E C O N O M I C S B U L L E T I N

Non-linear PPP in South Asia and China

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Abstract

This study tests the purchasing power parity hypothesis for four South Asian economies and China by employing a recent nonlinear test of stationarity. Besides testing the CPI based PPP, we have also used PPI based real exchange rate in the analysis. The results indicate that nonlinear tests are more successful in validating PPP

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1. Introduction

The behaviour of real exchange rate has been vastly studied in literature because of its many repercussions in the area of international finance. The competitiveness of a country in world trade can be examined by analysing real exchange rate movements. Moreover, the validity of purchasing power parity can be tested by observing the performance of real exchange rate. Besides other important implications, absence of purchasing power parity forbid the existence of monetary approach to the exchange rate if a country is following flexible exchange rate or monetary approach to the exchange market pressure if a country is following managed floating exchange rate system. After the failure of linear models to validate purchasing power parity, there is increasing trend to employ nonlinear methodologies to capture the behaviour of real exchange rate and these new techniques have been more successful in validating purchasing power parity assumption. A recent survey on the topic can be found in Sarno (2005). Some other important studies on the topic include Michael et al. (1997), Taylor et al. (2001), Sarno and Taylor (2002), Liew et al. (2004), and Bahmani-Oskooee et al. (2007). The present study uses recent nonlinear cointegration technique advanced by KSS (Kapetanious et al. (2003)) and a more powerful test suggested by KPSS (Kwiatowski et al. (1992)). The detail about these methodologies is given in the coming sections.

This study examines the behaviour of real exchange rate for South Asian countries viz. India Pakistan, Sri Lanka, Bangladesh and China using monthly data for the period 1974M2 to 2006M2, 1974M2 to 2006M2, 1975M2 to 2006M2, 1993M7 to 2006M2, and 1986M12 to 2006M2, respectively. The choice of this time period is influenced by the availability of the data series.

In another study Zhou (1997) has analysed the behaviour of real exchange rate using nonlinear unit root test for Asian-Pacific countries. Our study is different from Zhou's study in four ways. First, we have two measures of real exchange rate i.e., consumer price index (CPI) base real exchange rate and wholesale price index (WPI) based real exchange rate whereas Zhou has used only CPI based real exchange rate. Second, the data used in Zhou's study is quarterly while we use monthly data. Third Zhou's study does not include Bangladesh and China in his analysis. Fourth, we have employed an additional test of stationarity (KPSS), which is considered to be more powerful compared to ADF test.

The KSS and KPSS methodologies are presented in section 2, while estimation results are given in section 3. Section 4 concludes.

2. Methodology

A number of the empirical studies in econometrics literature have reported that the classical or conventional non-stationarity tests (such as DF, ADF and PP) are not very powerful against relevant alternatives. For instant, Delong et al. (1989) found that the Dickey-Fuller tests are not able to reject a unit root null hypothesis against stable autoregressive alternatives with roots close to unity. Similarly, Diebold and Rudebusch (1990) provided empirical evidence that standard unit root tests have low power against fractionally integrated alternatives. To avoid this problem the present study employs two alternative tests of stationarity i.e., KPSS (Kwiatowski et al. (1992)) methodology (the LM statistic) and KSS (Kapetanious et al. (2003)) methodology, besides the conventional linear ADF test.

The standard ADF test is used to check the stationarity of a series under the null hypothesis that series is non stationary while the alternative hypothesis tests the absence of unit root. In the KPSS methodology, under null hypothesis it is defined that series is stationarity while the alternative states the existence of a unit root in the series. This ensures that the alternative will be accepted (null rejected) only when there is strong evidence for (against) it. The KPSS test statistic is defined as follows;

$\hat{\eta} = T^{-2}\sum \frac{S_t^2}{s^2(l)}$, where S_t is the partial sum process of the residuals ξ_t which are obtained from a regression of the respective variable on only intercept in case of level stationary, and on intercept and trend in case of trend stationary. It is defined as; $S_t = \sum_{i=1}^{t} \xi_i$ and $s^2(l) = T^{-1}\sum_{t=1}^{T} \xi_t^2 + 2T^{-1}\sum_{m=1}^{l} w(m,l)\sum_{t=m+1}^{T} \xi_t \xi_{t-m}$, $w(m,l)$ is an optional weighting function; this is, $w(m,l) = 1 - m/(1+l)$, where l is the maximum lag.

A nonlinear test proposed by Kapetanious, Shin and Snell (KSS) (2003) under null hypothesis tests the series to be non stationary; however the alternative hypothesis is that the series is nonlinear but globally stationary. This test is based upon the following exponential smooth transition autoregressive process:

$$\Delta y_t = \gamma y_{t-1}\left[1 - \exp\left(-\theta y^2{}_{t-1}\right)\right] + \varepsilon_t \qquad (1)$$

where y_t is the de-meaned or de-trended series of interest and ε_t is an i.i.d. error with zero mean and constant variance and $\left[1 - \exp\left(-\theta y^2{}_{t-1}\right)\right]$ is the exponential transition function used to present the nonlinear adjustment. The null hypothesis H_0: $\theta = 0$ implies that $\Delta y_t = \varepsilon_t$ as $\left[1 - \exp\left(-\theta y^2{}_{t-1}\right)\right] = 0$ while the alternative hypothesis that series is nonlinear but globally stationary process entails that $\theta > 0$, where θ determines the speed of mean reversion. The null hypothesis H_0: $\theta = 0$ cannot be directly tested as γ in above equation under the null is not identified, KSS has reparameterised equation 1 based on first-order Taylor series approximation to equation 1 to obtain the auxiliary regression specified as:

$$\Delta y_t = \theta y^3{}_{t-1} + \text{ error} \qquad (2)$$

to correct for the serially correlated errors in equation 2, regression equation 2 can be written as:

$$\Delta y_t = \sum_{j=1}^{p} \rho_j \Delta y_{t-j} + \theta y^3{}_{t-1} + \text{ error} \qquad (3)$$

the null hypothesis in equation 1 or 2 to be tested is H_0: $\theta = 0$ while the alternative hypothesis is H_1: $\theta < 0$. As the KSS show that the t-statistics for $\theta = 0$ against $\theta < 0$, does not have an asymptotic standard normal distribution and one must resort to simulations for asymptotic critical values.

On the basis of equation 3, we have estimated two values of *t*, i.e., $t_{KSS(c)}$ and $t_{KSS(c+t)}$ where the former represents de-meaned and later indicates the de-trended data. These data series are obtained by first regressing each series on a constant or on both a constant and a time trend and then saving the residuals.

3. Estimation

The table one provides some interesting information about the existing of PPP. We apply linear as well nonlinear unit root tests to test whether the real exchange rates are stationary or not. The tests are applied for two real exchange rates, one is computed using consumer price index (CPI) and the second is calculated with respect to producer price index. The producer price index based real exchange rate is tested with an assumption that in these countries there are more trade barriers on consumer goods and less on producer goods, therefore, it is more likely that these countries hold PPP with respect to wholesale price index rather than consumer price index.

Table 1
Unit Root Test Results for Real Exchange Rate

Country	ADF		KPSS		KSS	
	$t_{ADF(c)}$	$t_{ADF(c+t)}$	$LM_{KPSS(c)}$	$LM_{KPSS(c+t)}$	$t_{KSS(c)}$	$t_{KSS(c+t)}$
Pakistan						
$REX(CPI)$	-0.519	-2.613	2.233	0.183	-2.114	-2.649
$REX(WPI)$	-1.124	-2.849	1.837	**0.123**	-1.474	**-4.279**
India						
$REX(CPI)$	-1.274	-1.298	2.235	0.290	-1.662	-2.264
$REX(WPI)$	-1.286	-2.517	2.243	0.212	**-2.657**	-3.234
Sri Lanka						
$REX(CPI)$	**-3.337**	-2.829	1.092	0.385	-1.918	**-4.684**
$REX(WPI)$	**-3.454**	**-3.544**	0.539	0.157	**-6.029**	**-7.878**
Bangladesh						
$REX(CPI)$	-2.040	-2.310	1.274	0.270	**-2.482**	-1.992
China						
$REX(CPI)$	-2.357	-2.027	1.778	0.431	**-6.377**	-1.624

Notes: $t_{ADF(c)}$ and $t_{ADF(c+t)}$ are the standard ADF test statistics for the null of nonstationary of the variable in the study without and with a trend, respectively, in the model for testing. $LM_{KPSS(c)}$ and $LM_{KPSS(c+t)}$ are the KPSS test statistics for the null of stationary of the variable in the study without and with a trend, respectively in the model for testing. $t_{KSS(c)}$ and $t_{KSS(c+t)}$ are the KSS test statistics for the de-meaned and the de-trended dada, respectively, using the models with augmentation. The 10% and 5% asymptotic critical values are -2.57 and -2.86 for $t_{ADF(c)}$ respectively, and are -3.12 and -3.41 for $t_{ADF(c+t)}$ respectively. The 10% and 5% asymptotic critical values are 0.347 and 0.463 for $LM_{KPSS(c)}$ respectively, and 0.119 and 0.146 for $LM_{KPSS(c+t)}$ respectively. The 10% and 5% asymptotic critical values for $t_{KSS(c)}$ are -2.66 and -2.93 respectively and those for $t_{KSS(c+t)}$ are -3.313 and -3.40 respectively, taken from Kapetanios et al. (2003, p.364). the bold statistics indicate stationarity at level.

The standard ADF linear unit root has been failed to reject the null of nonsationary for all the examined countries apart from Sri Lanka. In case of Sri Lanka, both the real exchange rates –

with respect to consumer price index as well as with respect to wholesale price index appeared stationary. We did not find any significant evidence of stationarity for the consumer price index based real exchange rate for Pakistan and India even by using nonlinear unit root tests. Thus, CPI based PPP neither exists in linear context nor in nonlinear context in these two economies. On the other hand, CPI based PPP -the only available price measure- exists in Bangladesh and China, when applied nonlinear KSS test.

From above discussion we can conclude that nonlinear stationarity tests are relatively more successful in rejecting the null of non stationary against the alternative of nonlinear but stationary process. This result is consistent to other studies which employ nonlinear techniques.

Despite the South Asian countries have a number of trade barriers[*], their trade volume is increasing significantly and they are gradually removing, or at least giving relief in tariffs and other barriers. With given institutional circumstance of South Asian countries, the standard forms of PPP based on consumer price index perhaps not compatible; however, since they have fewer barriers in capital goods as compared to consumer goods the PPP with respect to wholesale price index seems more well-matched and robust for the South Asian countries.

4. Conclusion

This paper has tested the purchasing power parity assumption for Four South Asian economies, i.e., Bangladesh, India, Pakistan, Sri Lanka, and for China by examining the stationarity of real exchange rate. We have used two measures of real exchange rate, the consumer price index based real exchange rate and producer price based real exchange rate. As the conventional linear models of testing the PPP have met with limited success, this study uses two recent methodologies to validate PPP theory. The results indicate that nonlinear tests are more successful in validating the purchasing power parity assumption in the examined economies. Moreover, relatively strong prevalence of producer price index based PPP indicates that intermediate goods face less barrier to trade in these economies.

References

Bahmani-Oskooee et al. (2007) "Testing PPP in non-linear STAR framework" *Economics Letters* 94, 104-110.

Calvo, A. G. and C. M. Reinhart (2000) "Fear of Floating" NBER Working Paper 7993

Delong, D. N., J. C. Nankervis, N. E. Savin, and C. H. Whiteman (1989) "Integrated versus Trend Stationarity in Macroeconomic Time Series" Department of Economics, University of Iowa Working Paper No. 89-99

Diedbold, F. X. and G. D. Rudebusch (1991) "On the Power of Dickey-Fuller Test against Fractional Alternatives" *Economics Letter* 35, 155-160.

Kapetanios, G., Shin, Y., Snell, A., (2003) "Testing for a unit root in the nonlinear STAR framework" *Journal of Econometrics* 112, 359-379.

Kwiatkowski, D., P. C. B. Phillips, P. Schmidt and Y. Shin (1992) "Testing the Null Hypothesis of Stationarity against the Alternative of a Unit Root" *Journal of Econometrics* 54, 159-178.

[*] Principally it seems that these trade barriers slow down the process of pass through of the changes in exchange rates to domestic prices of commodities. However, as said by Calvo and Reinhart (2000), the pass through from exchange rate swings to domestic prices is far higher in emerging economies (including India and Pakistan) than in developed economies.

Liew, V.K., Baharumshah, A.Z., and T.T. Chong (2004) "Are Asian real exchange rates stationary?" *Economics Letters* 83, 313-316.
Michael, P., Nobay, A. R., and D. A. Peel (1997) "Transactions Costs and Nonlinear Adjustment in Real Exchange Rates: An Empirical Investigation" *Journal of Political Economy* 105, 862-879.
Sarno, L. (2005) "Viewpoint: Towards a solution to the puzzles in exchange rate economics: where do we stand?" *Canadian Journal of Economics* 38, 673–708.
Sarno, L., and M.P. Taylor (2002) "Purchasing power parity and the real exchange rate" IMF Staff Papers 49, 65–105
Taylor, M. P., P. A. David, and L. Sarno (2001) "Nonlinear Mean-Reversion in Real Exchange Rates: Toward a Solution to the Purchasing Power Parity Puzzles" *International Economic Review* 42, 1015-42.
Zhou, S. (2008) "Stationarity of Asian-Pacific real exchange rates" *Economics Letters* 98, 16-22.