circular” aspect. Lafrance, Osakwe and St.-Amant (1998) use comparisons of degrees of linear feedback between the exchange rate measure and the economic activity measure to determine which index “works best”.

¹⁴ E.g. Kaminsky and Reinhart (1999) and Frankel and Rose (1996). Chinn, Dooley and Shrestha (1999) use estimated deviations when they are justified by the cointegration tests.

calculating exchange rate overvaluations as a deviation from an estimated time trend is not a valid procedure unless the time series being examined are $I(0)$ variables.¹⁵

It turns out that in most cases, pre-1997 East Asian trade weighted real exchange rates do not appear to be $I(0)$ processes; hence, the standard practice of calculating exchange rate misalignments as deviations from estimated mean or trend was not justified. Table 1, drawn from Chinn (2000a), illustrates how rare it is for trade weighted indices to be mean stationary. Allowance for deterministic trends does not yield substantially more evidence for stationarity, either using the Johansen (1988) and Johansen-Juselius (1990) methods, adjusting for finite sample critical values (Cheung and Lai, 1993), or the Horvath-Watson (1995) procedure.

In some respects, this result is unsurprising. The finding of stationarity is rare enough for bilateral exchange rates. The trade weighted exchange rates are merely versions of these rates averaged across a number of trading partners, so unless the stationarity for bilaterals is much more pronounced for non-US and non-Japan based exchange rates, one would expect to find similar results.¹⁶ Furthermore, the CPI deflated series generated by the IMF give a fairly heavy weight to nontradables prices, so nonstationarity is to be expected. On the other hand, the PPI deflated series from J.P. Morgan experience a large weighting shift at the end of 1986.

One exception to this finding is the PPI deflated Hong Kong currency. According to a Horvath-Watson (1995) test applied to the period 1975-1996, this index was stationary (Chinn, 2000a). The estimated mean (displayed in Figure 24) implies an overvaluation of 20% in May 1997. Extending the sample from that used in Chinn (2000a) indicates that the real effective exchange rate has reverted toward its mean, ending 2001 overvalued by 14% (after going as high as 25% above).

¹⁵ See Breuer (1994) for a discussion of the distinction between finding trend stationarity, and the concept of relative PPP. Both Breuer (1994) and Rogoff (1996) provide good surveys of the empirical literature on PPP.

¹⁶ Phylaktis and Kassimatis (1994), and Fukuda and Kano (1997) find mean stationarity in PPI deflated bilateral exchange rates of the won and peso. Lee (1999) finds mean reversion for the PPI deflated rupiah, won, ringgit, peso and Singapore dollar (expressed against the US dollar) over longer samples spanning both the pre- and post-Bretton Woods periods.

In Table 2, I have updated the bilateral exchange rate results up to the end of 2001, using an admittedly less powerful test for stationarity (a standard ADF test) over the entire sample running up to 2001.12. These test results indicate that in the wake of the Crisis, there is little evidence of mean reversion for bilateral exchange rates. This pattern of results largely arises because of the decline in East Asian exchange rates during the US recession that began in 2001.¹⁷

The results in Table 3 indicate that there is also lack of evidence of mean stationarity for effective exchange rates; Japan, the Philippines and Taiwan are the only cases that exhibit relative PPP.¹⁸ Results from the implementation of the Horvath-Watson procedure on the CPI-deflated series did not yield substantially different results. The one exception is Korea; in this case the trade weighted won, and relative prices were cointegrated with the coefficients implied by relative PPP.

4.2 As a Dependent Variable: Productivity

One use of effective exchange rates is as a summary measure of relative prices, to be explained by any variety of factors (see e.g., Williamson, 1994; Hinkle and Montiel, 1999). For instance, Hsieh (1982), DeGregorio and Wolf (1994) and Chinn (2000b) investigate the determinants of effective real exchange rates. Hsieh focuses on productivity differentials in the Balassa-Samuelson framework as explanatory variables for the Yen and Deutschmark. To see this take equation (5), repeated here:

$$q_t^I = -\alpha(\hat{p}_t^N - \hat{p}_t^T) \quad (5)$$

¹⁷ Fujii (2002) finds using the Horvath-Watson test that US dollar based PPI deflated exchange rates are stationary, even in a sample encompassing the 1997 crisis. However, his sample extends only up to September 1999; the sample used in this paper includes an additional two and quarter years, during which time the East Asian currencies generally depreciated, and hence moved away from their respective means.

¹⁸ One might interpret this pattern of results as being driven by the 1987.01 change in trade weights of the J.P. Morgan series. However, sharp movements in the J.P. Morgan series are also apparent in the corresponding IMF series, so it is unlikely that any structural breaks are due to weighting changes.

If the relative price of nontradables is determined by the relative productivity levels in the two sectors:

$$(p_t^N - p_t^T) = (a_t^T - a_t^N) \quad (16)$$

then equation (5) becomes:¹⁹

$$q_t^I = -\alpha(\hat{a}_t^T - \hat{a}_t^N) \quad (17)$$

Hsieh found evidence for a productivity effect – that is, the faster productivity growth is in the tradable sector, the more the currency tends to appreciate in real terms. DeGregorio and Wolf, and Chinn examine a wider set of variables – such a productivity differentials, government spending, per capita income, oil prices – for a panel of 14 OECD real effective exchange rates. Both find a productivity effect in panel regressions.

Most of the time, theory is used to guide empirical research. For instance, the Balassa-Samuelson model motivates the aforementioned analyses. One interesting finding of Chinn and Johnston (1999) is that the above finding holds true even for exchange rates deflated by indices that are supposed to be representative of bundles of highly tradable goods. This result suggests that even when using price indices for goods – such as the PPI or deflators for the manufacturing sector output – there may still be a large nontraded component to the prices.

4.3 Competitiveness and Trade Balance

Since most effective exchange rates are based upon some form of trade flow magnitudes, it should be unsurprising that most of the uses for which these indices are put to use is to evaluate their effect upon trade flows. Rose (1991) is an early example of this application in the modern macroeconometric literature. Because he fails to find cointegration between trade flows, real

¹⁹ The following specification holds if the production functions in the two sectors are identical. If the labor share of income in the nontradable sector exceeds that of the tradable sector, then the coefficient on a^T would be greater than that on a^N in absolute value.

exchange rates and income variables (using the Engle-Granger technique), he estimates the relations in first differences. Overall, he fails to find evidence of an effect of the real effective exchange rate on trade flows for the G-7 economies.

More recently, cointegration tests with higher power have become available (e.g., the Johansen procedure). When cointegration is detected, then long run elasticities can be estimated. Examples of this approach include Chinn and Johnston (1996), who estimate error correction specifications for imports and exports. Using these estimated equations, they assess whether, and how much, US trade flows respond to real exchange rates in both the short and long run. Chinn and Johnston use the IMF's unit labor cost deflated measure of effective exchange rates because this best matches the concept of "cost competitiveness".

Marsh and Tokarick (1996) conduct a systematic analysis to determine which measure of real exchange rates – either unit labor, consumer price or export price deflated – provides the "best" measure, in terms of having the right sign, magnitude and statistical significance in error correction models of exports and imports of the G-7 economies. They find that for the US, all the measures are about equally successfully as a measure of relative prices or costs, whereas for France, only unit labor cost deflated rates appear to work. For Canada, no real rate has any success. They also conduct some non-nested statistical tests that yield approximately the same conclusions.

Wilson (2001) conducts an analysis that sheds more light on how much of an impact competitiveness measures have on trade flows for the East Asian countries of Singapore, Malaysia and Korea. He finds little evidence for any effect at the bilateral level (with the exception of US-Korea trade), and finds essentially no evidence for multilateral trade responsiveness. His measure of the real rate is a somewhat odd one, using as the home country deflator the wholesale price index, while using the CPI for the foreign, although it is not clear that these results would be overturned using a more conventional deflator mix.

More positive results are obtained by Cerra and Dayal-Gulati (1999), who apply an error correction framework to Chinese exports and imports. They find over the more recent period of 1988-97 that there is a long run (cointegrating) relationship between the real trade-weighted exchange rate and trade flows (while, as anticipated, no such relationship exists in samples encompassing the earlier 1983-96 period).

4.4 The Yen, the RMB and Competitive Devaluations

One prominent set of debates has centered upon the strategic interaction between Japanese and Chinese economic policymakers. In particular, the Chinese maintained the RMB's de facto peg against the dollar during the 1997-98 East Asian crisis, an action that by common assent prevented further rounds of competitive devaluation by other East Asian countries.

More recently, as the Japanese yen has depreciated against the dollar from near parity at the beginning of 2000 to 128 at the beginning of May 2002, anxieties have mounted about whether the resulting pressure on Chinese trade flows (primarily exports) would prompt a devaluation of the RMB.

Evaluation of this scenario requires assessing a mix of both political and economic factors. While the former is out of my purview, the latter is something that can be tackled using effective exchange rates. However, the analyst is hampered in this case by the shortcomings of the widely available exchange rate indices. One would like to have good measures on Japanese and Chinese competitiveness, vis à vis their trading partners. Unfortunately, the IMF series are not ideal for this purpose, because of the use of CPI's which embody large nontradable components. On the other hand, J.P. Morgan does not report a Chinese series, and indeed does not include Chinese trade flows in the calculation of its effective exchange rate indices. Deutsche Bank has recently produced a series incorporating Chinese price and exchange rate data and trade weights based on bilateral flows. As illustrated in Figure 25, the Deutsche Bank series tracks the IMF series at high frequencies over the 1990-2001 period, but exhibits a more pronounced appreciation.

Interestingly, inclusion of Chinese trade into the calculation of trade-weights does in certain instances lead to differing implications. For instance, while the Korean PPI-deflated trade weighted series from J.P. Morgan and Deutsche Bank do not differ substantially, in the case of Thailand, the two series do exhibit substantially different behavior (Figure 26). Indeed, the Deutsche Bank series exhibits a 12% greater appreciation relative to its 1990.01 value than the corresponding J.P. Morgan series.

In tackling the issue of competitive pressures, it is very difficult to dodge the question of whether the CES assumption is appropriate for generating the weights in calculating the real effective exchange rate. It is instructive at this point to recall that the weights are calculated in

standard effective exchange rate measures using trade flow data. These trade flow data stand in for the theoretically desirable weights of demand elasticities, only by virtue of the assumption that all goods sourced from different countries are equally substitutable (i.e., have the same demand elasticities). This is a convenient assumption that considerably simplifies the construction of a large number of effective exchange rates, but in the current context, one has to seriously question whether a car produced by Japan is a good substitute for a car produced by Korea, and similarly, whether a machine tool made by Japan is a good substitute for a machine tool made by China. Fernald, Edison and Loungani (1999) took up this issue in an earlier context of examining whether the 1994 Chinese devaluation spurred the East Asian crises of 1997. They compared the composition of Chinese and Southeast Asian exports, and how likely they were to be in direct competition, and concluded that the scope for such interaction was limited.

More recently, Spencer and Wong (2002) have created a series of real effective exchange rate indices where the individual elasticities are estimated econometrically. Such estimates suggest somewhat smaller weights upon the Japanese yen than simple bilateral trade flows would indicate. For instance, in their simple trade weighted index for China, Japan has a 0.22 weight, while the weights based on bilateral competition and estimated elasticities suggest a weight that is no greater than 0.10. Furthermore, the corresponding weight for an index focused on competition in third country markets is 0.15. As a consequence, they conclude that movements in the Japanese yen/US\$ exchange rate have much less impact than popularly thought.²⁰

5. Conclusions

In discussions of macroeconomic interactions between economies, the real exchange rate is often the key variable of interest. This paper has laid out the general principles underlying the appropriate deflators and appropriate weighting schemes for differing economic issues. In

²⁰ Of course, any of these conclusions are specific to the particular model underlying the calculation of the effective exchange rate indices. For example Ito, Ogawa and Sasaki (1998) and Ogawa and Ito (2000) have forwarded models strategic firm behavior and a role for imported inputs (an issue largely ignored in this paper). The conclusions regarding the weights to use in calculating the effective indices would naturally differ from the standard measures.

general, the choices that will be made will depend upon the economic issue at hand, constrained by the availability of data. One important conclusion is that the commonly cited indices may be inadequate in certain instances. In such cases, one may have to generate the effective exchange rate index specific to the task at hand.

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Appendix 1: Data Sources and Description

IFS denotes IMF, *International Financial Statistics*, February 2002 CD-ROM updated using the IMF's Economic Data Sharing System (EDSS) in February 2002.

- Exchange rates, *IFS* line ae, in US\$/local currency unit, end of period.
- Consumer price index, *IFS* line 64, 1990 = 100. Hong Kong CPI data is seasonally adjusted, and obtained from the EDSS.
- Producer price index, *IFS* line 63, 1990 = 100.
- Export price index, *IFS* line 74, 1990 = 100.
- Trade-weighted real exchange rates (CPI-deflated). 1990=100, 1988-1990 trade weights. Source: IMF Information Notice System.
- Trade-weighted real exchange rates (unit labor cost-deflated). 1990=100, 1988-1990 trade weights, *IFS* line *reu*.
- "Broad" trade-weighted real exchange rates (PPI-deflated). 1990=100, 1990 trade weights for 1987-2001; 1980 trade weights for 1970-86 (weights exclude China). Hong Kong series adjusted by Hong Kong retail price index Source: J.P. Morgan, <http://www.jpmorgan.com>. For a description of the series construction, see *World Financial Markets* (1993).
- Trade-weighted real exchange rates (PPI-deflated). 1990.01=100, Hong Kong and Singapore series adjusted by CPI, and China by retail price index and PPI. Source: personal communication with A. Wong. For a description of the series construction, see Spencer and Wong (2002).
- US "Major" trade weighted exchange rate (CPI deflated). Federal Reserve Board website, http://www.federalreserve.gov/releases/h10/Summary/indexnc_m.txt . Weights are listed at <http://www.federalreserve.gov/releases/h10/Weights/> .

Appendix 2: Details of Some Trade Weighted Indices

	Deflator	Trade weights	Index type	Comments
IMF <i>rec</i>	CPI , HP filtered	Allows for third market competition	Fixed base year weights	
IMF <i>reu</i>	Unit labor cost , HP filtered	Allows for third market competition	Fixed base year weights	Only available for selected industrialized countries
JP Morgan "narrow"	PPI	Bilateral, for OECD countries	Fixed base year weights	Only available for OECD countries
JP Morgan "broad"	PPI	For OECD and emerging markets	Fixed base year weights	Available for OECD countries and emerging markets. Excludes China
FRB "major"	CPI	For major trading partners	Chain weighting	United States
FRB "broad"	CPI	For broad set of trading partners	Chain weighting	United States
FRB Atlanta	CPI	For broad set of trading partners	Intermittent updating	United States
DeutscheBank	PPI	Allows for third country competition	Fixed base year weights	East Asian countries

Source: Zanetto and Desruelle (1997), *World Financial Markets* (1993), Leahy (1998), Acree (1999) and Spencer and Wong (2002).

Table 1
Horvath-Watson Test Results for US\$, ¥ and Trade-Weighted Exchange Rates, 1975.01-96.12

Panel 1.1: CPI

		HK	IN	JP	KO	MA	PH	SI	TH	TA
US\$	k	12	1	12	12	11	11	12	1	1
	W	11.549**	17.913***	4.484	14.323***	5.121	1.456	2.277	18.523***	10.544*
¥	k	1	12	--	12	12	12	12	12	
	W	8.773	9.309†	--	13.005**	4.104	8.674	6.202	4.936	16.914***
TWXR	k	1	1	1	1	1	1	1	1	
	W	7.414	4.569	8.372	4.059	1.322	2.356	2.061	1.408	9.198†

Panel 1.2: PPI

US\$	k	--	1	12	12	2	12	12	5	4
	W	--	10.544*	3.497	13.742**	2.649	4.036	7.095	12.050**	4.368
¥	k	--	12	--	11	1	2	3	2	6
	W	--	4.640	--	3.465	12.413**	9.867*	2.919	7.346	2.267
TWXR	k	1	1	1	1	1	1	1	1	
	W	10.098*	2.990	7.066	5.918	10.318*	8.674	0.111	1.403	1.835

Panel 1.3: Export Price Indices

US\$	k	12	11	12	1	4	12	1	1	--
	W	9.630†	5.366	3.926	3.926	7.690	8.374	3.337	22.270***	--
¥	k	1	11	--	1	1	2	2	1	--
	W	6.198	3.838	--	5.110	0.762	4.705	3.323	2.644	--

Notes:*(**)[***] is significance at the 10%(5%)[1%] MSL. † indicates borderline significance. k is the number of first difference lags included in the VECM (selected by Schwartz Information Criterion, for lags up to 12). W is the Wald statistic. Critical values are 9.72 (11.62)[15.41], from Horvath and Watson (1995). TWXR denotes trade weighted exchange rate (PPI deflated series from Morgan Guaranty, CPI deflated series from IMF). Source: Chinn (2000a), Table 3.

Table 2: ADF Root Test Results

		Indices Home Country	Price indices used for real exchange rates calculations					
			CPI		PPI		XPI	
			US	JP	US	JP	US	JP
1	AUSTRALIA ^{1/}	W/ constant	No Rejection	Reject	No Rejection	No Rejection (6%)	No Rejection	No Rejection
		W/ constant & trend	No Rejection	No Rejection	No Rejection	No Rejection	No Rejection (15%)	No Rejection
2	CHINA ^{2/}	W/ constant	Reject	No Rejection (6%)	PPI Unavailable	PPI Unavailable	XPI Unavailable	XPI Unavailable
		W/ constant & trend	No Rejection (7%)	No Rejection				
3	HONG KONG ^{3/}	W/ constant	No Rejection (10%)	No Rejection	PPI Unavailable	PPI Unavailable	No Rejection	No Rejection
		W/ constant & trend	No Rejection	No Rejection			No Rejection	No Rejection
4	INDONESIA ^{4/}	W/ constant	No Rejection	No Rejection	No Rejection	No Rejection	No Rejection	No Rejection
		W/ constant & trend	No Rejection (15%)	No Rejection	Reject	No Rejection	No Rejection	No Rejection
5	JAPAN	W/ constant	No Rejection (15%)		No Rejection		No Rejection	
		W/ constant & trend	No Rejection		No Rejection		No Rejection	
6	KOREA	W/ constant	No Rejection	No Rejection	No Rejection	No Rejection	No Rejection	No Rejection
		W/ constant & trend	Reject	Reject	No Rejection	No Rejection (15%)	No Rejection	No Rejection (7%)
7	MALAYSIA ^{5/}	W/ constant	No Rejection	No Rejection	No Rejection	No Rejection (14%)	No Rejection	No Rejection
		W/ constant & trend	No Rejection	No Rejection	No Rejection	No Rejection	No Rejection	No Rejection
8	PHILLIPINES ^{6/}	W/ constant	No Rejection	No Rejection	Reject	Reject	No Rejection	No Rejection
		W/ constant & trend	No Rejection	No Rejection	No Rejection	Reject	No Rejection	No Rejection (13%)
9	SINGAPORE ^{7/}	W/ constant	No Rejection	No Rejection	No Rejection	No Rejection	No Rejection	No Rejection
		W/ constant & trend	No Rejection	No Rejection	No Rejection	No Rejection	No Rejection	No Rejection
10	TAIWAN	W/ constant	No Rejection	No Rejection (14%)	No Rejection	No Rejection	XPI Unavailable	XPI Unavailable
		W/ constant & trend	No Rejection	No Rejection	No Rejection	No Rejection		
11	THAILAND	W/ constant	No Rejection	No Rejection	No Rejection	No Rejection	No Rejection	No Rejection
		W/ constant & trend	No Rejection	No Rejection (8%)	No Rejection (10%)	No Rejection (10%)	No Rejection	No Rejection

Note: All data are obtained from the *IMF-IFS CD-ROM*, except for Taiwanese CPI and PPI, both of which are from *National Statistics of Taiwan*. The data series start from January 1970 and end in December 2001 or the most recent available month. Lag lengths are decided based on the Akaike Information Criteria.

1/ Australian data are quarterly because of the unavailability of the monthly data.

2/ Chinese CPI data start from January 1984.

3/ Hong Kong CPI data start from January 1990, and so are XPI data from January 1976.

4/ Indonesian PPI series starts in January 1971.

5/ Malaysia's PPI series starts in January 1986 and ends in April 1998. Its CPI data end in April 2001.

6/ Phillipines XPI data starts from January 1998.

7/ Singapore's PPI and XPI start in January 1974 and January 1979, respectively.

Table 3.a: ADF Tests on Trade weighted Real Exchange Rates

			Trade Weighted Real Exchange Rates	
		Indices	TWCQ	TWPQ
1	AUSTRALIA ^{1/}	W/ constant	No rejection	No rejection
		W/ constant & trend	No rejection	No rejection ^(8%)
2	CHINA ^{1/}	W/ constant	No rejection ^(13%)	
		W/ constant & trend	No rejection	
3	HONG KONG ^{2/}	W/ constant	No rejection	No rejection
		W/ constant & trend	No rejection	No rejection
4	INDONESIA	W/ constant	No rejection	No rejection
		W/ constant & trend	Reject	No rejection
5	JAPAN ^{3/}	W/ constant	No rejection	Reject
		W/ constant & trend	No rejection	No rejection ^(7%)
6	KOREA ^{3/}	W/ constant	No rejection ^(15%)	No rejection
		W/ constant & trend	No rejection ^(14%)	Reject
7	MALAYSIA ^{2/}	W/ constant	No rejection	No rejection
		W/ constant & trend	No rejection	No rejection
8	PHILLIPINES ^{2/}	W/ constant	No rejection	Reject
		W/ constant & trend	No rejection	No rejection ^(7%)
9	SINGAPORE ^{2/}	W/ constant	No rejection	No rejection
		W/ constant & trend	No rejection	No rejection
10	TAIWAN ^{2/}	W/ constant	Reject	No rejection ^(10%)
		W/ constant & trend	No rejection	No rejection
11	THAILAND ^{2/}	W/ constant	No rejection	No rejection
		W/ constant & trend	Reject	No rejection
12	UNITED STATES ^{1/}	W/ constant	No rejection	No rejection
		W/ constant & trend	No rejection	No rejection

Note: TWCQ and TWUQ data series are obtained from the *IMF-IFS* CD-ROM, and TWPQ from JP Morgan. Lag lengths are decided based on the Akaike Information Criteria.

1/ Australian, Chinese, and U.S. TWCQ series start from December 1979.

2/ The TWCQ data series for Hong Kong, Malaysia, Philippines, Singapore, Taiwan, and Thailand start from January 1979.

3/ Japanese and Korean TWCQ series starts from January 1980.

Table 3.b: ADF Tests on Trade weighted Real Exchange Rates

	Indices	Trade weighted real exchange rates	
		TWUQ ^{1/}	MAJOR ^{2/}
JAPAN	W/ constant	No rejection	
	W/ constant & trend	No rejection	
UNITED STATES	W/ constant	No rejection	No rejection
	W/ constant & trend	No rejection	No rejection

Note: Lag lengths are decided based on the Akaike Information Criteria.

1/ TWUQ is the trade weighted real exchange rates deflated by the unit labor cost. For both the U.S. and Japan, the data series are obtained from the *IMF-IFS* CD-ROM, and start from January 1978.

2/ MAJOR is the Federal Reserve Bank's index for the U.S. dollar against major currencies, deflated by the CPI. The data series start from January 1973.

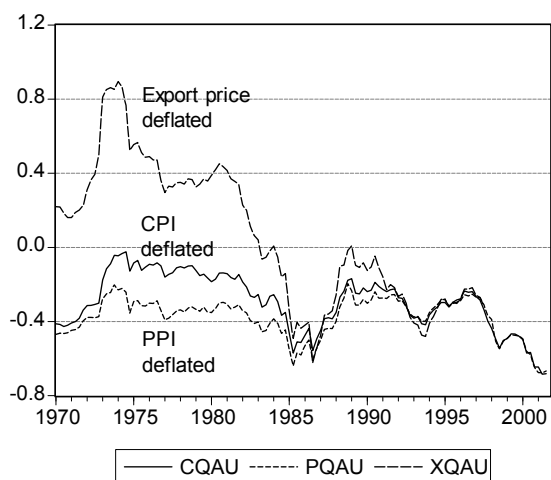


Figure 1: Australian Dollar/US\$ Real Exchange Rates

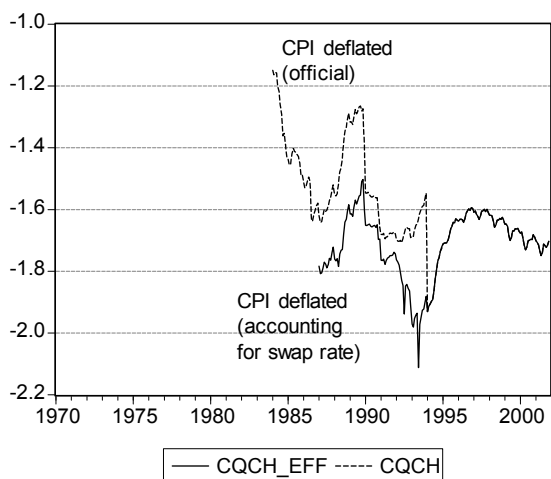


Figure 2: Chinese RMB/US\$ Real Exchange Rate

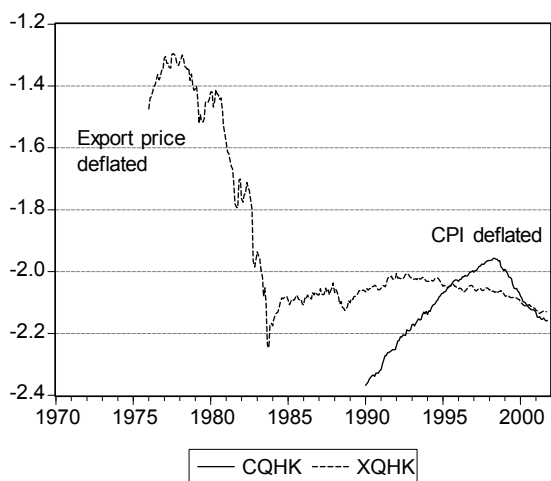


Figure 3: Hong Kong Dollar/US\$ Real Exchange Rates

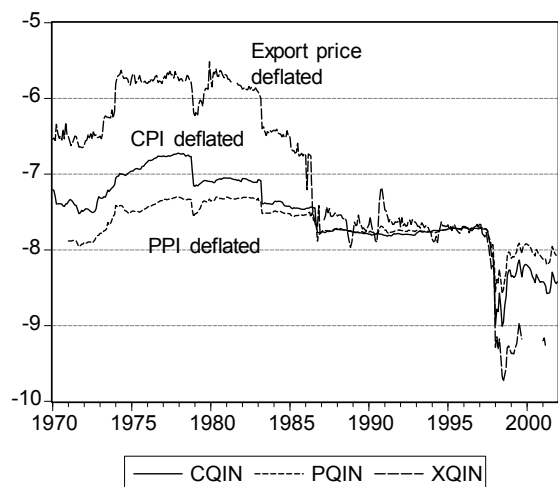


Figure 4: Indonesian Rupiah/US\$ Real Exchange Rates

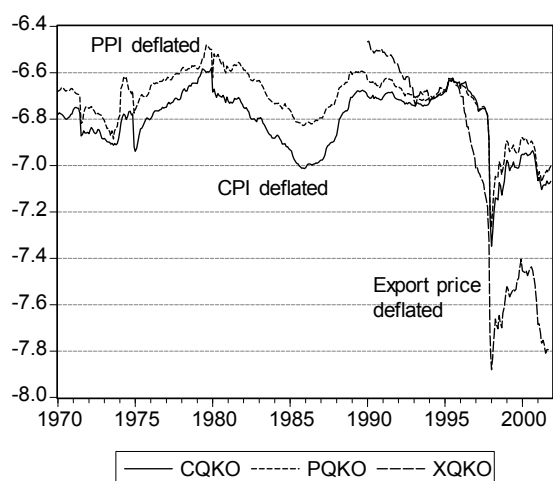


Figure 5: Korean Won/US\$ Real Exchange Rates

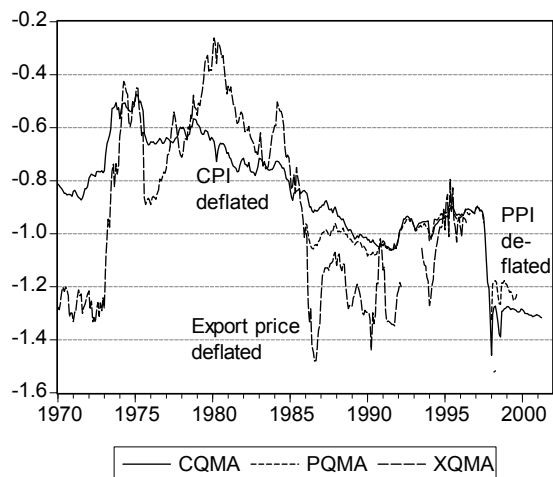


Figure 6: Malaysian Ringgit/US\$ Real Exchange Rates

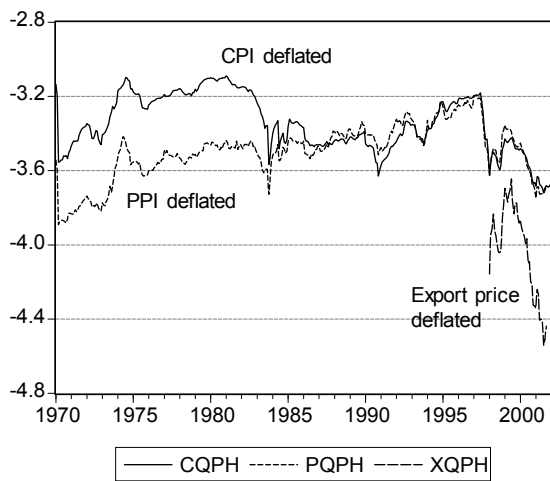


Figure 7: Phillipine Peso/US\$ Real Exchange Rates

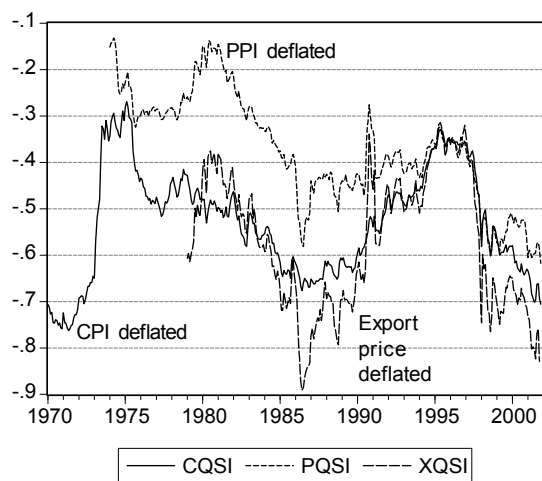


Figure 8: Singapore Dollar/US\$ Real Exchange Rates

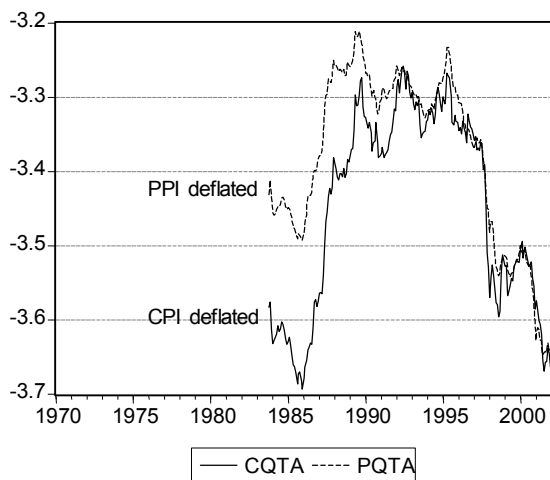


Figure 9: Taiwan NT\$/US\$ Real Exchange Rates

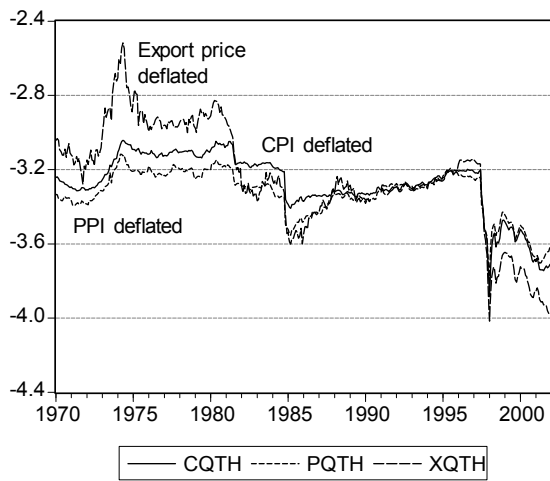


Figure 10: Thai Baht/US\$ Real Exchange Rates

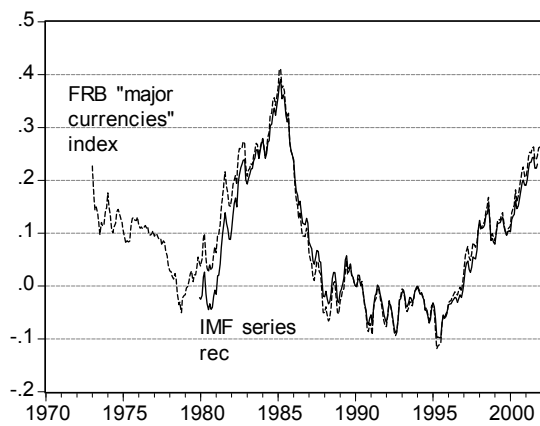


Figure 11: US\$ CPI-Deflated Exchange Rate Indices

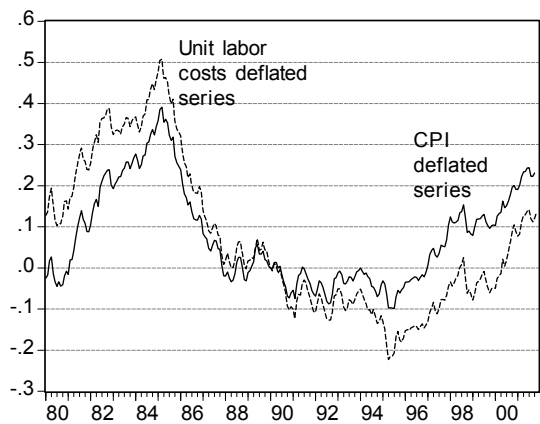


Figure 12: US\$ CPI and ULC Deflated Exchange Rate Indices

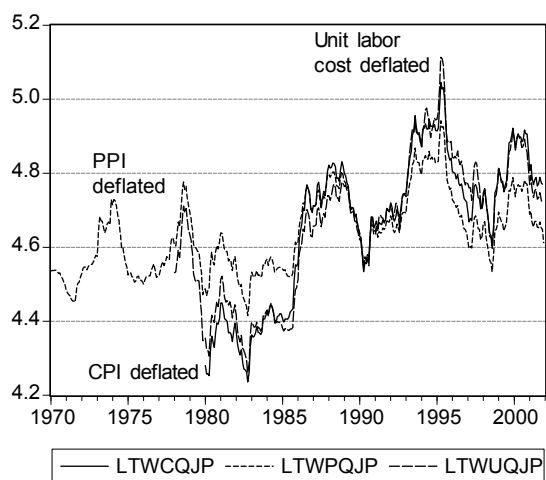


Figure 13: Japanese Yen CPI, PPI, ULC Deflated Indices

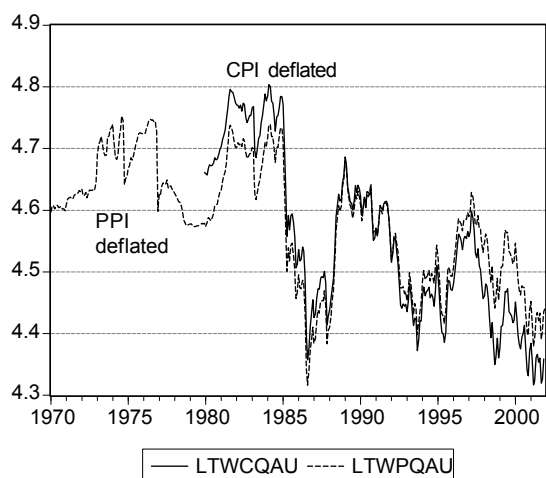


Figure 14: Australian \$ CPI and PPI Deflated Indices

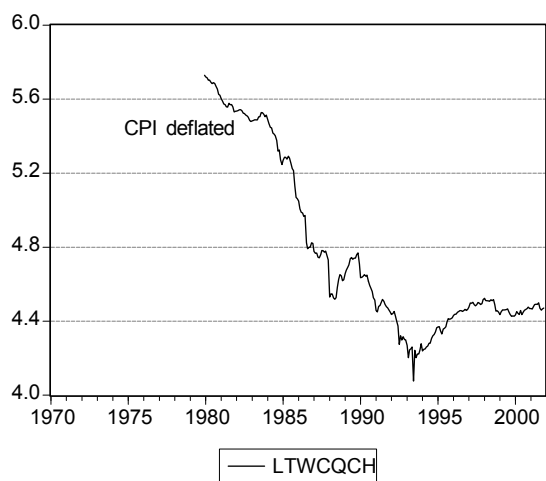


Figure 15: Chinese RMB CPI Deflated Index

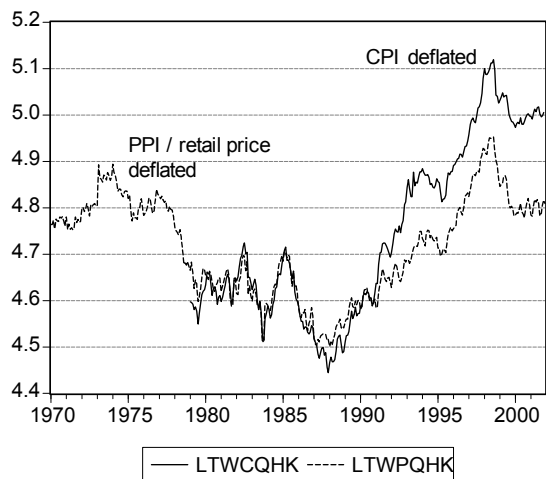


Figure 16: Hong Kong \$ CPI and PPI Deflated Indices

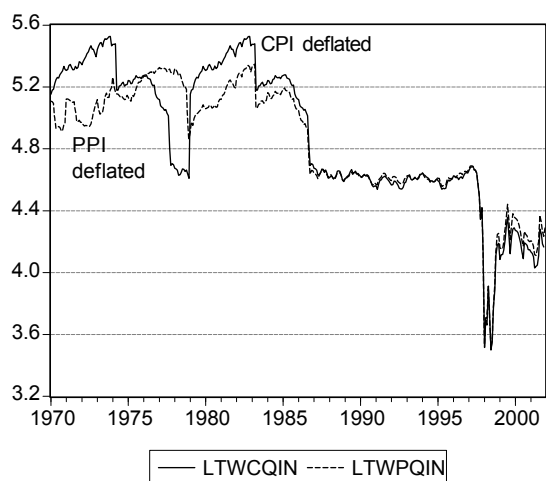


Figure 17: Indonesian Rupiah CPI and PPI Deflated Indices

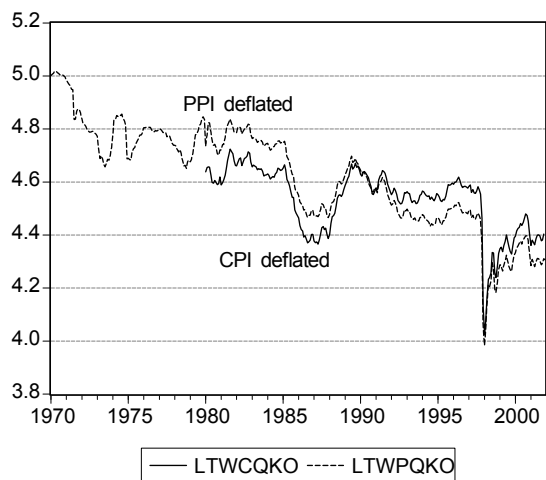


Figure 18: Korean Won CPI and PPI Deflated Indices

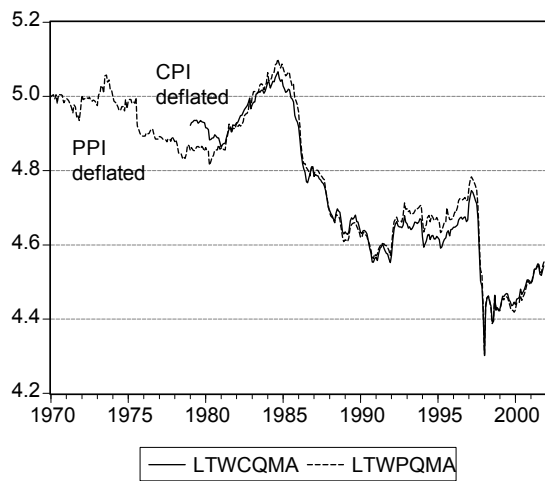


Figure 19: Malaysian Ringgit CPI and PPI Deflated Indices

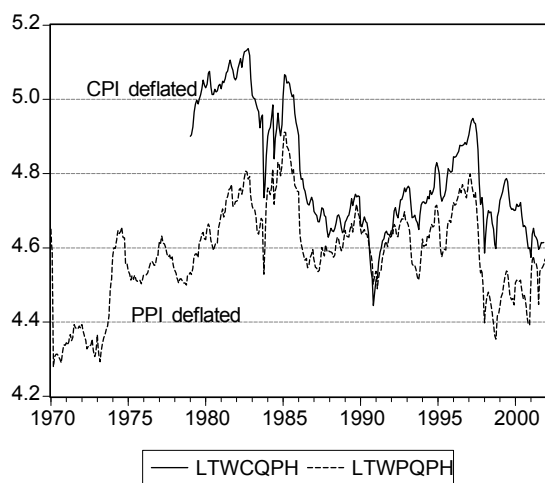


Figure 20: Philippine Peso CPI and PPI Deflated Indices

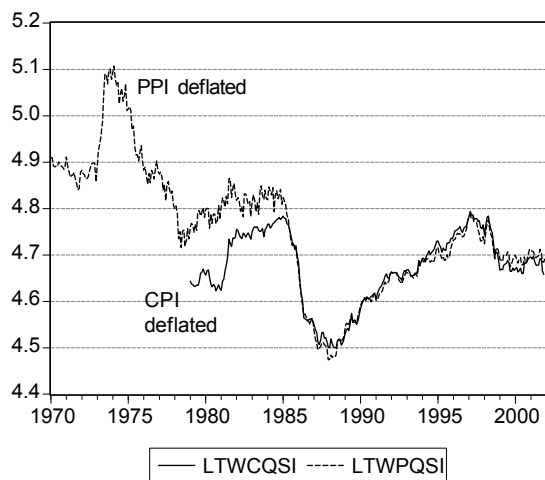


Figure 21: Singapore \$ CPI and PPI Deflated Indices

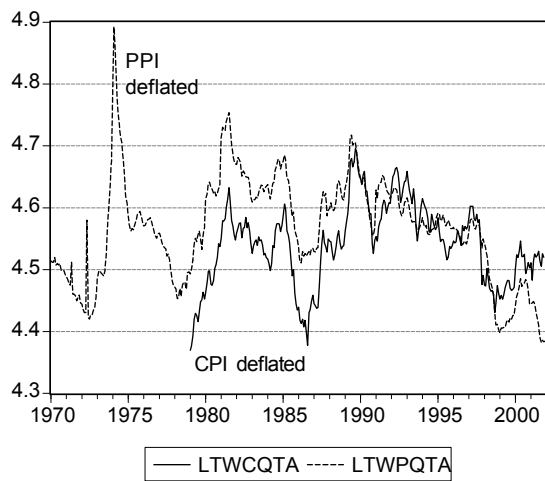


Figure 22: Taiwan NTS CPI and PPI Deflated Indices

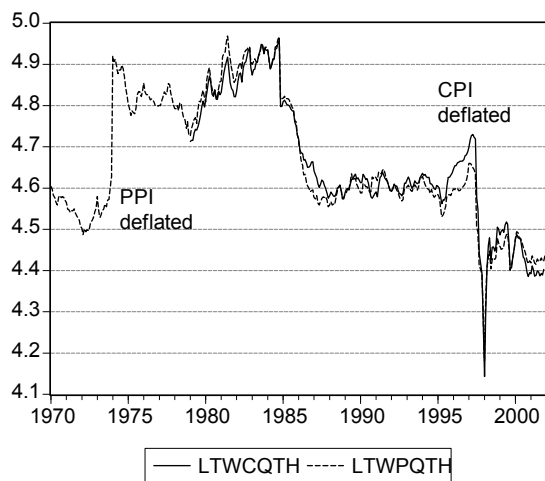


Figure 23: Thai Baht CPI and PPI Deflated Indices

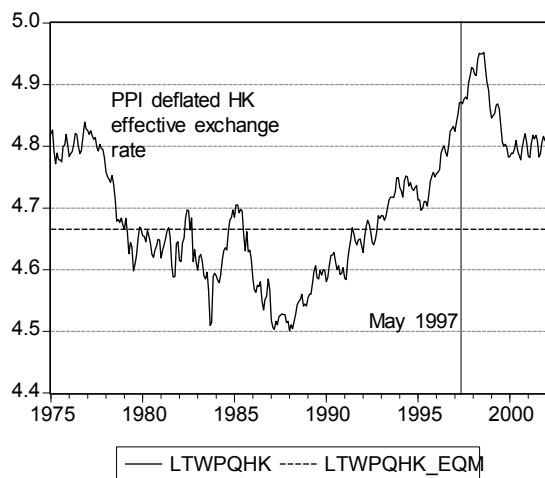


Figure 24: Hong Kong Index and Estimated PPP

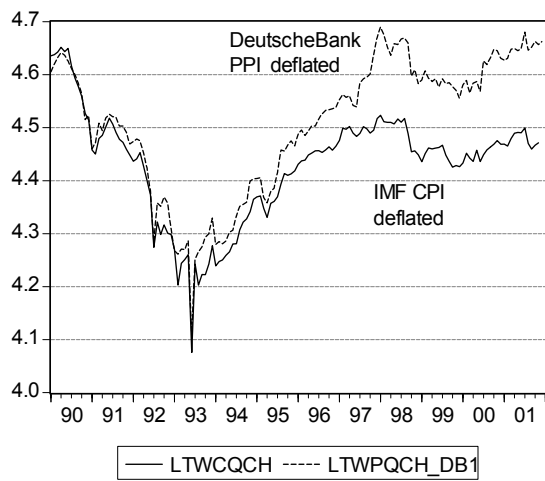


Figure 25: Comparison of IMF and DB Chinese Real Exchange Rate Series

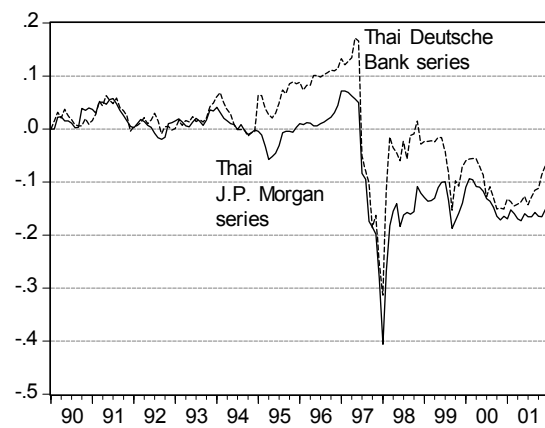


Figure 26: Comparison of J.P. Morgan and DB Thai Real Exchange Rate Series