PPP TESTS IN COINTEGRATED PANELS: EVIDENCE FROM ASIAN DEVELOPING COUNTRIES

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Abstract: This paper tests the relative version of purchasing power parity (PPP) for a set of ten Asian developing countries using panel cointegration framework. We employ 'between-dimension' dynamic OLS estimator as proposed by Pedroni (2001b). The test results overwhelmingly reject the PPP hypothesis.

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1. Introduction

The purpose of this study is to examine the empirical validity of relative purchasing power parity (PPP) doctrine in the context of a set of Asian developing economies. In the literature there has been an influx of empirical studies on PPP especially in the 90s with mixed findings. The main concern of these studies is to find any possible common stochastic trend(s) between exchange rates and relative prices in a bilateral context by employing a number of different unit root and cointegration tests. Majority of them use the post Bretton Woods data. Obviously these studies do not have sufficiently longer time series to overcome the possible problem of 'small sample distortions' that the traditional unit root and cointegration tests encounter. Of course there are other studies that use longer time span. However, the traditional tests for PPP using longer univariate time series usually overlook the potential problem of structural break as the data set covers both the fixed and floating exchange rate regimes [Qian and Strauss (2001)].

To circumvent these problems, researchers of late started recommending the use of panel cointegration framework to get econometrically robust findings [Baltagi and Kao (2000), Banerjee (1999), Pedroni(2000, 2001b) and Qian and Strauss (2001)]. A major advantage of this approach is that it allows one to selectively pool the long run information contained in the panel while permitting the short run dynamics (and heterogeneity) among different members. An important consideration regarding 'pooling' has to do with the dimension over which they are pooled. One can pool across either the 'within' or 'between' dimensions. Pedroni concluded that the 'between dimension' has relatively lower small sample distortions. The goal of this study is to employ this improved panel cointegration method to evaluate the PPP doctrine in the context of a set of somewhat homogeneous developing countries.

2. Methodological Discussions

Pedroni evaluates the asymptotic properties of three versions of panel estimators. "Residual-FM" and the "adjusted-FM" pooled the data along the 'within' dimension and "group-FM" pooled the data along the 'between dimension'. He shows that the "group-FM" has relatively lower small sample distortions and more flexibility in terms of hypothesis testing. For example, in the panel unit root regression $Y_{it} = \mu_i Y_{it-1} + \varepsilon_{it}$ for $t = 1,2...T$, and $i = 1,2...N$, pooled tests imply $H_0 : \mu_i = 1 \forall i$ and $H_A : \mu_i = \mu_A < 1 \quad \forall i$ where as grouped mean tests imply

$H_0 : \mu_i = 1 \forall i$ and $H_A : \mu_i < 1 \ \ \forall i$. It is clear that μ_i under the alternative hypothesis is not required to be the same among different i members of the panel. Hence the grouped tests often allow for a greater flexibility.

Consider the following cointegrated system for a panel of i = 1,2…N members

$$Y_{it} = \alpha_i + \beta X_{it} + \mu_{it}$$
$$X_{it} = X_{it-1} + \varepsilon_{it} \qquad (1)$$

where $Z_{it} = (Y_{it}, X_{it})' \sim I(1)$ and $\xi_{it} = (\mu_{it}, \varepsilon_{it})' \sim I(0)$ with long run covariance matrix $\Omega_i = L_i L_i^{'}$ (L_i is a lower triangular decomposition of Ω_i). In this case the variables are said to be cointegrated for each member of the panel, with cointegrating vector β. It should be noted that α_i allows the cointegrating relationship to include member specific fixed effects. This covariance matrix can also be decomposed as $\Omega_i = \Omega_i^0 + \Gamma_i + \Gamma_i^{'}$, where Ω_i^0 is the contemporaneous covariance and Γ_i is a weighted sum of autocovariances.

The panel FMOLS estimator for the coefficient β is given by

$$\beta_{NT}^* = N^{-1} \sum_{i=1}^{N} \left(\sum_{t=1}^{T} (X_{it} - \overline{X}_i)^2 \right)^{-1} \left(\sum_{t=1}^{T} (X_{it} - \overline{X}_i) Y_{it}^* - T\hat{\tau}_i \right) \qquad (2)$$

where $Y_{it}^* = (Y_{it} - \overline{Y}_i) - \frac{\hat{L}_{21i}}{\hat{L}_{22i}} \Delta X_{it}$, $\hat{\tau}_i \equiv \hat{\Gamma}_{21i} + \hat{\Omega}_{21i}^0 - \frac{\hat{L}_{21i}}{\hat{L}_{22i}} (\hat{\Gamma}_{22i} + \hat{\Omega}_{22i}^0)$. The associated t-statistic follows standard normal distribution.[1]

For the panel DOLS estimation, we need to augment the cointegrating regression in (1) as follows:

$$Y_{it} = \alpha_i + \beta_i X_{it} + \sum_{k=-K_i}^{K_1} \gamma_{ik} \Delta X_{it-k} + \mu^*_{it} . \qquad (3)$$

where the estimated coefficient β is given by

$$\beta_{DS}^* = N^{-1} \sum_{i=1}^{N} \left(\sum_{t=1}^{T} Z_{it} Z_{it}' \right)^{-1} \left(\sum_{t=1}^{T} Z_{it} Y_{it}^* \right) \qquad (4)$$

where $Z_{it} = (X_{it} - \overline{X}_i, \Delta X_{it-K}, ... \Delta X_{it+K})$ is $2(K+1)x1$ vector of regressors.

[1] The detail expression of the t-statistic is available in Pedroni (2000).

3. Results

3.1 Data

The panel consists of 240 monthly (and 80 quarterly) series of 'end of period' nominal U.S. dollar exchange rates (E) and aggregate consumer price index ratio (P) for 10 countries covering the period from January 1980 through December 1999 (1980:1 to 1999:4 for quarterly data). The sample countries are India, Indonesia, South Korea, Malaysia, Nepal, Pakistan, The Philippines, Singapore, Sri Lanka and Thailand. The selection of these countries is somewhat arbitrary, except that they belong to a set of major Asian developing economies. All data have been taken from IMF's *International Financial Statistics* CD-ROM. The required log-transformation has been done. The results reported here are only for monthly data[2].

3.2 The panel unit root and the panel cointegration tests

In order to determine the presence of a unit root in individual country specific data we employ standard ADF test. For a panel unit root we conduct Levin-Lin (1992) and IPS t-bar (1997) tests. Both the panel tests include a constant and a heterogeneous time trend in their specifications. The test results show that the unit root null could not be rejected and hence the series are generated by an *I(1)* process.

Next we perform cointegration tests for all the sample individual countries by using Johansen and Juselius (1990) method and for the panel by using Pedroni (1999) procedure. We find the evidence of no cointegration from both individual and panel cointegration tests. So, the PPP does not hold in the long-run in this context. To conserve space we report only panel unit root (upper panel) and panel cointegration (lower panel) results in Table 1.

3.3 FMOLS and DOLS

Table 2 reports the results of individual and panel FMOLS and DOLS. Individual FMOLS and DOLS estimates and the respective t-statistics for H_0: $\beta_i = 1$ are provided in the first 10 entries in Table 2, while results for the panel estimators with and without common time dummies are shown at the bottom of the table. Both individual and panel tests overwhelmingly reject the null hypothesis of strong PPP. As for the individual countries, 7 out of 10 cases we find the rejection of the null. We should also note that both FMOLS and DOLS test results are in agreement.

[2] Similar results on quarterly data will be made available upon request.

For the panel tests, all 4 reported tests reject the null at least at 5% level except in the case of within-dimension panel DOLS without time dummies. However, it is important to note that the between-dimension estimators consistently produce larger estimates than the within-dimension estimators. This finding is thus consistent with Pedroni (2001b). Following him, we argue that these higher values to be a more accurate representation of the average long-run relationship between nominal exchange rates and aggregate price ratios.

4. Conclusion

In this study we employ panel cointegration method for evaluating the purchasing power parity doctrine in a panel of ten Asian developing economies for the post Bretton Woods period. The empirical findings of this paper do not support the relative version of PPP. The analysis of the individual countries furthermore indicates that this failure of the PPP is not driven by the data from only a few countries. Rather, the failure of strong PPP appears to be pervasive in the flexible exchange rate regime.

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Table 1: Panel Unit Root and Cointegration Test Statistics

Panel Unit Root Tests[a,b,c]	*Log of* ***E***	*Log of* ***P***
Levin-Lin rho-stat	-0.40220	1.96964
Levin-Lin t-rho-stat	-0.08784	0.88196
Levin-Lin ADF-stat	-0.63467	1.19161
IPS ADF-stat	-0.77409	0.45507
Panel Cointegration Tests[d]	*Constant*	*Constant + trend*
Panel v-statistics	0.03497	1.06003
Panel ρ-statistics	0.38135	0.74992
Panel t-statistics (non-parametric)	0.35931	0.90140
Panel t-statistics (parametric)	-0.12432	0.57380
Group ρ-statistics	-0.00968	1.35524
Group t-statistics (non-parametric)	0.29615	1.26993
Group t-statistics (parametric)	-0.15929	0.80218

Notes:

a. The critical values are from Levin and Lin (1992) Table 3 (with N=10 and T=250).
b. IPS indicates the Im et al. (1997) test. The critical values are taken from Table 4.
c. Unit root tests include a constant and heterogeneous time trend in the data.
d. The critical values for the panel cointegration tests are base on Pedroni (2001a).

Table 2: Purchasing Power Parity Tests

Country	**FMOLS**	**t-stat**	**DOLS**	**t-stat**
India	1.80	16.27***	1.80	15.79***
Indonesia	-0.03	-6.19***	-0.19	-5.99***
Korea	1.07	0.38	1.04	0.20
Malaysia	-0.42	-3.04***	-0.49	-3.67
Nepal	1.63	20.66***	1.64	23.88***
Pakistan	1.64	8.64***	1.55	6.76***
The Philippines	1.16	3.55***	1.15	3.27***
Singapore	1.21	1.52	1.20	1.50
Sri Lanka	0.98	-0.89	0.96	-1.91*
Thailand	1.97	3.28***	1.77	2.42**
		Panel Results		
		without time dummies		
within[a]	0.80	-1.72*	0.95	-0.44
between[b]	1.10	13.97***	1.04	13.35***
		with time dummies		
within	0.43	-6.34***	0.57	-5.06***
between	1.07	-2.26**	1.19	2.55**

Notes: *t-stats* are for H_0: $\beta_i = 1$. ***,**,* indicate, 1%,5%,10% rejection level, respectively.

a. "*within-dimension*" reports Mark and Sul (1999) unweighted within-dimension DOLS and an analogous unweighted FMOLS.
b. "*between-dimension*" reports Pedroni (1996) group mean panel FMOLS and the group mean panel DOLS introduced in Pedroni (2001b).