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Purchasing Power Parity and Real Exchange Rates

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Abstract

Purchasing power parity (PPP), the doctrine that prices of goods and services expressed in a common currency are equalized, is described. The evidence regarding PPP, obtained using long run statistical methods, long spans of data, or both, is evaluated. The failure of absolute PPP provides the basis for discussing the determinants of real exchange rate changes, both over the short and long run. Various theoretical models, and their relation to empirical evidence, is then recounted.

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1. Introduction

The real exchange rate is a key relative price in open economy macroeconomics, defining how many bundles of home goods have to be given up to obtain a single bundle of foreign goods. In its simplest formulation, purchasing power parity (PPP) is the case where a single bundle of home goods always trades for a single bundle of foreign goods. In other words, PPP implies a constant real exchange rate. To the extent that PPP fails to hold in the short run, then the real exchange rate varies over time.

In this chapter I discuss the literature on PPP as a departure point for the investigation of exchange rate models developed during the post-Bretton Woods era. These approaches are separated into monetary models incorporating price stickiness, and models with real factors, like productivity, government spending, and factors affecting wealth.

2. Purchasing Power Parity

2.1 A Framework

Purchasing power parity (PPP) is one of the most important concepts in international finance. Several excellent surveys exist on the subject, including Breuer (1994), Rogoff (1996), and Taylor and Taylor (2004).[1] While a thoroughgoing discussion of purchasing power parity is beyond the scope of this chapter, some discussion of PPP is necessary to set the stage for a discussion of real exchange rate determination.[2] The simplest statement of PPP is that the common currency price of an identical bundle of goods is equalized:

[1] An early survey, with discussion of Cassel and the origins of the term PPP, is to be found in Officer (1982).
[2] A myriad of definitions for PPP exist. I define PPP as pertaining to relationships between relatively broad price indices such as the consumer price index (CPI), the producer price index (PPI), or GDP deflator, on the one hand, and the exchange rate on the other.

$$S_t \times P_t^* = P_t \ \Leftrightarrow s_t + p_t^* = p_t \tag{1}$$

Where P corresponds to the price of a bundle of goods and services, and S is the exchange rate (in units of home currency per foreign), and a * superscript denotes a foreign variable. Lowercase letters denote log values. Equation (1) is termed "absolute" PPP to the extent that common currency prices are exactly equalized. As we seldom have prices of bundles of goods, but rather price indices with differing base years, we cannot directly test absolute PPP. This means when using price indices, equation (1) should be augmented by a constant, to obtain what is sometimes called relative PPP (in levels).

In contrast, relative PPP in *growth rates* is:

$$\Delta s_t = \Delta p_t - \Delta p_t^* \tag{2}$$

Where Δ's indicate difference operators. Equation (2) means the rate of exchange rate depreciation equals the inflation differential. Alternatively, exchange rate depreciation equals the rate at which the home currency loses value against the foreign; home (foreign) inflation is the rate at which home (foreign) currency loses value against home (foreign) goods, when home and foreign baskets of goods trade off one-for-one.

Notice that there is a correspondence between the Law of One Price (LOOP) and absolute PPP. The former is:

$$s_{i,t} + p_{i,t}^* = p_{i,t} \tag{3}$$

Where i indexes each good. LOOP means the common currency price of an individual good is equalized. Interestingly, even if LOOP holds, PPP might not hold. Consider the case when the weights in the consumer bundles differ. If in the home country, good A is consumed in proportion β, and good B is consumed in proportion (1-β), while in the foreign country, good A is consumed in proportion δ, and good B in proportion (1-δ), then at any given time:

$$p_t = \beta p_{A,t} + (1-\beta) p_{B,t} \tag{4.1}$$

$$p_t^* = \delta p_{A,t}^* + (1-\delta) p_{B,t}^* \tag{4.2}$$

Then even if the LOOP holds, the following equality

$$s + p_t^* = \delta\left(s + p_{A,t}^*\right) + (1-\delta)\left(s + p_{B,t}^*\right) = \beta p_{A,t} + (1-\beta) p_{B,t} = p_t \tag{5}$$

will hold only if β=δ, i.e., the weights in the baskets are identical.

There is, in this context, a direct relationship between the deviation from PPP, and the implied value of the real exchange rate. Rearranging (1), one obtains:

$$q_t \equiv s_t - p_t + p_t^* = 0 \tag{6}$$

where q is measured in domestic units of the domestic basket of goods required to purchase a single basket of foreign goods. If absolute PPP holds, then the (log) real exchange rate should be a zero (and a constant if relative PPP in levels holds). In practice, the distinction is of limited relevance, since most tests involve price indexes, rather than prices of bundles of goods.[3]

One can decompose the general price index along several dimensions. One is the tradable/nontradable distinction; furthermore, the tradable category can be further divided into importables and exportables. Consider the first dimension; then, writing the general price index as:

$$p_t = \alpha p_{N,t} + (1-\alpha) p_{T,t} \tag{7.1}$$

[3] Exceptions include the price levels in the Penn World Tables (Heston and Summers, 1991), the International Comparison Program (ICP) see World Bank (2015), the Big Mac index (Pakko and Pollard, 2003; Parsley and Wei, 2007),

$$p_t^* = \alpha p_{N,t}^* + (1-\alpha) p_{T,t}^* \qquad (7.2)$$

where a N subscript denotes nontradables and T tradables, one obtains the resulting expression for the real exchange rate (assuming the weights are identical):

$$q_t = q_{T,t} - \alpha(\hat{p}_{N,t} - \hat{p}_{T,t}) \qquad (8)$$

where

$$q_{T,t} \equiv (s_t - p_{T,t} + p_{T,t}^*)$$

The real exchange rate thus deviates from zero if either common currency prices of tradables differ, or the relative price of nontradables versus tradables differs across countries.[4] This decomposition underpins Engel's (1999) analysis of the sources of US real exchange rate movements.[5]

The relative price variable may be determined by any number of factors. In the Balassa (1964) and Samuelson (1964) model, relative prices are driven by relative differentials in productivity in the tradable and nontradable sectors.[6] [7]

Relative prices may also be affected by demand side factors.8 In the long run, the rising preference for services, which are largely nontradable, may induce a trend rise in the relative price of nontradables. Over shorter horizons, government spending on public services may also

[4] This interpretation is a possible explanation why PPP evaluated using consumer price indices (CPIs) is typically less successful than using measures incorporating mostly traded goods, such as producer price indices (PPIs).
[5] This approach is driven by Engel's (1993) observation that prices of different goods within the same country exhibit less variation than prices of the same good in different countries.
[6] This view is adopted in DeGregorio and Wolf (1994), Canzoneri, Cumby and Diba (1996), Chinn (1997a,b, 2000b) among others. The first two studies examine annual total factor productivity data for 14 OECD countries in a panel context, while Chinn (1997a,b) undertakes a higher frequency analysis.
[7] The intertemporal approach to consumption smoothing in the presence of nontradables is examined in Backus and Smith (1993) and Apte et al. (2004).
[8] A whole set of models dispenses with any sort of PPP, to the extent that different countries produce explicitly different goods; see for instance Lucas (1982) and Stockman (1980).

induce changes in relative prices (DeGregorio and Wolf (1994) and Chinn (1999)).[9] This issue is further investigated in Section 3.

2.2 Empirical Investigation of PPP

At one level, it is clear that relative purchasing power parity in levels, let alone absolute, holds over all exchange rates, over long stretches of time. Summers and Heston developed a database of price levels are based on the same basket weights across countries, in the Penn World Tables.10 Hence, if the Law of One Price held, PPP in levels should hold. But as is well documented in the Penn Effect (Summers and Heston, 1991), the price level rises with per capita income (e.g., Cheung, et al. 2007).[11] Nonetheless, one could still investigate whether PPP holds for countries of relatively similar levels of economic development, e.g., the advanced economies. It therefore makes sense that evidence for PPP is much less pronounced for developing countries (Bahmani-Ookooee, 1993).

Early work on PPP relied upon Classical regression techniques, and addressed the question of whether PPP held on a period by period basis. That literature concluded that absolute PPP did not hold for broad price indices, in the short run. One important exception was that identified by Frenkel (1976) who found that during the German hyperinflation of the 1920s, PPP did hold. Hence, the conclusion that PPP held only when nominal (monetary) shocks were large relative to real shocks.

However, the bulk of the work confirmed that in less pathological periods, PPP in levels did not hold in the short run – and indeed potentially not even in the long run. One of the most

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[9] See also Chen and Rogoff (2003) for a commodities price channel.
[10] The most recent version is described in Feenstra et al. (2015).
[11] More recent estimates allow for the possibility of a nonlinear, U-shaped, relationship

prominent of these is Isard (1978) who showed prominent and persistent deviations for aggregate price indices as well as individual goods.

Subsequently, research took several directions.

1. Testing for statistical long run PPP
2. Evaluating long spans of history
3. Allowing for nonlinearities

2.2.1 Purchasing power parity in the (statistical) long run

The advent of the unit root and cointegration brought a resurgence in the PPP literature. Recall from equation (1) that PPP implies that the real exchange rate calculated using price indices is equal to a constant. Corbae and Ouliaris (1988) was one of the first formal analyses of stationarity of real exchange rates. They failed to reject the null hypothesis of stationarity for five dollar real exchange rates. Subsequent, more powerful tests obtained greater evidence for stationarity, as in Cheung and Lai (1998).

Unit root tests impose a common rate of reversion on the exchange rate, and price levels. This suggest alternative approaches. The cointegration literature, originating with Engle and Granger (1987) suggested a two step procedure of allowing for estimated cointegrating vectors (non-unit coefficients could arise from tariffs, for instance).[12] However, applying unit root tests to estimated relationships (the error) still imposes common factor restrictions. Unsurprisingly, Mark (1990) obtained only slightly greater evidence for PPP using unit root tests and first generation cointegration tests.

[12] Findings of cointegration, but without unitary coefficients, is sometimes interpreted as "weak" PPP, when it was consistent with a trending real exchange rate. This terminology is used by Pedroni (2001).

Advances in econometric techniques gave rise to more powerful tests for cointegration. Cheung and Lai (1993) are among the first to use the multivariate maximum likelihood approach associated with Johansen. The approach involves a two step procedure of testing for the presence of at least one cointegrating vector, and then testing to see if the unitary coefficients is rejected. Cheung and Lai find evidence in favor of cointegration for dollar based exchange rates. However, they also find the long run coefficients typically reject the null of unit coefficients.

Edison et al. (1997) conduct a similar analysis on updated data, but use the Horvath-Watson (1995) approach, which imposes coefficients on the cointegrating vector. This more powerful test yields greater evidence for PPP than the other time series approaches.[13]

Cointegration can also be investigated in a panel context. Once again, the PPP model can be investigated by either examining whether the real exchange rate is mean reverting or (less literally) trend reverting. Oh (1996) investigates G-6 currencies using panel unit root tests, while MacDonald (1996) and Wu (1996) examine up to 23 OECD currencies. In all three cases, greater evidence in favor of PPP is found than in time series approaches, even when only examining the post-Bretton Woods period. Frankel and Rose (1996) used annual data over the entire post-war period, and found confirmation of PPP. Papell (1997) found the evidence for PPP is stronger for wider panels, monthly data, and for non-US based exchanged exchange rates.[14][15]

The advent of panel cointegration techniques allowed for a different approach to testing for PPP. Pedroni (2001) applies panel cointegration procedures and finds substantial evidence

[13] Chinn (2000a) applies cointegration techniques to examine whether East Asian currencies were misaligned on the eve of the 1997 currency crises.

[14] Papell and Theodoridis (1998) indicate that evidence of PPP rises with the extension of the sample length.

[15] The traditional tests for panel PPP assumed that the errors were independent across exchange rates. This seems untenable when the exchange rates are all expressed against the US dollar, for instance. O'Connell (1998) showed that the evidence in favor of panel PPP was considerably reduced when such cross-sectional dependence is allowed for.

against PPP; hence his results are less supportive (although evidence of cointegration with non-unit coefficients is more widespread).

2.2.2 Exploiting the Long Span of History

Since unit root tests are notoriously low-powered, it makes sense to try to increase the sample size. Increasing the sample size by increasing the frequency will not typically enhance the power of the test, so the alternative is to increase the historical span. The drawback is that the data then typically span different exchange rate regimes, and the data generating process is likely to change over such long historical spans. Nonetheless, the increase in power might be worth the attendant complications.

Edison (1987) examines the pound/dollar rate over the 1890-1978 period. Lothian and Taylor (1996) apply unit root tests to 200 years (1791-1990) of data on two exchange rates – dollar-sterling and franc-sterling; they find much more evidence in favor of PPP/stationary real exchange rates. This study uses the longest span of price index data; a related paper dealing with the Law of One Price examines 700 years of data (Froot, Kim and Rogoff, 1995). Using more powerful multivariate techniques, Taylor (2002) finds evidence for PPP for 20 dollar-based currencies over the 1871-1996 period.

2.2.3 Nonlinearities

The previous methods assumed linearity either in the short run (relative PPP in growth rates), or in levels. Long run stationarity is more likely to be found if nonlinear reversion is assumed, either in the form of discrete or smooth thresholds.

The motivation for these nonlinearities is manifold. One arises from the idea of a band of inaction, where arbitrage is prevented by transactions costs. Only when outside the band of inaction does arbitrage force reversion to PPP. For instance, Hecksher's "commodity points" provides the basis for Obstfeld and Taylor's (1997) threshold autoregressive (TAR) approach to measuring PPP. They find that it is much easier to reject no PPP (a unit root in the real exchange rate) in favor of stationarity when allowing for thresholds. In addition, the width of the thresholds appears to vary positively with the extent of exchange rate volatility.

Taylor et al. (2001), following up on the observation that adjustment lags can make discrete thresholds behave like smooth thresholds, implements smooth transition autoregressions (STARs) on four major dollar currencies, and finds substantial evidence for mean reversion. These results follow those of Michael et al. (1997). Smooth transitions can be rationalized by the idea that policy authorities seek to stabilize exchange rates around their means, and do so more aggressively the farther away from the mean.

Nonlinearities can also apply to exchange rates and prices differently, suggesting a nonlinear error correction mechanism. Beckmann (2013) and Nam (2011). Beckmann allows for smooth transition while Nam assumes thresholds. Ca' Zorzi et al. (2017) and Eichenbaum et al. (2017) suggest asymmetric adjustment as well. In general, there seems to be a benefit to deviating from linear specifications when modeling PPP.

2.3. Conclusions

Relative purchasing power parity in levels seems to hold in the long run, evaluated either using very long spans of data, or using the most advanced cointegration techniques. However, one puzzle pointed out by Rogoff (1996) is that the persistence of the deviations from absolute PPP in levels -- with half-lives of 3 to 4 years -- is too long to be rationalized by what most economists believed drove deviations – namely monetary shocks in the presence of nominal rigidities.[16] On the other hand, Cheung and Lai (2000a) note the imprecision of estimates, and the non-monoticity of responses to shocks, which doesn't rule out a role for nominal rigidities.

One set of explanations relies on the difference between median and mean estimates of the rate of reversion. Murray and Papell (2002), as does Koedijk et al. (2011), argue this point. The second set of explanations centers on aggregation bias – heterogeneity in the reversion coefficients associated with the constituent components of the basket lead to upward bias in the estimates (Imbs, et al., 2005).

3. Real Exchange Rates

3.1 Nominal Models with Sticky Prices

It's useful to recall that if PPP does not hold instantaneously, then models of nominal exchange rate determination are also models of (short run) real exchange rate determination. This is most easily seen in the context of the real interest differential model of Dornbusch (1976) and Frankel (1979). Assume an overshooting model where the nominal exchange rate reverts to its long run value monotonically. Then under rational expectations:

$$\Delta s_{t,t+1}^{e} = -\theta(s_t - \bar{s}_t) + \pi_t^{e} - \pi_t^{e*} \tag{9}$$

Where $\Delta s_{t,t+1}^{e}$ is the expected depreciation in the nominal exchange rate based on time t information over time period t to t+1, $\bar{s}_t$ is the long run exchange rate, and π_t^{e} is expected inflation. Assuming uncovered interest parity and re-arranging yields:

[16] Cheung and Lai (2000b) link reversion rates to levels of development, exchange rate arrangements, productivity growth, and inflation. They find faster reversion with higher inflation, suggesting price stickiness is one factor in reversion rates.

$$s_t = \bar{s}_t - \frac{1}{\theta}[(i_t - \pi_t^e) - (i_t^* - \pi_t^{e*})] \tag{10}$$

The nominal rate is equal to the long run rate, minus the real interest differential. When the real interest differential is positive, then the home currency is stronger than the long run value.

Subtracting both sides by $p_t - p_t^*$ leads to:

$$q_t = \bar{q}_t - \frac{1}{\theta}[(i_t - \pi_t^e) - (i_t^* - \pi_t^{e*})] \tag{11}$$

Where $\bar{q}_t$is the long run real exchange rate; in the simplest monetary models, where there are no real shocks, the long run real exchange rate is a constant (and zero if PPP holds). The real rate deviates from the long run real rate by a factor that depends on the degree of price flexibility (θ) and the size of monetary shocks.

Meese and Rogoff (1988) examined the implications of this specification. They found that for major currencies, the real interest differential variously proxied has the right sign; that is a higher real interest rate is associated with a stronger currency, holding all else constant. However, the coefficients are not statistically significant. Similarly, Edison and Pauls (1993) fail to find strong evidence of cointegration between the real rate and real interest differentials, even after accounting for portfolio effects a la Hooper and Morton (1982). In contrast, Baxter (1994) finds the posited link, but only at the business cycle horizon. MacDonald and Nagayasu (2000) only detect strong evidence of a link using panel cointegration techniques.[17]

Fiscal policy can also have an impact in the context of sticky-price (Keynesian) models. Obstfeld (1985) develops a rational expectations Keynesian model with sticky prices that predicts that fiscal impulses – essentially budget deficits – affect the exchange rate. Chinn

[17] Mark (1990) examines whether the dynamics of the real exchange rate conform to the Dornbusch, Keynesian, and Lucas models. Mark and Choi (1997) conclude monetary fundamentals better fit the real rate dynamics.

(1997a) evaluates the model and finds this particular model, incorporating IMF measures of fiscal impulses, has only a limited degree of explanatory power.

3.2 Balassa-Samuelson and Productivity Based Models

The basic motivation for most empirical exercises addressing the exchange rate productivity nexus rely upon the tradable-nontradable distinction highlighted by Balassa (1964) and Samuelson (1964). Recall that in the presence of nontradables, one can write the real exchange rate as:

$$q_t = q_{T,t} - \alpha(\hat{p}_{N,t} - \hat{p}_{T,t}) \tag{8}$$

Assuming perfect capital mobility, free intersectoral factor mobility, the internal relative price of traded and nontraded goods is given by

$$p_t^N - p_t^T = a_t^T - a_t^N \tag{12}$$

where for expository simplicity the production functions are assumed to be identical; a^T and a^N are the total factor productivity levels in the traded and nontraded sectors, respectively. In words, (12) implies that the relative price of traded goods moves one-for-one with the productivity differential. As tradable sector productivity rises relative to nontradable, the price of tradable goods relative to nontradable falls.

Combining (8) with (12) yields a standard expression for the real exchange rate:

$$\begin{gathered} q_t = q_t^T + \alpha(\hat{a}_t^N - \hat{a}_t^T) \\ \text{where } q_t^T \equiv s_t - p_t^T + p_t^{T*} \end{gathered} \tag{13}$$

In this framework, the real exchange rate is a function of the intercountry relative productivity differential. And if PPP holds for tradable goods, then q^T is 0, and the real exchange rate depends solely upon the productivity differential.

A number of papers have examined the relationship expressed in equation (13), including Hsieh (1982), Marston (1990), DeGregorio and Wolf (1994), but in first differences. The relationship in levels has proven more elusive. Chinn (1997a,b) finds evidence for individual currencies and East Asian currencies (Chinn, 2000b), in levels. Strauss (1996) finds evidence of cointegration using the conventional over half of fourteen cases, he also finds the parameter restrictions implied by the model are generally rejected.

More evidence of a long run relationship between the level of the real exchange rate and the productivity differential is found in a panel context. Canzoneri, et al. (1999) test the proposition in equation (13) using labor productivity differentials, and find that it holds fairly well in a panel cointegration context for the OECD countries. They also test the hypothesis that purchasing power parity holds for traded goods (i.e., that the second line of (13) equals zero), and while they do find evidence of cointegration, the estimated coefficients are not of the expected sign. Hence, Canzoneri et al. do not *directly* confirm the proposition embodied in the top line of equation (13).[18]

It is of interest to note that the expressions in equation (12) and the top line of (13) *with* $q^T=0$ require fairly strong assumptions. In particular, if the form of the production functions differs in the two sectors, then the coefficients on tradable and nontradable productivity need not be of equal and opposite sign. Moreover, in some dynamic models incorporating a fixed factor assumption (Rogoff, 1992), the coefficient on nontraded productivity differs from that of traded, because consumption smoothing can only take place through traded goods production.

[18] Strauss (1999) found slightly more evidence in favor of a role for productivity and government spending for exchange rates.

Finally, if exact PPP does not hold for traded goods, it may be the case that traded sector productivity affects the real exchange rate through the relative price of traded goods. Engel (1999) has argued that this is an important factor for developed country exchange rate behavior. If this turns out to be the case, then the symmetry restrictions on tradable and nontradable productivity in the determination of the real exchange rate may be violated.

Chinn (1999) find some evidence that productivity does not enter in the expected manner, particularly when total factor productivity (which is implied by the theory), is substituted for labor productivity. The analysis is conducted on annual data over 1970-94 period, using panel dynamic OLS (DOLS).[19] He finds that relative productivity does not have a significant impact on the real exchange rate, but tradable sector productivity does, with a coefficient of -0.420. If one believed that the coefficient relating relative prices to relative productivities should instead be one, then the implied value is -0.5; the actual point estimate is insignificantly different from this value.

Lee and Tang (2007) provide one of the more recent test of the Balassa-Samuelson hypothesis. Using data for ten OECD countries over the 1970-1995 period, they show (using panel regression techniques) that the findings regarding the link between productivity and the real exchange rate -- or the relative price of tradables (bottom line of equation 13) – is highly sensitive to the productivity measure that is used. Increases in total factor productivity, which is suggested by theory, tends to *depreciate* the q_T, so that the net effect on the real exchange rate is muted.

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[19] Bilateral exchange rates are are deflated by general price while the tradable and nontradable sector total factor productivity (TFP) data were constructed from the ISDB database which contains TFP disaggregated by sector. The tradable and nontradable categorization is the same as that used by DeGregorio and Wolf (1994). Tradable sectors include agriculture, mining, manufacturing, and transportation, while the nontradable sectors include all other services.

Ricci, Milessi-Ferretti and Lee (2013) extends this analysis to a sample encompassing 48 industrial and emerging market economies. They find that while productivity measures have a statistically significant impact on real exchange rates, in the posited direction, the size of the effect is fairly small. Other effects, including those associated with government consumption and net foreign asset accumulation, are also statistically significant.20

To sum up, the evidence in favor of the standard Balassa-Samuelson hypothesis is weak, when focusing on the developed economies, and using total factor, rather than labor, productivity. The most recent research suggests that this is the case because PPP rarely holds for traded goods, perhaps because these goods are highly differentiated (see Cheung, Chinn and Fujii, 2001). In fact, productivity growth in the tradable sector might have a bigger impact on the intercountry price of traded goods than on the relative price of traded to nontraded goods. If this is the case – at least for developed economies – then the difficulty in identifying the productivity/real exchange rate link might be more explicable.

3.3 Composite Models: BEERs

The preceding approach focused primarily on productivity differentials, perhaps with government spending included. One can allow for other effects. In addition, more easily obtained proxy measures for the intercountry productivity differential are often substituted in. The resulting composite models have been coined behavioral equilibrium exchange rate (BEER) specifications, and are often used to evaluate equilibrium exchange rates for developed country currencies, typically applied to effective exchange rates, treating the rest-of-the-world as the

[20] Demographics in principle could also affect the exchange rate; see the real exchange rate specification in the IMF's External Balance Assessment methodology (Phillips, 2013). Wei (2011) highlights the sex ratio.

foreign country.

An early BEER-like model is Faruqee (1995). Clark and MacDonald (1999) provide a formal framework to identify the characteristics of BEERs. The model starts with real interest parity, augmented by a risk premium. The risk premium is a positive function of the ratio of domestic government debt to foreign. The real exchange rate expected k periods hence equals a function of long run factors, including a proxy variable for Balassa-Samuelson motivated productivity differentials (usually a relative price of nontraded to traded prices). The other long run factors are the terms of trade (*tot*), and net foreign assets (*nfa*). Hence:

$$q = f[(\hat{p}_{N,t} - \hat{p}_{T,t}), tot, nfa, \widehat{gdebt}]$$

Because the main criterion is goodness of fit, BEERs have proven popular, despite their mixed theoretical heritage.[21] Benassy et al. (2009) uses this approach for G-20 currencies, while Wang (2004), Coudert and Couharde (2007) and Wang et al. (2007) apply the BEER approach to modeling China's currency. They are also used extensively in the practitioner literature; see Brehon (2011) for investment banking, Maeso-Fernandez et al. (2006) for central banking, and Phillips et al. (2013) in the IMF's External Balance Assessment (EBA) methodology.

4. Conclusion

Given the presence of trade barriers, price stickiness, and nontradable goods, it seems odd to presume purchasing power parity in absolute level terms should hold. The pervasive aspect of the Penn Effect – the correlation of price levels and per capita income levels – even when basket weights are identical, is consistent with that view. Still, absolute PPP, or relative PPP in levels, could plausibly hold in the longer term when nominal rigidities do not bind.

[21] See Driver (2003) for a discussion of other related equilibrium exchange rate concepts.

Most econometric tests now confirm stationarity of the real exchange rate, although the fact that many tests do not distinguish between mean and trend reversion means that long run relative PPP in levels might not be validated. In other words, just because the real exchange rate is found to be trend stationary doesn't mean the real exchange rate mean reverts, a finding necessary for long run relative PPP in levels.

The reasons PPP might not hold – nontradables, sticky prices – motivates the search for determinants of real exchange rate movements. Productivity differentials, government spending, risk premia determinants, terms of trade can all affect the relative price of nontradables as well as the inter-country relative price of tradable goods. Which variables matter depends on the currency and time periods.

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