Lecture VI:

The Nominal and the Real Exchange Rate

The Nominal and the Real Exchange Rate

We shall stick to most conventions and define the Nominal Exchange Rate as

$$E = units \text{ of domestic currency/1\$ of foreign currency}$$

This means that a rise in E implies a nominal currency *depreciation*. And conversely for a fall in E.

This can be confusing, so some authors and institutions (like the IMF) define E in terms of e.g. dollar per reais so a rise in E means an appreciation.

Here we stick to the tradition as define E as above.

The Nominal and the Real Exchange Rate

The **Real** Exchange Rate is (as other real metrics) corrects for differences in price levels so is defined as:

$$RER = \frac{P}{\varepsilon P*} \qquad (6.1)$$

where P is the domestic consumer price level and P* is the foreign consumer price level.

Now, here a rise in RER means an *appreciation*, i.e., the home country is becoming more ***expensive*** viz the foreign country.

The Nominal and the Real Exchange Rate

Going back to the work of English philosopher David Hume, the foundation of the RER concept is that countries' price levels, once measured on the same currency, should equalize:

$$P = \varepsilon P^* \qquad (6.2)$$

Otherwise, it would be just cheaper to buy one good in the US and sell, say, in Brazil for a profit. As more and more people do this, then this would eliminate this "arbitrage opportunity".

This is the famous "purchasing power theory" (PPP), which implies *in absolute terms* that RER=1!

The Nominal and the Real Exchange Rate

As you may have already experience with your international shopping experiences, and we will see in the data, equation (6.2) does not hold well in practice.

So, it is become usual to define PPP in relative terms:

$$\Delta \ln P = \Delta \ln \varepsilon + \Delta \ln P^* \qquad (6.3)$$

$$.: \pi = \Delta e + \pi^*$$

Relative PPP thus says that inflation in the home country is given by the nominal exchange depreciation plus world inflation.

The Nominal and the Real Exchange Rate

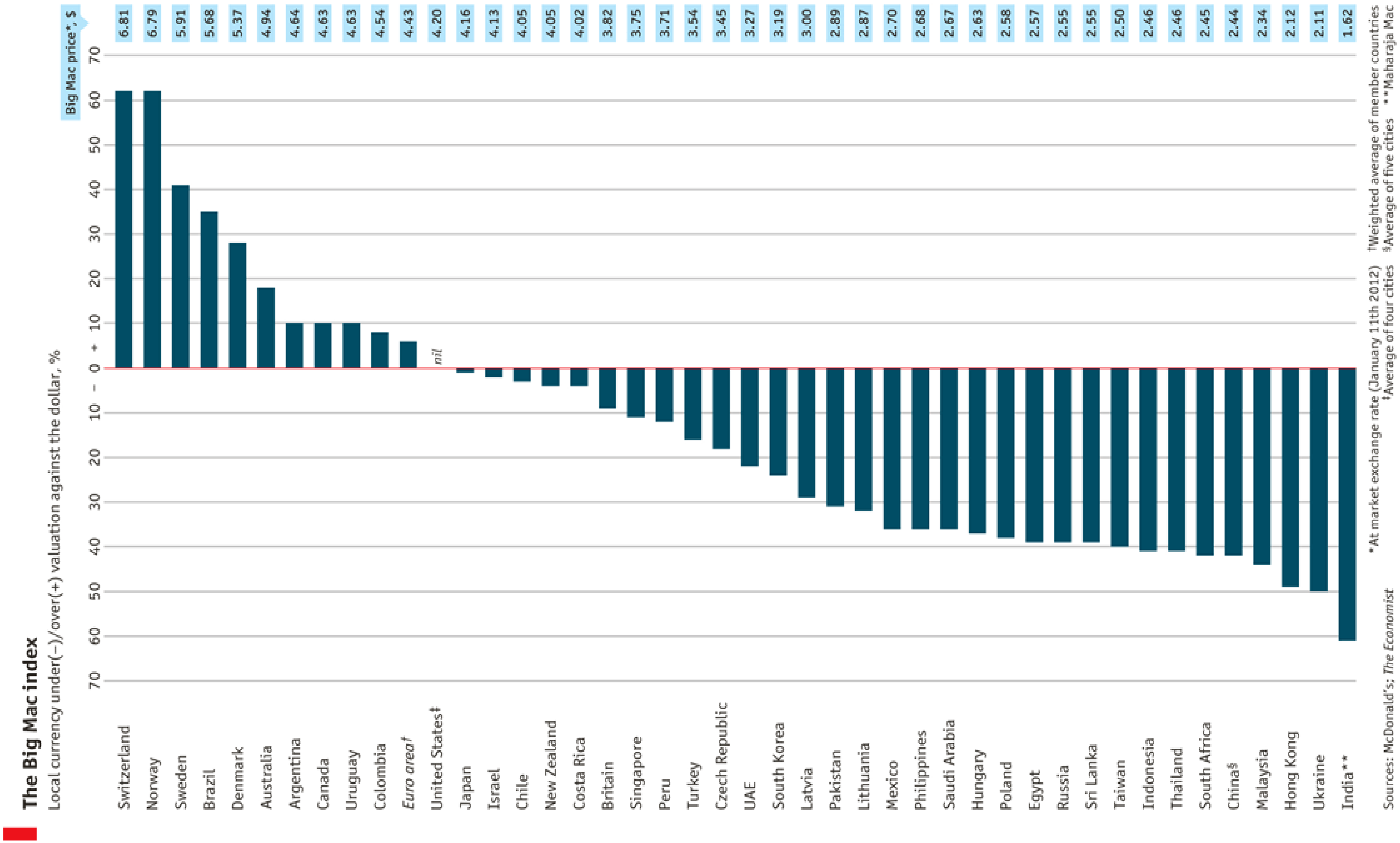
One key problem in testing PPP is that usual measures of ***aggregate*** P are based on index numbers, e.g. P=P*=100 in 2000.

This is not a problem for testing relative PPP as in (6.3), but it is a problem for testing absolute PPP in (6.2).

One remedy for that is to compare the actual price of every individual product in the various countries.

The magazine “The Economist” has it for “Big Macs”.

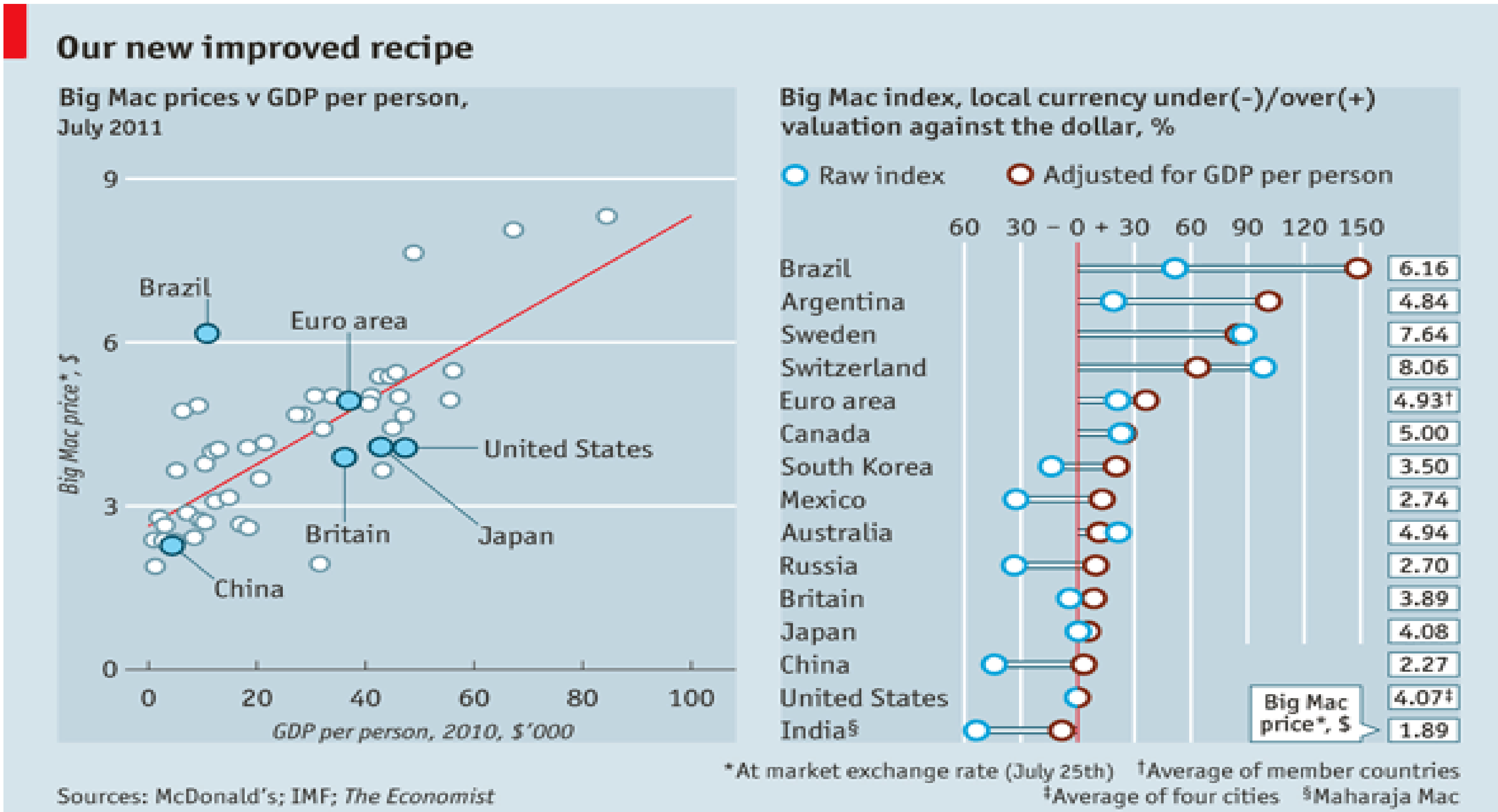
PPP and The Big Mac Index



The Nominal and the Real Exchange Rate

- But the Big Mac is just one good.
- Research has made an effort to broaden price level comparisons at a micro level (Penn World Table).
- The evidence is that there are large deviations from absolute PPP: some countries are quite cheaper than others!
- Further these deviations are associated with some “fundamentals” – one of them being per capita income.

Big Mac Price Misalignment and Per Capita GDP



The Nominal and the Real Exchange Rate

- This positive correlation between RER and per capita income has been associated with the so-called **“Balassa-Samuelson” effect**.

- The idea is that absolute PPP does not hold – in which case there would be no systematic positive association – because some goods are not traded internationally.

- One classic example of non-traded goods: **hair-cut**. It tends to be higher in richer countries.

- In what follows we still study what then determines the price of such non-tradable goods.

Small Open Economy Model with non-Tradable Goods

(taken from O-R, section 4.2)

Two composite goods: T and NT.

$$Y_T = A_T F(K_T, L_T);\ Y_N = A_N G(K_N, L_N) \qquad (6.4)$$

Total Labor supply is fixed: $\bar{L} = L_T + L_{NT}$ (6.5)

Capital internationally mobile, all shocks anticipated (perfect foresight eq.)

But only T goods are used for K accumulation

The Nominal and the Real Exchange Rate

As before, r is the (given) real world interest but now denominated in tradable units as standard.

Firms maximize NPV of revenues:

$$Max.\sum_{s=t}^{\infty}[A_{T,s}F(K_{T,s},L_{T,s})-w_s\mathrm{L}_{T,s}\text{-}\Delta\mathrm{K}_{T,s+1}]$$

$$Max.\sum_{s=t}^{\infty}[A_{NT,s}F(K_{NT,s},L_{NT,s})-w_s\mathrm{L}_{NT,s}\text{-}\Delta\mathrm{K}_{NT,s+1}]$$

The Nominal and the Real Exchange Rate

Let k=K/L and p=P_N/P_T, the FOC will give:

$$A_T f'(k_T) = r \tag{6.7}$$

$$A_T[f(k_T) - f'(k)k_T] = w \tag{6.8}$$

$$pA_N g'(k_N) = r \tag{6.9}$$

$$pA_N[g(k_N) - g'(k_N)k_N] = w \tag{6.10}$$

The Nominal and the Real Exchange Rate

- Main Point: with r given, 4 eqs. [(6.7) to (6.10)] and 4 unknowns (k's, w, and p), so p is determined!

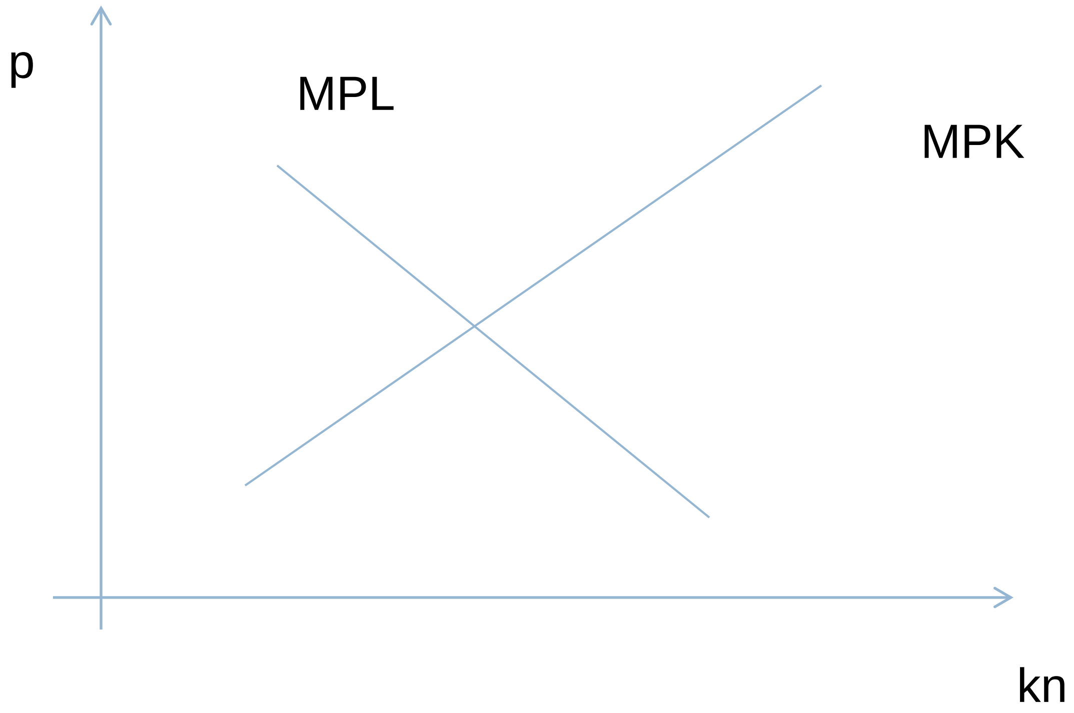
The model also highlights an important entity – the factor price frontier:

$$w(r, A_T) = A_T f[k_T(r, A_T) - rk_T(r, A_T)] \quad (6.11)$$

$$\therefore \frac{\partial w(r, A_T)}{\partial r} = -k_T(r, A_T) < 0 \quad (6.12)$$

The Nominal and the Real Exchange Rate

Equilibrium is given by MPK in (6.9) and MPL in (6.10):



The Nominal and the Real Exchange Rate

- Unless the two countries have the same technology and the same shocks to A's, then their non-tradable relative price p will be different.

- So, absolute PPP will not hold.

As usual, having characterized the eq., we can now do comparative statics.

The Nominal and the Real Exchange Rate

Let's now look at the effects of changes in differential productivity and world interest rates.

First recall that since this is a perfectly competitive eq., zero profit condition holds, so:

$$A_T f(k_T) = rk_T + w \qquad (6.13)$$

$$pA_N g(k_N) = rk_N + w \qquad (6.14)$$

The Nominal and the Real Exchange Rate

Log and deriving (6.13):

$$\frac{dA_T}{A_T} + \frac{rk_T}{A_T f(k_T)} \frac{dk_T}{k_T} = \frac{rk_T}{A_T f(k_T)} \frac{dk_T}{k_T} + \frac{w}{A_T f(k_T)} \frac{dw}{w} \qquad (6.15)$$

$$.: \dot{A}_T = \frac{w}{A_T f(k_T)} \dot{w} = \frac{w}{y_T} \dot{w} = \frac{wL_T}{Y_T} \dot{w} = \mu_{LT} \dot{w} \qquad (6.16)$$

Likewise for (6.14):

$$\dot{p} + \dot{A}_N = \mu_{LN} \dot{w} \qquad (6.17)$$

The Nominal and the Real Exchange Rate

Combining the two yields:

$$\dot{p} = \frac{\mu_{LN}}{\mu_{LT}} \dot{A}_T - \dot{A}_N \qquad (6.18)$$

Important Result: if $\frac{\mu_{LN}}{\mu_{LT}} > 1$ tradable productivity is faster than non-tradable productivity, then the relative price of non-tradables will go up.

The Nominal and the Real Exchange Rate

We proceed similarly for r to obtain:

$$\dot{p} = -\frac{(\mu_{LN} - \mu_{LT})}{\mu_{LT}}\dot{r} \qquad (6.19)$$

Important Result: if $\frac{\mu_{LN}}{\mu_{LT}} > 1$ then rising world interest rate implies **lower** non-tradable prices.

The intuition is that wages will be depressed and since the non-tradable is more labor intensive, then its relative cost and hence price will fall.

This relates to the Stolper-Samuelson theorem.

The Nominal and the Real Exchange Rate

- Now back to the RER definition.

The domestic and foreign price indices will be:

$$P = (1)^{\gamma} p^{1-\gamma} = p^{1-\gamma} \qquad (6.20)$$

$$P^{*} = (1)^{\gamma} (p^{*})^{1-\gamma} = (p^{*})^{1-\gamma} \qquad (6.21)$$

So, the RER is:

$$RER = \frac{p^{1-\gamma}}{\varepsilon (p^{*})^{1-\gamma}} \qquad (6.22)$$

The Nominal and the Real Exchange Rate

- Take logs and let e=1 (so the tradable price in domestic currency remains the numeraire).

- The, the real exchange rate between any two countries depend only on their respective non-tradable prices relative to the tradable good.

- Changes in the RER to productivity will then be:

$$R\dot{E}R = (1-\gamma)(\dot{p} - \dot{p}^*) = (1-\gamma)\left[\frac{\mu_{LN}}{\mu_{LT}}(\dot{A}_T - \dot{A}_T^*) - (\dot{A}_N - \dot{A}_N^*)\right] \quad (6.23)$$

The Nominal and the Real Exchange Rate

So, we have just formalized the famous Balassa-Samuelson effect!

Which, as discussed, can explain why the level of prices and hence real exchange rates are higher in countries that are richer.

And that as countries get relatively richer, their RERs tend to appreciate.

Issues in Real Exchange Rate Measurement

Recall eq. (6.1) and define the log of the real exchange rate (q) as:

$$q_t = e_t - p_t + p_t^* \qquad (6.24)$$

where now q=-ln(RER), p=ln(P) and p*=ln(P*), and e=ln(ε).

According to this definition of RER, a rise means a ***depreciation***.

Note that in (6.1) we defined it the other way around. Recall: Be mindful that different people use different conventions!

Issues in Real Exchange Rate Measurement

Now as we did in (6.20) and (6.21), we let aggregate price indices be a geometric average of the price indices of tradable and non-tradable goods:

$$p_t = \alpha p_t^N + (1-\alpha) p_t^T \qquad (6.25)$$

$$p_t^* = \alpha^* p_t^{N^*} + (1-\alpha^*) p_t^{T^*} \qquad (6.26)$$

Substituting into (6.24) yields:

$$q_t = \underbrace{(e_t - p_t^T + p_t^{T^*})}_{\text{Relative price of tradables between home and foreign country}} - \alpha \underbrace{(p_t^N - p_t^T)}_{\text{Price of non-tradables viz tradables at home}} + \alpha^* \underbrace{(p_t^{N^*} - p_t^{T^*})}_{\text{Price of non-tradables viz tradables in foreign country}} \qquad (6.27)$$

Relative price of tradables between home and foreign country | **Price of non-tradables viz tradables at home** | **Price of non-tradables viz tradables in foreign country**

Issues in Real Exchange Rate Measurement

Several widely used measures of the "real exchange rate" are specific cases of the general expression in (6.27). The subsequent discussion follows Chinn (2006).

The first specialized measure assumes that the weights of tradables and non-tradables are similar between home and abroad, i.e., $\alpha = \alpha^*$. In this case, we have:

$$q_t^1 = (e_t - p_t^T + p_t^{T^*}) - \alpha(\hat{p}_t^N - \hat{p}_t^T) \qquad (6.27a)$$

where $\hat{p}_t^N = p_t^N - p_t^{N^*}; \hat{p}_t^T = p_t^T - p_t^{T^*}$.

Issues in Real Exchange Rate Measurement

A further specialization is when PPP holds for tradable goods:

$$q_t^2 = -\alpha(\hat{p}_t^N - \hat{p}_t^T) \qquad (6.27b)$$

This in particular is a very widely used measure of the real exchange rate: the (log) ratio of non-tradable to tradable price indices. In fact, for the small open economy (SOE) which faces given $(p_t^{N^*} - p_t^{T^*})$, then this RER measure simply collapses to:

$$q_t^3 = -\alpha(p_t^N - p_t^T) \qquad (6.27c)$$

.

Issues in Real Exchange Rate Measurement

Some researchers however emphasize that PPP in tradable goods does not hold and that much of the international relative price changes take place between ***tradable*** goods.

In this case, a better proxy of the real exchange rate is:

$$q_t^4 = (e_t - p_t^T + p_t^{T^*}) \qquad (6.27d)$$

Which some people see this as a good measure of international "competitiveness".

Issues in Real Exchange Rate Measurement

Yet, another related measure of the RER that focuses on the "competitiveness" side is the ***relative unit labor cost*** (ULC) measure.

To compute that start with a standard mark-up pricing equation:

$$p_t^T = \ln[(1+\mu)\left(\frac{W_t}{A_t}\right)] = \ln(1+\mu) + \ln W_t - \ln A_t \simeq \mu + w_t - a_t$$

Substituting in (6.27d), and for μ= μ*, this yields:

$$q_t^5 = [e_t - (w_t - a_t) + (w_t^* - a_t^*)] \qquad (6.27e)$$

Issues in Real Exchange Rate Measurement

- Each of these specialized measures has pros and cons, depending on what macro "problem" you are concerned with.

- If the issue is domestic macroeconomic balance in a small open economy, (6.27c) is used and normally it is measured as the log ratio between CPI (which contains a lot of non-tradable retailing goods in its composition) and PPI (which is an index of producer prices, mainly comprising tradable goods), i.e.:

$$q_t^3 \simeq \ln(PPI) - \ln(CPI)$$

- In practice, this is usually done by computing the so-called real ***effective*** exchange rate (REER) as a index comprising a (usually geometric) weighted average of each bilateral RER.

$$\ln(REER_t) = \sum_{j=1}^{n-1} w_j q_t^j \qquad (6.28)$$

which can be reverted back to levels by taking exponential transformation of the above.

- There are several methods to compute the weights, but usually they are based on trade data (see the discussion in Chinn, 2006, pp.122-24) and using CPI-based RER.

Issues in Real Exchange Rate Measurement

- As one might expect, depending of which version of (6.27) one uses, and which deflators (CPI, PPI, labor costs), the resulting REER series can look a bit different…
- In fact, sometimes a lot different in magnitude!
- Let's see some illustrations, again taken from Chinn (2006).

Issues in Real Exchange Rate Measurement

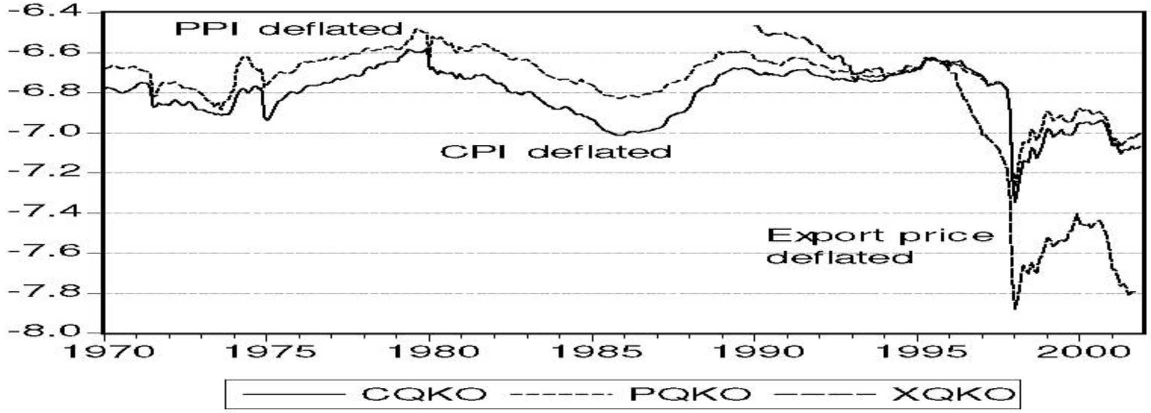


Figure 3: Korean Won/US$ Real Exchange Rates

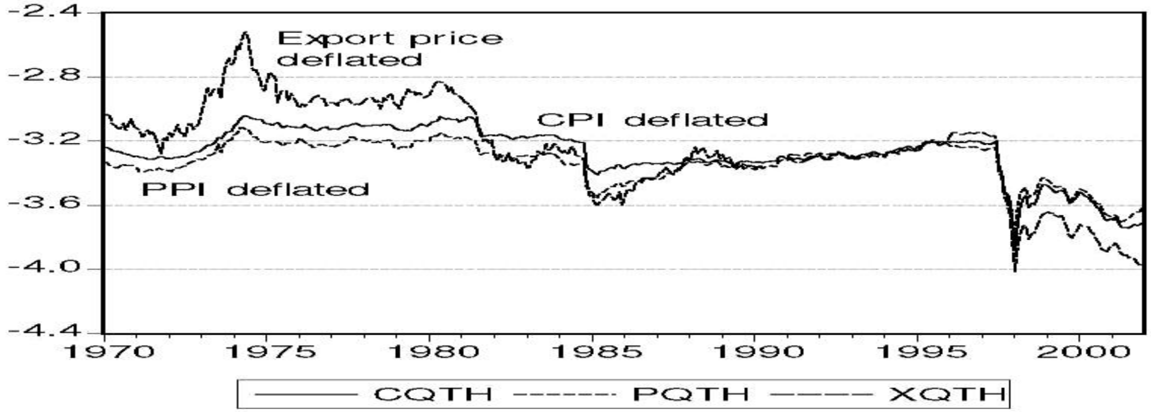


Figure 4: Thai Baht/US$ Real Exchange Rates

Issues in Real Exchange Rate Measurement

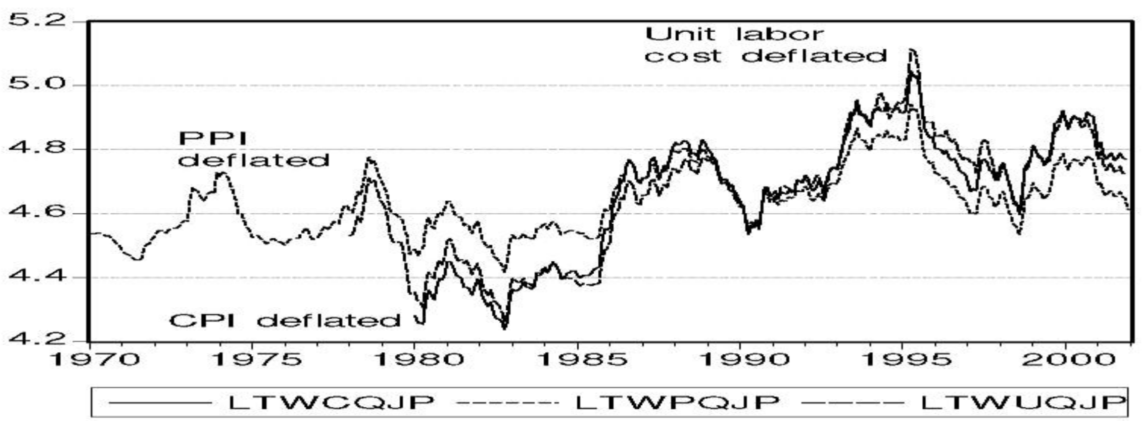


Figure 7: Japanese Yen CPI, PPI, ULC Deflated Indices

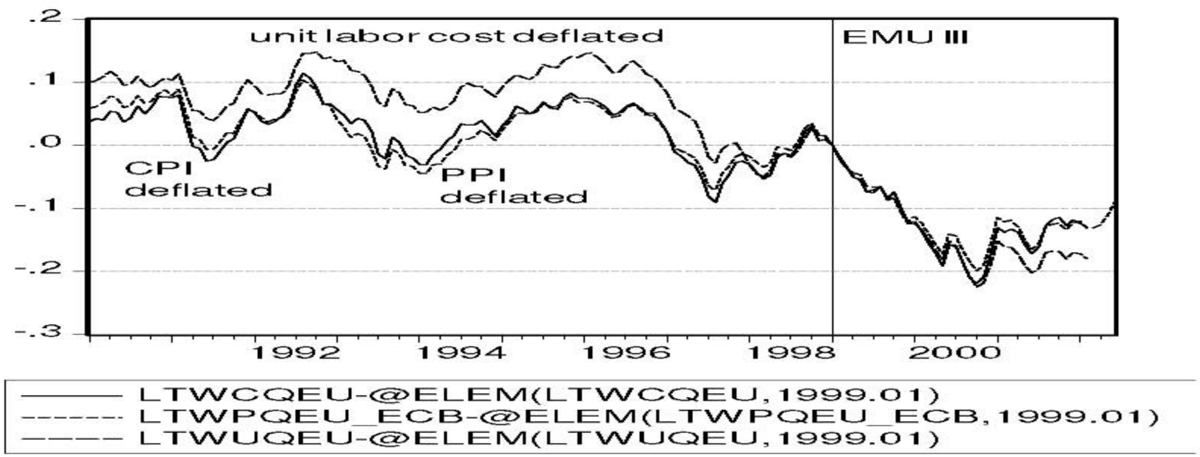


Figure 8: Euro CPI, PPI, ULC Deflated Indices