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Menzie D. Chinn
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Purchasing Power Parity

1. Law of One Price (LOOP) and PPP

An unsophisticated way of thinking about the way the exchange rate is determined to think about what must be true about prices. Consider about two identical blocks of steel, one in Japan, one in the US. From an American's perspective s/he can sell it in the US for let's say $100, or in Japan. Suppose the exchange rate is 0.01 $/¥ (i.e., 100 ¥/$, which is about right). Then the American could ship it to Japan, and (assuming no transportation costs, tariffs, etc.) sell it for

$$P_i^{US}/S \Longrightarrow 100 \text{ \{\$/block\}} / 0.01 \text{ \{\$/¥\}} = 10{,}000 \text{ \{¥/block\}}$$

Now consider the Japanese block of steel. If it's selling for more than ¥ 10,000 (let's say ¥ 12,000), then the Japanese producer will be undercut by the US producer, who could sell it for ¥ 11,999, and make a hefty profit relative to what s/he could in the US. Consequently the Japanese producer will be forced to drop his/her price. (If the Japanese price is less than the US, then the reverse would occur.) Now consider if there are many blocks of steel in each country. Then the US producer would start shipping lots to Japan, driving down Japanese prices, and driving up US prices (as the supply of blocks of steel in the US declines). This process is called arbitrage. Eventually prices (after adjustment by the exchange rate) would equalize. This suggests the following equality:

$$P_i^{US} = S \times P_i^{JP}$$

Suppose (1) this is true for all goods, and (2) the basket of goods in the US is the same as the basket of goods in Japan. This then implies the following:

$$S = P^{US}/P^{JP}$$

This expression is called "*absolute* purchasing power parity". If this relationship holds only up to a constant proportion, $(1+\psi)$ (i.e., prices in common currency are higher by ψ percent), then that is called "*relative* purchasing power parity". An example is:

$$P_i^{US} = (1+\psi) \times S \times P_i^{JP}$$

Here the price level in the US is ψ percent higher than those in Japan after converting Japanese prices into dollar terms by way of the exchange rate.

2. Why PPP May Not Hold

One can think about a lot of reasons why this process might not happen completely, or very fast.

- First, transportation is costly for a lot of bulky or massive commodities.
- Second, tariffs and other trade restrictions still exist.
- Third, laws, regulations, and standards (health, safety, consumer protection) differ a lot between countries, so commodities or services may have to be altered in order to cross borders.
- Fourth, and perhaps most importantly more macroeconomic issues, prices may be sticky. This condition may arise because firms don't like changing prices all the time, or because workers don't like changing wages continuously. This will lead to some "stickiness" in prices (in the latter case because prices depend on wages). Hence, one should not expect this equality in prices expressed in a common currency to hold every instant. This is made clear in the following graph (Figure 1) for the US Dollar/Euro and the United States and the Euro Area CPIs.

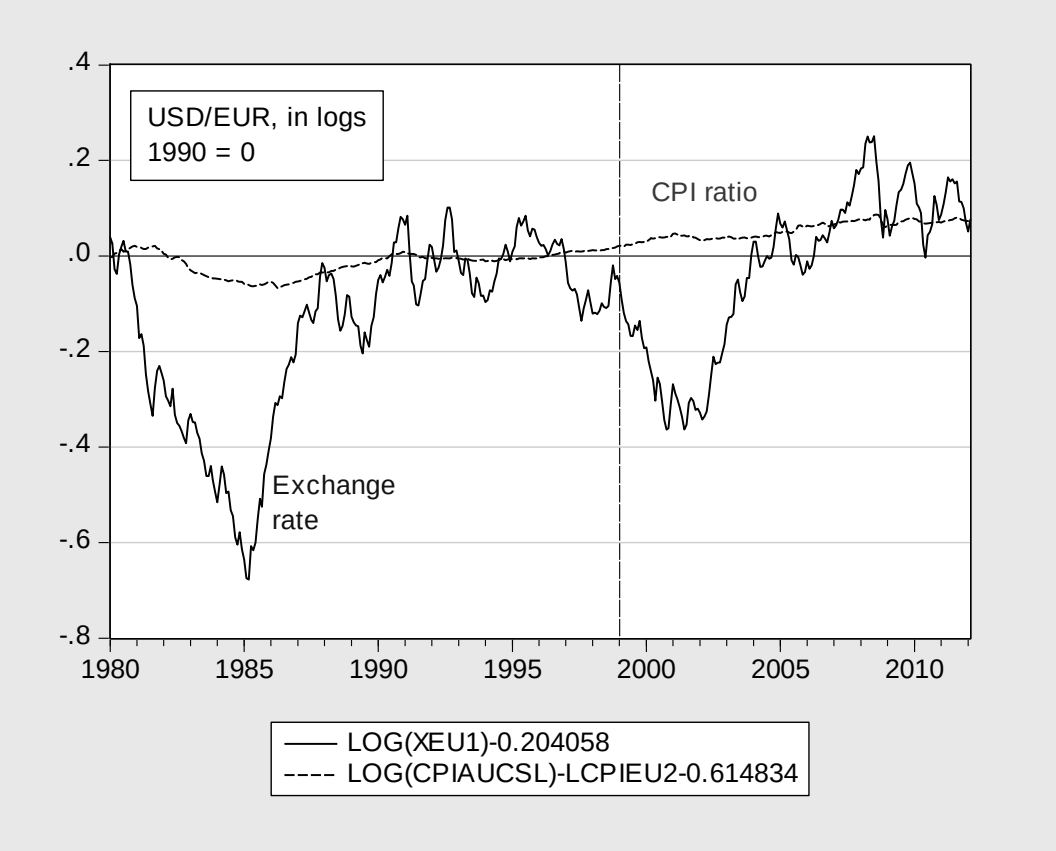


Figure 1. Log US dollar/euro exchange rate and log relative consumer price indices, both rescaled to 1999M01 = 0. Source: IMF, *International Financial Statistics,* St. Louis Fed and author's calculations.

3. What's the Evidence for PPP?

In general, we don't have too much information on prices on individual goods. Rather, we have general price indices, like the Consumer Price Index (CPI), which measures the prices of lots of things (including things that can't be easily traded between countries, like haircuts and rent on apartments). Let's ignore this complication for the moment, and look at the evidence. Looking at Figure 1, one sees that exchange rates move roughly in the right direction with prices, but that they also move a lot more. This suggests that maybe this criterion is useful for thinking about matters in the long run, but it's not terribly useful for day to day, or even year to year, variations in the exchange rate.

In Figure 2, the relevant picture for Japan is presented.

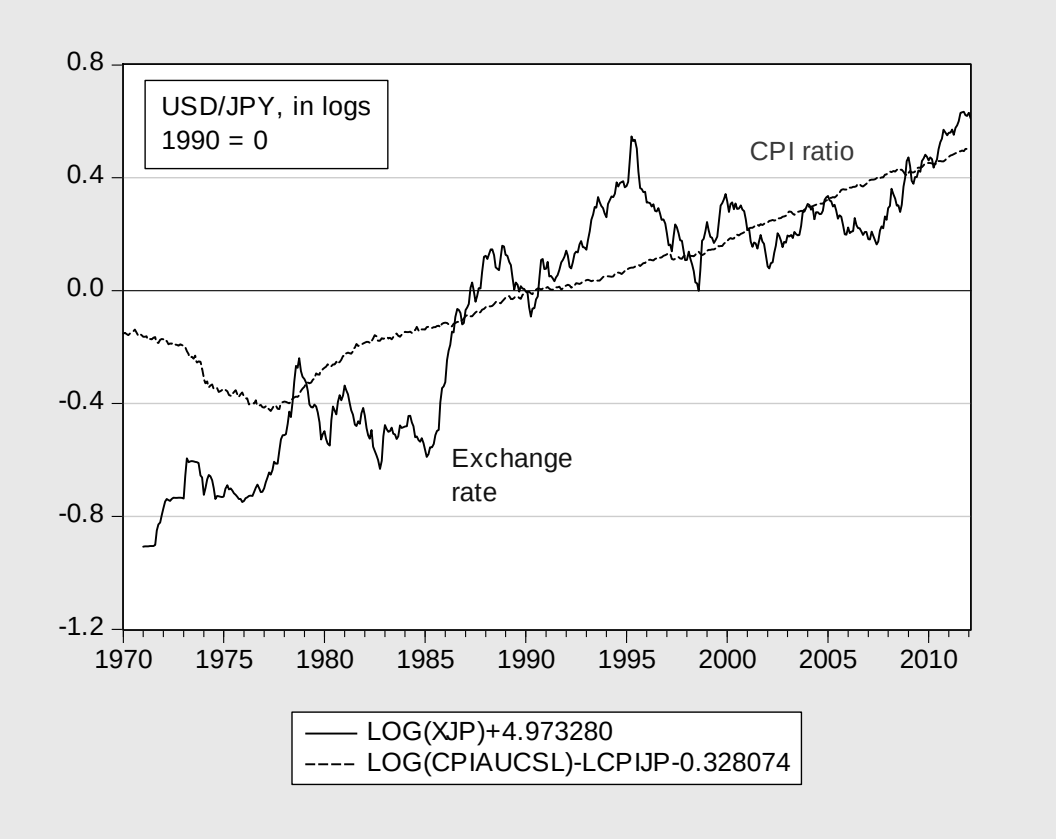


Figure 2. Log US dollar/Japanese yen exchange rate and log relative consumer price indices, both rescaled to 1973q1 = 0. Source: IMF, *International Financial Statistics* and author's calculations

Notice for Japan, relative prices don't seem to explain the exchange rate even in the right direction. This is often explained as a function of the importance of nontradable goods, and the divergence in productivity between the traded and nontradable sectors.

4. Big Mac Index

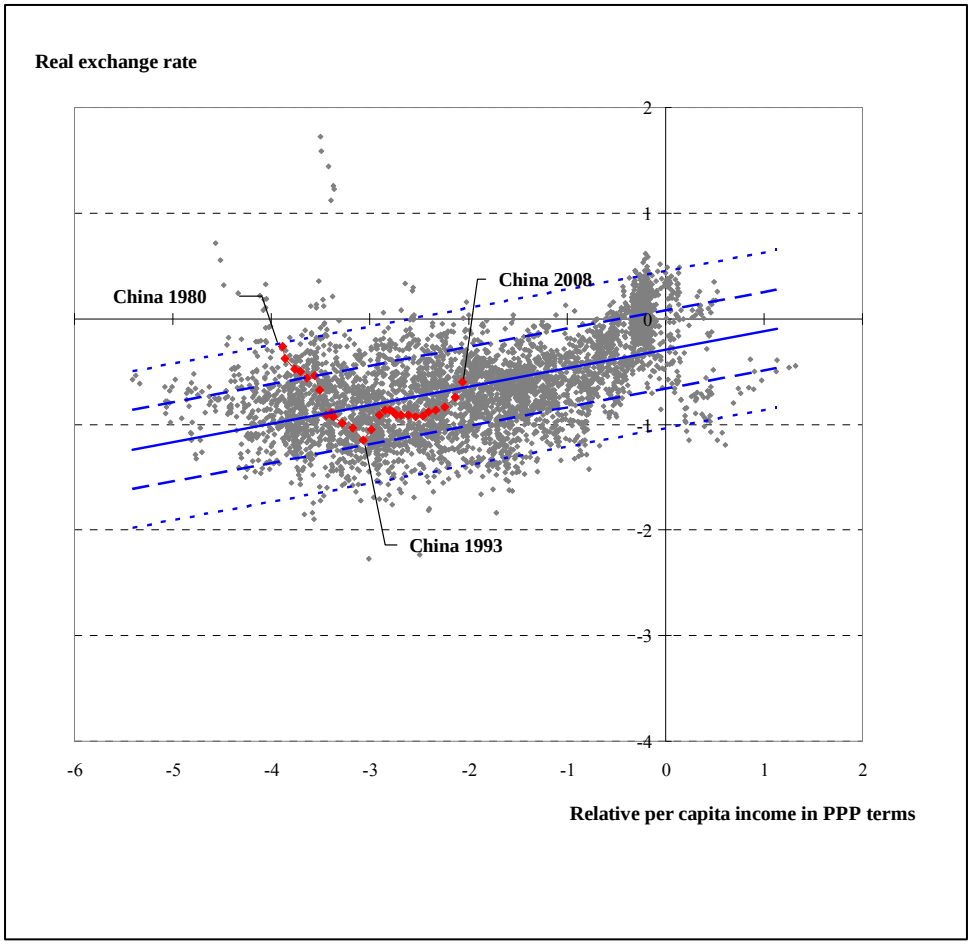
Each year, the Economist conducts a survey of Big Mac prices. The latest survey (1/12/2010) results are presented in the graph below:

Source: "The Big Mac index," *Economist*, January 12, 2012.
http://www.economist.com/blogs/graphicdetail/2012/01/daily-chart-3

The Big Mac index is useful partly because the basket is pretty similar across countries. This is unlike the case for consumer price indices, which vary considerably across countries.

The undervaluation/overvaluation calculations underlying the Big Mac index are based on the assumption that that all components are tradable. Labor, a large component of costs, are clearly not tradable. And labor costs rise with per capita income. Hence, a more realistic manner in which to assess misalignment is to see whether a currency value deviates from that implied by a given per capita income level.

In Cheung et al. (2010), the Penn World Tables data on "price levels" is used to show whether the RMB is misaligned. The regression line is estimated using relative per capita income, in PPP terms. The data are available at: http://pwt.econ.upenn.edu/php_site/pwt_index.php



Source: Y.-W. Cheung, M. Chinn, E. Fujii (2010).

References

Cheung, Yin-Wong, Menzie Chinn, and Eiji Fujii, 2010, "China's Current Account and Exchange Rate," *China's Growing Role in World Trade*, edited by R. Feenstra and S.-J. Wei (U.Chicago Press for NBER.