Purchasing Power Parity in the Pacific Rim

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<개 요>

본 논문의 연구목적은 환태평양지역에서 구매력평가설(Purchasing Power Parity)의 성립여부를 계량경제학적으로 검증하는 데 있다. 본 논문의 계량모형의 추정에 사용된 데이터는 월별 데이터로써, 기간은 1974년 1월부터 1997년 12월까지이다. 구매력평가설의 검증력을 높이기 위해서 다 국가 구매력평가설(multi-country PPP)의 검증을 시도하였다. 두 국가 구매력평가설의 검증에 사용된 기존의 단위근 및 공적분 검정(unit root and cointegration test)방법을 지양하고 다국가 구매력평가설을 검증하기 위하여 GMM(generalized method of moment)추정방법을 시도하였다. 추정결과에 의하면 미국을 주축으로 한 환태평양지역에서 상대적 구매력평가설이 성립하지 않았다. 이에 대한 부분적인 이유는 동 연구기간 동안 Balassa-Samuelson 가설에 의한 구매력평가설의 구조적 편차이다. 왜냐하면, 한국과 일본이 동 기간동안 미국에 비하여 교역재(tradable goods)산업부문에서 급속히 성장하였기 때문이다. 본 연구의 향후 연구과제는 구매력평가설의 검증을 환태평양 지역에 국한할 것이 아니라 전 세계적으로 확대하는 것이다.

I. Introduction

Purchasing Power Parity(PPP) is the simple empirical doctrine that national price levels, expressed in a common currency unit, should be equal. The underlying mechanism of this proposition is the international goods market arbitrage. This goods market arbitrage enforces broad parity in prices across a sufficient range of individual goods. If we interpret PPP relationship as a real exchange rate(expressed in log terms), the movement of the real exchange rate should be stationary for PPP to hold.

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The standard money neutrality proposition is that any variety of monetary shocks should not affect the relative price(real exchange rate) in the long run. Given short-run sticky prices, monetary or financial shocks should affect the movement of the real exchange rate in the short run if exchange rate behaves like the asset prices(Dornbush, 1976). Only real shocks such as productivity shocks, government spending and etc. could affect the movement of the real exchange rate both in the short and the long run.

Most of the empirical studies have shown that real exchange rate(nominal exchange rates adjusted for differences in national price levels) tends toward PPP in the very long run: the speed of convergence to PPP is very slow; the short-term deviations from PPP are very large and volatile. How can we reconcile the enormous short-term volatile deviations from PPP with the extremely slow convergence to PPP. This is the Purchasing Power Parity puzzle termed by Rogoff(1996).

In this paper, we have examined the multi-country version of relative PPP in the pacific rim nations. These nations include United States. Japan, Korea, Indonesia, India, and Philippines. Note that Japan and Korea represent rapidly growing nations with strong trading ties to the United States. In our time span(1974~1997) of data set, productivity shocks might be dominant in the two countries. Our conjecture from Balassa-Samuelson Hypothesis[1] is that there is a structural deviations from PPP when investigating the behavior of the real exchange rate(United States vs. Korea, United States vs. Japan).

In section 1, we have fitted the multi-country version of PPP into the Generalized Method of Moment(GMM) Estimation framework. We also discussed the basic notions of

1) The underlying mechanism of Balassa-Samuelson hypothesis is that the productivity increase in the traded sector may increase the wage level in that sector provided the price of tradable goods was equalized across countries. Given free mobility of labours between tradable and nontradable sectors, the price of nontradable goods should increase. This implies that if some country shows very rapid growth in the tradable sectors, that county's overall price level(including tradable and nontradable goods) should increase rapidly relative to his trading partners.

standard GMM estimation technique. One aim of the panel projection of relative PPP is to increase the power of the test for PPP. The empirical results was reported in section 2. As we conjecture from Balassa−Samuelson hypothesis, The relative PPP has failed in the Pacific Rim nations.

Ⅱ. GMM Estimation of Relative PPP

The notion of absolute PPP can be written as follows:

$$e(t) = p(t) - p^*(t); \tag{1}$$

where e(t) is the log exchange rate (domestic currency price of the foreign currency), p(t) is the log of the domestic currency price level, and $p^*(t)$ is the log foreign currency price level.

A traditional econometric model of PPP takes the following form:

$$e(t) = \alpha + \beta(p(t) - p^*(t)) + \varepsilon(t) \tag{2}$$

where $\varepsilon(t)$ is the stochastic disturbance term.

Absolute PPP imposes the joint restrictions α and $\beta=1$; the relative PPP does not restrict the parameters α and β. However, if $\varepsilon(t)$ is not stationary, the standard inference procedures may not be valid. Note that e(t), p(t) and $p^*(t)$ are jointly determined endogenous variables. There is no obvious candidate for the left hand side variable. Furthermore, these variables are not stationary. This implies that classical OLS estimation is not appropriate. One way to circumvent these problems is use Unit root Co−integration tests(e.g. Corbae and Ouliaris(1988), and Enders(1988)).

Instead of using Unit root and Co−integration tests for PPP, we propose here GMM estimation technique to test relative PPP. The relative version of PPP may be written as follows:

$$\triangle e(t) = \triangle p(t) - \triangle p^{*}(t) \tag{3}$$

where only changes in relative price levels are linked to the change in the exchange rate. The econometric model of above relative PPP may be written as follows:

$$\triangle e(t) = \alpha + \beta(\triangle p(t) - \triangle p^{*}(t)) + \varepsilon(t) \tag{4}$$

where here again $\varepsilon(t)$ is the indeterministic error term.

If relative PPP holds, β should be equal to 1. Our aim is not to estimate the above single equation. Instead, we attempted to form a multi−country version of relative PPP. The panel projection of PPP might increase the power of the test for PPP.[2] In our empirical study, we have collected the data set for United States's major trading partners in the pacific rim (Japan, Korea, India, Indonesia, Philippines). Of course, United States is the bench mark country.

Consider the following econometric model of relative PPP:

$$\triangle ei(t) - \alpha - \beta(\triangle p(t) - \triangle pi(t)) = \varepsilon i(t) \tag{5}$$

where subscript i represents each of 5 countries of Japan, Korea, India, Indonesia, and Philippine; $\varepsilon i(t)$ is the disturbance term which represents the deviations from relative PPP.

If relative PPP holds, β should be equal to 1. Here, α could be any constant number because the relative PPP does not restrict it. Given the true parameters α and β, the mathematical expectation of the deviations of relative PPP should be zero. With United States being the bench mark country, there are 5−country relative PPP relations which hold simultaneously. With this empirical proposition, we fit this econometric problem into the standard GMM estimation framework. Along this line of GMM framework, we de-

2) Several recent papers have employed panel data to investigate PPP: for example, Frankel and Rose(1996), Engel, Henderickson, and Rogers(1997). In PPP literature, there are two ways in enhancing the power of the test for PPP. One way is to use the longer time series data for the real exchange rate if it shows slow convergence to PPP, the other way is to use the panel data of multi−country PPP.

fine the moment function $\Psi(\triangle e, \triangle p, \triangle p^*, \alpha, \beta)$ as in (6).

$$\Psi(Z, \theta) = \begin{bmatrix} \triangle e(t)_{japan} - \alpha - \beta(\triangle p(t) - p^*_{japan}(t)) \\ \triangle e_{korea}(t) - \alpha - \beta(\triangle p(t) - p^*_{korea}(t)) \\ \triangle e_{imdomesia}(t) - \alpha - \beta(\triangle p(t) - p^*_{indonesia}(t)) \\ \triangle e_{india}(t) - \alpha - \beta(\triangle p(t) - p^*_{indi}(t)) \\ \triangle e_{philippines}(t) - \alpha - \beta(\triangle p(t) - p^*_{philippines}(t)) \end{bmatrix} \quad (6)$$

where Z indicates the vector of $\triangle e$, $\triangle p$, and $\triangle p^*$; θ indicates α and β.

With the true parameter θ_0, the mathematical expectation of Ψ should be equal to 0. To estimate θ, we follow the standard GMM estimation technique(Hansen(1984), Chamberain(1987), Newey and Mcfadden(1994). They estimate θ as the solution to:

$$\min_\theta Q_w(\theta) \quad (7)$$

where $Q_w(\theta) = (\Sigma\Psi(zi,\theta))'^*W^{-1*}(\Sigma\Psi(zi,\theta))$, for some positive semidefinite matrix W.

Under standard regularity conditions, the minimand of Q_w is consistent for θ_0. To obtain efficient estimator, we require that W, the inverse of the weight matrix, in the limit, equals $\Delta = E(\Psi(Z,\theta_0)\Psi(Z,\theta_0)')$. We follow Hansen(1984)'s two step procedure in implementing this estimator. First, we minimize $Q_w(\theta)$ for some arbitrary positive definite matrix. One option is the identity matrix. Let θ_e be the estimate from this procedure. The inverse of the optimal weight matrix is then estimated as $\Delta_e=(1/N)\Sigma\Psi(zi,\theta_e)\Psi(zi,\theta e)'$. Finally, an efficient estimator θ_{gmm} is obtained by minimizing Q_{Δ_e}.

Given the standard assumptions in GMM estimation, the asymptotic normality of GMM estimator holds as follows:

$$N^{1/2}(\theta_{gmm} - \theta_0) \text{ converges in distribution to } N(0, (\Gamma' \Delta^{-1}\Gamma)) \quad (8)$$

where $\Delta = E[\Psi(Z,\theta_0)\Psi(Z,\theta_0)']$, and $\Gamma=E[\partial\Psi(Z,\theta_0)/\partial\theta']$.

To test the overidentifying restrictions, we use the additional results in GMM estimation:

$$N^*Q_w(\theta_{gmm}) \text{ converges in distribution to } \chi^2(M-K) \quad (9)$$

Ⅱ. Empirical Results

Using monthly data from the International Monetary Fund data tapes, we obtained whole sale prices and exchange rates data for 5 of United States's major trading partners in the pacific rim(Japan, India, Indonesia, Philippines, and Korea) over the 1974 to 1997 period.

In our empirical implementation, we have modified the moment function as follows:

$$\Psi(Z,\theta) = \begin{bmatrix} \triangle e_{japan}(t) - \alpha - \beta(\triangle p(t) - \triangle p^*_{japan}(t)) \\ \triangle e_{korea}(t) - \alpha - \beta(\triangle p(t) - \triangle p^*_{korea}(t)) \\ \triangle e_{indonesia}(t) - \alpha - \beta(\triangle p(t) - \triangle p^*_{indonesia}(t)) \\ \triangle e_{india}(t) - \alpha - \beta(\triangle p(t) - \triangle p^*_{india}(t)) \\ \triangle e_{philippines}(t) - \alpha - \beta(\triangle p(t) - \triangle p^*_{philippines}(t)) \\ Z_{indonesia}(t) - mean(Z_{indonesia}(t)) \\ Z_{india}(t) - mean(Z_{india}(t)) \\ Z_{philippines}(t) - mean(Z_{philippines}(t)) \\ Z_{korea}(t) - mean(Z_{korea}(t)) \end{bmatrix} \quad (10)$$

where $Z_i(t) = \triangle e^j_i - (\triangle p^j - \triangle p^*_i)$: e^j_i = japanese currency price of foreign currency i, p^j = the japanese price level, and p^*_i = foreign country i's price level. ; $mean(Z_i(t))$ is the sample mean of $Z_i(t)$

The rationale for including $(Z_i(t) - mean(Z_i(t)))$ in the moment function is that the expected deviations from relative Purchasing Power Parity(Japan vs. Country i) should be zero. Thus, we considered the intra-planetary relative PPP(Japan vs. Asian countries) in our moment functions.

Using OLS estimates as initial consistent estimates to estimate the optimal weight matrix, the optimal GMM estimates are shown in table 1:

Table 1: GMM estimates

$\Theta(\alpha,\beta)$	S.E.	t−stastistic
−0.1297	0.0713	−1.8182
1.0485	0.0109	96.3575

Above t−statistics for (α,β) states that α is zero, and β is not zero. Our primary concern is to test the null hypothesis of β being equal 1. The test t−statistic for this is 4.4495, which implies that the null hypothesis of that is rejected. The relative version of PPP does not hold in the Pacific Rim.

To test the overidentifying restricions(the dimension of moment functions greater than the dimension of parameter space), we calculated $N*Q_w(\theta_{gmm})$ which converges to $\chi^2(l-k)$. Here l is the dimension of the moment function $\Psi(Z,\theta)$. The estimated statistic for this is 152.5134 which is greater than $\chi^2(7)=14.57$ at 5% significance level. Thus, we rejected the null hypothesis of overidentifying restrictions.

Ⅲ. Conclusion

We have explored the multi−country PPP in the Pacific Rim of United States by using the Generalized Method of Moment estimation technique. The empirical result was that the relative PPP has failed in the Pacific Rim. This is corresponding to previous empirical studies on multi country PPP. To enhance the power of the test for PPP, we hope in the future to expand the panel to a large number of countries.

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