Does Purchasing Power Parity Hold Globally?
Empirical Panel Data Evidence for Post Bretton-Woods Period

Mingming zheng*

January 2009

Abstract: This paper do not try to solve the PPP puzzle, instead, to give positive evidence to support the Purchasing Power Parity. I adopt potential bias adjustments used by Choi, Mark and Sul (2006). As literatures have focused on, this paper also examines the unit root of the real exchange rates, using a panel data approach established by Levin, Lin and Chu (2002). This panel data unit root test method allows the researchers more flexibility and higher power of the test statistics, compared to performing separate unit root tests for each cross-sectional country. The paper finally rejects a unit root for the panel structure. With a bias adjusted half-life estimation of approximate eight months, this paper illustrate an interesting phenomenon that in the world wide the PPP may hold.

Keywords: Purchasing Power Parity; Bias Adjustment; Panel Unit Root Test.

JEL Classification Numbers: C23; F31.

*Department of Economics, University of Kansas. Address: 257 Snow Hall, The University of Kansas, Lawrence, KS66044, USA. Telephone: 1-785-864-1884, e-mail:*zmm120@ku.edu*. The author is grateful to Shigeru Iwata and Ted Juhl for advice and suggestions.

1 Introduction

The purchasing power parity (PPP) theory uses the long-term equilibrium exchange rate of two currencies to equalize their purchasing power. Developed by Gustav Cassel in 1920, PPP is based on the Law of One Price (LOP). LOP states that, under several assumptions, the commodity in two different locations should have a same price, regardless of the locations. The assumptions include an ideally efficient market, which means that the commodity is perfectly tradable, and efficient financial markets, which allow free financial capital mobility.

If we formulate the real exchange rate for different countries, those real exchange rates should only affected by the real macro-variables, such as the capital-labor ratio, or technical progress. The nominal variables should not account for the change of the real exchange rates because by switching the nominal exchange rates to real exchange rates, we have already eliminated the price level fluctuation. Thus, no permanent change will appear to the real exchange rates if there is a nominal shock. To be specific, if we let P be the home price level, and P^* be the foreign price level, E be the nominal exchange rate, we can easily find out that the textbook definition of the real exchange rate is $Q = EP^*/P$, Where is the (home/foreign) quoted spot exchange rate, and Q is the formulated (absolute) real exchange rate.

However, foreign exchange market is one of the most volatile markets. Theoretically, given nominal rigidity assumption, real exchange rates will jump dramatically according to the volatile nominal exchange rate. Kanas (2006) studies stationarity of the real exchange rate time series using a Markov regime switch approach. Kanas conclude that for most countries, the real exchange rates are "regime-dependent" stationary, and the probability that the real exchange rates are stationary is less than one half. Caporale and Cerrato (2006) gives a good overview of the panel structure test of the PPP. Those literatures are trying to solve the PPP puzzle which is concluded by Rogoff (1996). The PPP puzzle could be stated as: How we can reconcile the short-term volatility of real exchange rates with the extremely slow mean reversion in the long-run.

Price stickiness is one aspect to explain the short-term volatility of real exchange rate. Gopinath and Rigobon (2008) reports an at-the-dock price stickiness to be 12 months for imports, and 14 months for exports. This one year nominal rigidity is far less than the Rogoff's consensus real exchange rate persistence period, which has a three- to five-year half-life. [1]his 1996 paper, Rogoff summarized theoretically, in the long-run equilibrium, the Law of One Price $P_t = EP_t^*$ should be held, not only intra-nationally, but also across country boundaries. Based on LOP, economists argued that Absolute version PPP takes the form of

$$\sum P_i = E \sum P_i^*$$

where $\sum P_i$ and $\sum P_i^*$ are aggregate price indices of home country and foreign country, respectively. Some literatures use Consumer Price Index (CPI).[2] But there arises other problems such as choosing CPI baskets, base countries and the numeraire for different periods. To fix part of the identification problem, people introduced Relative PPP

$$\frac{\sum P_{i,t}}{\sum P_{i,t-1}} = (\frac{E_t}{E_{t-1}})(\frac{\sum P_{i,t}^*}{\sum P_{i,t-1}^*})$$

which only concerns the relative price index change.

A spate of literatures reported that the typical OLS method shall give biased estimation of the auto-regression coefficients for the real exchange rates time series.[3] Choi, Mark and Sul (2006) uses three potential sources to adjust the bias. They use annual data of CPI-based real exchange rates for 21 Organization for Economic Co-operation and Development (OECD) countries from 1973 to 1998, and obtained an "unbiased half-life" of 3.0 years with 95% con-

[1]The half-life is the typical terminology that recent empirical researchers use to describe the mean reversing speed of the real exchange rates. Let $t*$ be the half-life. This means if there is a shock to the real exchange rate, causing it diverse from its mean, it requires $t*$ years for the real exchange rate reverts back to halfway to the mean. Suppose the real exchange rate follows an $AR(1)$ process

$$q_{i,t} = \phi q_{i,t-1} + \epsilon_{i,t}, i = 1, ..., N, t = 1, ..., T \tag{1}$$

then the half-life takes the form of

$$t^* = \frac{\ln(0.5)}{\ln \phi}$$

[2]For example, Choi, Mark and Sul (2006) uses annual CPI data

[3]The adjustment of bias is important. Suppose the real exchange rate is following 1, where we assume for this while that ϵ_{it} is mean-zero serially uncorrelated innovation with at least finite twice moments. Small bias from the true estimate of ϕ could cause a large diversify of t^*. For example,

$$t^*_{\phi=0.93} = 9.56, t^*_{\phi=0.95} = 13.5, t^*_{\phi=0.97} = 22.8,$$

Furthermore, even if we somehow eliminate the bias of OLS estimation of ϕ, we still have a unit root worry. That is, if $\phi \to 1$, we will have $t^* \to \infty$, which means there is no convergence to the PPP.

fidence interval of between 2.3 and 4.2 years. Their point estimation touched the lower bound of Rogoff's consensus but still far away to explain the PPP puzzle. Imbs et al (2005) employs a panel data structure estimating and they include 19 common commodities with monthly data from 1975:1 to 1996:12, a period after the collapse of Bretton-Wood System. They adopt an aggregation bias adjustment to revise the auto-regression coefficient and result a half-life of real exchange rate mean reversion fall to a little more than one year, and then claim that the PPP puzzle is solved.

To solve the PPP puzzle, one could probably expect a PPP mean reversion half-life to be balanced with the nominal rigidity changing period. Nevertheless, half-life itself is not to show the entire mean reversion period, but to illustrate mean reversing speed. As Reidel and Szilagyi (2005) argue, we are expecting that the real exchange rate is determined by the real shocks such as technology progress or preference changes. They asserted that one should expect monetary shocks on the real exchange rate disappear rapidly. Yet, most empirical evidence suggested it will take quite several years of dissipation of the nominal shock effects, some even shows an divergence to PPP, which mean the nominal shocks have permanent effect.

2 Three Kinds of Bias Adjustment

If we let q_{it} be the logarithm of the real exchange rate, e_{it} be the logarithm of the nominal spot exchange rate, p_{it} be the logarithm of the US Consumer Price Index (CPI) and p_{it}^* be the logarithm of the foreign Consumer Price Index (CPI), $i = 1, ..., N$ stands for the individual countries, $t = 1, ..., T$ stands for the time periods, the real exchange rate takes the form of

$$q_{it} = e_{it} + p_{it}^* - p_{it}$$

Through out this paper, let us assume the real exchange rate satisfies an auto-regression process.

2.1 Sectoral Heterogeneity Bias

Imbs et al (2005) showed that if we use panel data estimation for the auto-regression coefficient, but actually the coefficients of the processes, namely, the convergence speeds of different countries are indeed different, we will have a sectoral heterogeneity bias (Cross-sectional Aggregation Bias). Cross-sectional Aggregation bias is an upward bias. However, Chen and Engel (2005) concluded that sectoral heterogeneity is not a substantial bias of the panel estimation. To see the cross-sectional bias, suppose the real exchange rate of country i follows an $AR(1)$ process without a fixed or random effect given by

$$q_{it} = \phi_i q_{i,t-1} + \epsilon_t, i = 1, ..., N, t = 1, ..., T, \tag{2}$$

where $\phi_i = \phi + \theta_i$, with $E(\theta_i) = 0$ for all i. The pooled OLS estimate is

$$q_t = \phi q_{i,t-1} + \theta_i q_{i,t-1} + \epsilon_t, \tag{3}$$

rewrite it in matrix form,

$$q = \phi q_{-1} + (I_N \otimes \iota_T)\theta q_{-1} + \varepsilon, \tag{4}$$

where $q = [q_{11}, ..., q_{1T}, ..., q_{N1}, ..., q_{NT}]'_{NT\times1}$, $q = [q_{10}, ..., q_{1T-1}, ..., q_{N0}, ..., q_{NT-1}]'_{NT\times1}$ and $\iota_T = [1, ...1,]'_{T\times1}$. Thus the OLS estimation is

$$\begin{aligned}\hat{\phi}_{OLS} &= (q_{-1}^T q_{-1})^{-1} q_{-1}^T q \\ &= \phi + (q_{-1}^T q_{-1})^{-1} q_{-1}^T \varepsilon + (q_{-1}^T q_{-1})^{-1} q_{-1}^T [(I_N \otimes \iota_T)\theta]^T q_{-1}\end{aligned} \tag{5}$$

The last term of equation(5) is bias part from which in typical OLS regression. To see the upward bias of the OLS estimation, Choi, Mark and Sul (2006) gives a decomposition of the OLS estimate coefficient. Let π be the fraction of the number of countries that exhibit covariance stationary of the real exchange rates, and $1 - \pi$ be the fraction of the numbers of non-stationary countries. In this case, the pooled OLS estimator can be expressed as

$$\hat{\phi}_{OLS} = \frac{\phi\pi(\sum_{i=1}^{N} \frac{1}{1-\phi_i^2}) + (1-\pi)(\frac{T+1}{2})}{\pi(\sum_{i=1}^{N} \frac{1}{1-\phi_i^2}) + (1-\pi)(\frac{T+1}{2})} \geq \phi \quad (6)$$

If we find heterogeneity of the data, panel data approach is inappropriate and we shall find other estimate strategy.

2.2 Small Sample Bias

Instead of including a constant into the auto-regression process, we could estimate the process with observations that are deviations from the sample mean. But the problem comes up when for any time period t, the regressor will correlated with the current and future error terms. This violates the Gauss-Markov Theorem's assumption for the Ordinary Least Square, and the estimated coefficient will be biased.

Furthermore, let us include the fixed effect factor into account. This will change our $AR(1)$ process with a drift for each country. Referring to the panel data regression(2), let us estimate the dynamic regression with fixed effects

$$q_{i,t} = \gamma_i + \phi_i q_{i,t-1} + \epsilon_{i,t}. \quad (7)$$

Reidel and Szilagyi (2005) assume both γ and ϕ are constant drifted random walk variables. To satisfy the fixed effect purpose, this paper assumes only the cross-sectional coefficient following a drafted random walk, and γ's are constant fixed effect factor for each country. Since γ's are constants across countries, the Within estimation of the pooled OLS coefficient estimation is

$$q_{i,t} - \bar{q}_i = \phi_i(q_{i,t-1} - \bar{q}_i) + (\epsilon_{i,t} - \bar{\epsilon}_i) \quad (8)$$

where $\bar{q}_i = \frac{1}{T}\sum_{t=1}^{T} q_{i,t}$.

Nickell (1981) studied the properties of the dynamic fixed effect panel data approach. He referred this approach as Least Square Dummy Variable method for the dynamic panel regression model. He showed that the bias caused by OLS cannot be eliminated even asymptotically, and shows the bias

$$p\lim_{t\to\infty}\hat{\phi}_{FE}=\phi-(\frac{1+\phi}{T-1})(1-\frac{1}{T}(\frac{1-\phi^T}{1-\phi}))[1-(\frac{1}{T-1})(\frac{2\phi}{1-\phi})(1-\frac{1}{T}(\frac{1-\phi^T}{1-\phi}))]^{-1} \quad (9)$$

we can see from equation (9) that the fixed effected estimate of the panel coefficient is downward biased.

2.3 Time Aggregation Bias

Since we shall use the real exchange rate based on time-averaged Consumer Price Index, we should be aware that the nominal (spot) exchange rate is not on average, but reported daily, even in minutes for some specific research purpose. However, the government or other agencies report the CPI monthly or seasonally, even annually. To eliminate this kind of spot-average unbalance, we could use the CPI as periodically detail as possible. But the most detailed CPI is based monthly, thus we cannot totally ignore this spot-average unbalance. Taylor (2001) argues that the Rogoff's 3- to 5-year consensus half-life over estimate the true converging speed because of time-averaging bias. Let $t=1,...,T$ be the observation time index and we may find there are M subintervals indexing the spot exchange rates.[4] Then the $AR(1)$ process with TM total subintervals will be given as

$$q_{i,t+M}=\gamma_i+\phi^M q_{i,t}+\epsilon_{i,t} \quad (10)$$

and the coefficient we estimated by traditional $AR(1)$ model is actually ϕ^M. Taylor shows that the actual auto-regression coefficient after fixing the time-average bias for an $AR(1)$ process would be

$$\phi=\frac{\hat{\phi}_{OLS}(1-\hat{\phi}^M_{OLS})^2}{M(1-\hat{\phi}^2_{OLS})-2\hat{\phi}_{OLS}(1-\hat{\phi}^M_{OLS})} \quad (11)$$

which causes an upward bias.

[4]In this paper, since I use monthly data, t stands for the month index, and $M=30$ illustrates the daily intervals.

3 Adjustment of Bias

As we have seen above, OLS Between Regression will suffer by the correlation of the regressor and the error term, thus is biased and undesirable. By considering the upward bias caused by the individual coefficients switch,[5] Pesaran and Smith (1995) have shown that the fixed effect panel data estimate AR(1) coefficient for equation(8) is

$$\hat{\phi}_{Between} = \phi + \Delta \tag{12}$$

where $\Delta = \frac{\frac{1}{N}\sum_{i=1}^{N}(\frac{\theta_i \sigma_i^2}{1-\phi_i^2})}{\frac{1}{N}\sum_{i=1}^{N}(\frac{\sigma_i^2}{1-\phi_i^2})} = \sum_{i=1}^{N}(\phi_i - \phi)\alpha_i$, with $\alpha_i = \frac{\frac{\sigma_i^2}{1-\phi_i^2}}{\sum_{i=1}^{N}(\frac{\sigma_i^2}{1-\phi_i^2})}$ and $\sigma_i^2 = E(\epsilon_{it}^2)$.

Imbs et al (2005) showed that if we treat the coefficient bias as a trade weighted aggregation with different international trade share, the α_i's will be a weighted average factor.

After the adjustment of the sectoral heterogeneity bias of the coefficient, we left the the Small Sample Bias and the Time Average Bias. However, Time Average Bias is dominated by the Small Sample bias. Because we could understand the Time Average Bias as the confliction of the time-averaged price index and the spot exchange rate we observe. Some researchers have extended the annual estimate data to pre-Breton Wood period, with extreme case to extend as far as two hundreds years ago. Nevertheless, pre Breton-Woods period has a dominate numeraire as gold or US dollar, Thus is undesirable and not valid for this paper's purpose.

Once we combine Small Sample Bias and Time Averaging Bias, we could have the bias adjusted formula:[6]

$$\hat{\phi}_{Adjusted} = B^{-1}(\hat{\phi}_{FE}, M, T) \tag{13}$$

[5] e.g., we are correcting the Sectoral Heterogeneity Bias

[6] This formula is given by Choi, Mark and Sul (2006)

where $B(\phi_{FE}, M, T) = \frac{A_1 - A_2(T-1)^{-2}}{B_1 - B_2}$ with

$$\begin{aligned}
\phi_{FE} &= \varphi^M \\
A_1 &= (T-1)\varphi(1-\varphi^M)^2 \\
A_2 &= M(T-2)(1-\varphi^2) + \varphi^{M(T-1)}[2\varphi + \varphi(1-\varphi^M)^2] - 2\varphi^{M+1} \\
B_1 &= M(T-2)(1-\varphi^2) \\
B_2 &= 2\varphi\{(T-1)(1-\varphi^M) - \frac{1}{T-1}(1-\varphi^{M(T-1)})\}
\end{aligned}$$

Andrews (1993) adopts median-unbiased estimator, and thus avoid the small sample bias caused by mean-unbiased estimator (such as OLS). The intuition of median-unbiased estimation is quite straight-forward. Because as we will see later on, the fixed effect estimation of the $AR(1)$ coefficient will be suffered on the potential unit root, traditional mean-unbiased regression will fall when the converging coefficients are substantially close to one. As an alternative, we could estimate the individual time-serials' coefficients using Least Square to get ϕ_i^{LS} and find median-unbiased estimator $\hat{\phi}^{median} = median\{\phi_1^{LS}, ..., \phi_N^{LS}\}$. However, the idea of a panel data approach is to combining different time series together to find out the "shared" coefficients. Following this "shared" coefficients idea, I choose not to adopt the median unbiased estimator for the converging speed, but to use the ADF regression coefficient stated in section 4.

4 Unit Root Test

A spate of literatures has focusing on the existence of the unit root of the PPP. The story to exam the unit root is fairly acceptable. Suppose there is a unit root of the simple univariate time-series, in other words, $\phi = 1$, the estimated half-life will converge to infinite, meaning there is no convergence to the PPP. This paper forms the null hypothesis that there are unit roots for all the countries, and the alternative to be no unit roots for any single countries. If we fail to reject the null, we will simply accept the purely random walk of the real exchange rates for the global major countries. Thus the real exchange rates will not converge to the PPP globally.

Levin, Lin and Chu (2002) gives powerful and flexible panel data unit root test method. According to their paper, the Panel Unit Root Test yields higher test power than the separate univariate time series unit root test. The Panel Unit Root Test is the extension of the original Augmented Dickey-Fuller unit root test, with bias judgment of the t-statistic.

It is not surprising to see residual serial correlation in time series data. To eliminate the residual serial correlation effect, we could add enough lagged terms in the time series regressors. Suppose the true real exchange rate follows an $AR(p)$ process:

$$q_{i,t} = \phi_1 q_{i,t-1} + \cdots + \phi_j q_{i,t-j} + \cdots + \phi_p q_{i,t-p} + \epsilon_{i,t} \tag{14}$$

where $\epsilon_{i,t}$'s are identically independent distributed residuals. Instead of the above estimate equation, Levin, Lin and Chu choose to use the Augmented Dickey-Fuller regression

$$\Delta q_{i,t} = \rho q_{i,t-1} + \sum_{j=1}^{p_i} \psi_{ij} \Delta q_{i,t-j} + \epsilon_{i,t} \tag{15}$$

where $\rho = (\sum_{j=1}^{p_i} \phi_i) - 1$ and $\psi_{ij} = -\sum_{\tau=j+1}^{p_i} \phi_\tau$. $\Delta q_{i,t-j}$'s are the differenced individual lag terms of the auto regression time series. The purpose to examine the unit root of the $AR(p)$ process is to test the null hypothesis that $\rho = 0$ is true.

The procedure begins at selecting the individual lag periods p_i for each country indexed by i. Suggested by Campbell and Perron (1991), Levin, Lin and Chu (2002) adopted the method proposed by Hall (1990), which gave the method to select appropriate p_i's for each individual. The method is stated as following for this paper's purpose. First, choose 72 as the maximum lag order. This is the six years period and according to Rogoff (1996) work, if real exchange rates do exhibit mean converge, the half life should be between three and five years. And then use the t-statistics of $\hat{\psi}_{ij}$ to determine if a smaller lag order is preferred. By choosing six years' months as maximum lag order, and taking appropriate lag order for individual countries, the serial correlation should be eliminated.

Second, to choose the optimal individual lag components numbers, we need to perform seventy-nine times $ARIMA$ model of each univariate time series with artificially forcing the MA process has zero lags (no serial correlations). Then we could test individual stationarity of the $\{\Delta q_{it}\}$ series for $i = 1, ..., 79$ using equation (15) by varying the appropriate lag numbers. The optimal number of lag terms is the minimum number that provides the serial correlation of the innovation below the given significance.[7]

After determine auto-regression lag orderp_i, we could run tow auxiliary regressions to eliminate the effect of the lagged difference terms and produce orthogonalized residuals. That is, regress Δq_{it} and $q_{i,t-1}$ on the lagged period terms$\Delta q_{i,t-j}$, for $j = 1, ..., p_i$. Then save the residuals from each of the auxiliary regressions. In detail, those two pre-regression is given by

$$\Delta q_{it} = \sum_{j=1}^{p_i} \hat{\psi}_{ij} \Delta q_{i,t-j} + \hat{e}_{it} \tag{16}$$

and

$$q_{it-1} = \sum_{j=1}^{p_i} \hat{\Phi}_{ij} \Delta q_{i,t-j} + \hat{v}_{it-1} \tag{17}$$

Save the two orthogonal residuals $\hat{e}_{it}$ and $\hat{v}_{it-1}$, we are confident to regress $\hat{e}_{it}$ on $\hat{v}_{it-1}$and test the coefficient ρ. Specifically,

$$\hat{e}_{it} = \rho \hat{v}_{i,t-1} + \hat{\varepsilon}_{it} \tag{18}$$

Then form the adjusted t-statistic and test the null hypothesis that the coefficient ρ is not significant. Levin, Lin and Chu (2002) also provides a method to calculate the t-ratio statistics for the null hypothesis.

5 Empirical Results

In this paper, I use Economic Research Service (USDA) trade weighted data. The data set contains 79 countries with monthly real exchange rate of 466 observations for most countries, from Jan. 70 to Oct. 08, although the data for Uruguay and Peru only occur after 1984. The purpose of choosing a long time period data is to eliminate the Small Sample Bias discussed above. As the original data set formulated, I take 2005 US dollar as numeraire and 2005 international trade as the base basket.

[7] I choose to use the significance of 5% and 1%. See Appendix for individual countries for the number of the lagged periods and univariate half-life estimation.

In the data set, the spot exchange rate is quoted as the (home/foreign) rate. Since I use the US dollar as the consensus numeraire, for example, the real exchange rate for Canada dollar during December 2007 is 1.032, which means one standard real US consumer basket can buy 1.032 Canadian standard real consumer basket.

As researcher may point out, the data set includes a long and finely separated time interval, that is, monthly data. The mainly reasoning of using the monthly data is to eliminate the Time Aggregation Bias. As someone will argue that after 1999, the Euro area has passed the use of the single currency and empirical analysis should not include the countries which belong to the single currency zone. The argument is acceptable in theoretical sense, but as we could see in general, countries for single currency zone shall have different Consumer Price Index changing speed, meaning the individual inflation rate. After changing the nominal exchange rate to real exchange rate by the effect of the inflation, we shall find that Euro Zone countries have quite different mean reverting character.

I have included three years prior to the collapse of the Breton Woods System (Jan. 1970 to Feb. 1973). Although the real exchange rate converge speed shifted dramatically after Bretton-Wood System, including 37 months prior to the threshold point is a good initial value to start.To eliminate the auto-regression residual serial correlation, we should include enough lagged difference terms. When people practically perform the auxiliary regression, one will see missing values for the months before the time of "Closing the Gold Window".

In fact, the Purchasing Power Parity has strong assumption of the mobility of the capital as well as most of the commodities are tradable. Choi, Mark and Sul (2006) uses 21 OECD countries to examine the PPP, and as one could observe, the capital mobility and commodity and service tradability within the OECD countries are much stronger than that within the emerging economy as well as the undeveloped countries. As an example, quite a number of Asian countries choose to regulate their capital account. Following this map, when using the globally data, one shall reasonably expect a disconvergence of the cross sectional time series.

As a result, I found that the panel estimation for the summed up coefficients (ρ) is -0.010315, with an adjusted t-statistic of 0.0320976. For the null that there is a unit root of the panel data, the p-value is 0.97. After we adjust the panel estimate result using the methods discussed above, I find that the adjusted coefficient ρ_{adj} is -0.086, which means the coefficient of the $AR(p)$ for the real exchange rate is 0.914. I also find that the adjusted t-statistic of is 24.32794.

It is quite interesting to note that for the adjusted autoregression coefficient estimation, the half-life is 8 months. This estimation is much lower than the Rogoff's consensus of 3 to 5 years, and also is lower than the 13 months half-life estimated by Imbs et al (2005). As stated before, people would expect a much longer half-life because I use more countries than the normal empirical research which usually use the developed countries. This 8-month half-life may still be far to solve the PPP puzzle, but gives a strong evidence that the Purchasing Power Parity holds for the world wide.

6 Concluding Remarks

This paper examines world wide countries real exchange rate. Despite the mean reversion force of the real exchange rate (technology progress or preference change), the substantially large international financial capital movement is probably the main drift of the diversification of the real exchange rate. Without proper and accurate measurement of the daily international financial capital movement, one cannot confidently tell that PPP is the main reason of the convergence of the real exchange rate. Also, since the researchers always highlight the measuring limitation of the aggregate price index, as well as the argument that whether CPI is a good instrument to use, it is hard to totally eliminate the bias caused by using the aggregate price index.

Nevertheless, theoretical holding of Purchasing Power Parity does not mean empirically evidence to support. Especially for the developing and less developed countries, PPP seems not a valid assumption. People usually observe that those emerging countries have all kinds of explicit and implicit tariffs and trade barrier, as well as strict capital account control for some of them. After practical use of Levin, Lin and Chu (2002) panel data estimation approach and adjust bias, this paper shows an attractive result that even theoretically PPP may be more likely to be rejected world wide, Purchasing Power Parity may really valid in a global view. I estimate the half-life to be 8 months. This half-life is still far to be consistent with the period of nominal rigidity, but is lower than the Rogoff's consensus of 3- to 5-year.

It is doubtable that we get a much lower half-life estimation using global countries than just use developed countries. However, we could find some economic reasoning for this phenomenon. Since a large number of the developing countries use pegged exchange rate policy and try to control the inflation rate, the co-movement may be not large. When I examine the European countries, the real exchange rate always act odd for most of the west European. This may also account for the large estimation of half-life if we use OECD countries.

References

Caporale, G. and Cerrato, M.. 2006. "Panel Data Test of PPP: a critical overview" Applied Financial Economics, 2006, 16, 73-91

Choi, C., Mark, N. and Sul, D.. 2006. "Unbiased Estimation of the Half-life to PPP Convergence in Panel Data". Journal of Money, Credit and Banking. Vol. 38, No.4

Dickey, D.. "Stationarity issues in time series models". North Carolina State University, paper 192-30.

Gopinath, G. and Rigobon, R.. 2008. "Sticky Borders", Quarterly Journal of Economics, May 2008, Vol. 123, No. 2, 531-575

Imbs et al. 2005. " 'Aggregation Bias' DOES Explain the PPP Puzzle." NBER working paper.

Kanas, A.. 2006. "Purchasing Power Parity and Markov Regime Switch." Journal of Money, Credit and Banking, Vol. 38, No. 6.

Levin, A., Lin, C. and Chu, C.. 2002. "Unit root test in panel data: asymptotic and finite-sample properties". Journal of Economitrics 108 (2002) 1-24.

Murray, C. and Papell, D.. 2005. "Do panel help solve the purchasing power parity puzzle?" Journal of Business and Economic Statisics, Vol. 23, No. 4

Pesaran, M.H., Smith, R.. 1995. "Estimating long-run relationships from dynamic heterogeneous panels", Journal of Econometrics 68, 79-113.

Reidel, D. and Szilagyi, J.. 2005. "A biased view of PPP". Harvard University mimeograph

Rogoff, K.. 1996. "The Purchasing Power Parity Puzzle. Journal of Economic Literature", Vol. XXXIV, pp. 647-668

Appendix