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Purchasing Power Parity in the BRICS and the MIST Countries: Sequential Panel Selection Method

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Abstract: The Sequential Panel Selection Method (SPSM) procedure is applied to the real effective exchange rates of BRICS (Brazil, Russia, India, China, and South Africa) and MIST (Mexico, Indonesia, South Korea and Turkey) countries, using monthly data over the period 1994-2012. While several panel unit root tests give us mixed results, SPSM classifies the whole panel into a group of stationary series and a group of non-stationary series, identifying stationary series within the panel. Empirical results from the SPSM procedure that uses the Panel KSS unit root test with a Fourier function indicate that mean-reversion in real effective exchange rates holds true for these two groups of countries under study.

JEL Classifications: C22, F31, F37

Keywords: Purchasing Power Parity, BRICS countries, MIST countries, Sequential Panel Selection Method, Fourier function

[1] Valuable comments of an anonymous referee are greatly appreciated. Remaining errors, however, are ours.

1. Introduction

It is not difficult to find studies which attempt to test Purchasing Power Parity (PPP) theory either for a single country or group of countries. With advances in time-series econometrics unit root testing procedure, the task is reduced to one of establishing whether real exchange rates are stationary (supporting the PPP) or they contain a unit (rejecting the PPP).

The common practice to test the PPP was to regress the nominal exchange rate on relative prices and test whether the constant is zero and the slope is close to unity, implying support for the PPP. Since introduction of cointegration analysis in 1987, the emphasis shifted to establishing the stationarity of the residuals of regression models since the nominal exchange rate and relative prices were shown to be non-stationary. These studies did not provide much support for the PPP. Examples include Taylor (1988), Corbae and Ouiliaris (1988), McNown and Wallace (1989), Karfakis and Moschos (1989), Layton and Stark (1990), Kim (1990), Bahmani-Oskooee and Rhee (1992), and Bahmani-Oskooee (1993).

Rather than engaging in regression analysis, another strand of the literature applied unit root tests such as linear ADF test or Nonlinear KSS to establish mean reverting properties of real exchange rates. Again, they have provided mixed results. Examples include Bahmani-Oskooee (1995a, 1995b), Taylor (2002), Hasan (2004), Liew, *et al*. (2004), Lopez, *et al*. (2005), and Bahmani-Oskooee, *et al*. (2007a, 2007b, 2008).

A third group of studies have criticized univariate unit root tests (linear or non-linear) on the ground that they do not employ enough observations over longer period, hence they suffer from low power and yield misleading results. These studies employ panel unit roots and again provide mixed support for the PPP. Some examples are Taylor, *et al*. (2001), Alba and Park (2003), Kapetanios, *et al*. (2003), Chortareas and Kapetanios (2004), and Sarno, *et al*. (2004).

Failure to support the PPP either by a univariate or panel test is also said to be due to excluding structural breaks. Indeed, Perron (1989) argued that if there is a structural break, the power to reject a unit root decreases when the stationary alternative is true and the structural break is ignored. A common practice to account for structural break is to include dummy variables. However, the available unit root tests only allow one or two dummies. Nunes, *et al.* (1997), Lee and Strazicich (2003) and Kim and Perron (2009), among others, demonstrate that such tests suffer from serious power and size distortions due to the asymmetric treatment of breaks under the null and alternative hypotheses. The issue becomes too serious when number of breaks is more than two. To solve the problem, Becker, *et al.* (2004, 2006) and Enders and Lee (2012) develop tests which model any structural break of an unknown form as a smooth process via means of Flexible Fourier transforms. They argue that their testing framework requires only the specification of the proper frequency in the estimating equations. By reducing the number of estimated parameters, they ensure that the tests have good power irrespective of the time or shape of the break.

Thus far we know that in order to increase power of the unit root tests we must increase number of observations by relying upon panel tests. We also know that we must incorporate a Fourier function to account for unknown structural breaks. However, standard panel unit root tests have been criticized on the ground that they assume homogeneity across each unit within the panel. To this end, Maddala and Wu (1999) and Im, *et al.* (2003) have developed tests that permit the autoregressive parameters to differ across panel members. Even these tests produce biased outcome if some series within the panel are stationary and some non-stationary. In contrast to those panel-based unit root tests that are joint tests of a unit root for all members of a panel and that are incapable of determining the mix of I(0) and I(1) series in a panel setting, the Sequential Panel Selection Method (hereafter, SPSM), proposed by Chortareas and Kapetanios (2009) offers a unique solution. The method classifies the whole panel into a group of stationary series and a group of non-stationary series. In so doing, they clearly identify how many and which series in the panel are stationary processes.

Finally, there is a growing consensus that real exchange rates exhibit nonlinearities and, consequently, conventional unit root tests such as the Augmented Dickey Fuller (ADF) test may have low power in detecting mean reversion.[2] As such, stationarity tests based on a nonlinear framework must be applied. Ucar and Omay (2009) propose a nonlinear panel unit root test by combining the nonlinear framework in Kapetanios, *et al*. (2003, hereafter, KSS) with the panel unit root testing procedure of Im, *et al*. (2003), which has been proven to be useful in testing the mean reversion of real exchange rates.

The main purpose of this paper is to test the PPP for two groups of countries, i.e., BRICS (Brazil, Russia, India, China, and South Africa) and MIST (Mexico, Indonesia, South Korea and Turkey) using the Panel KSS unit root test with a Fourier function, based on the Sequential Panel Selection Method (SPSM) procedure. To this end we discuss the data in Section 2. The method is explained in Section 3 with the results in Section 4. A summary is provided in Section 5.

2. Data

Our empirical analysis covers two groups of countries: BRICS and MIST countries. Monthly real effective exchange rate (REER) data over the period January 1994- June 2012 are used and the data are taken from the Bank for International Settlements (BIS) website. There has been an exponential rise in the growth and economic power of the emerging markets ever since the 1990s, with the emerging economies in general, and the transition economies in particular, having received widespread attention within the literature. Clearly, the BRICS economies stand out amongst all of the emerging economies, having demonstrated remarkable economic progress over recent years. Ever since the recognition of their status in the study "Dreaming with BRICs: The Path to 2050" (Wilson and Purushortaman, 2003), the emerging markets of the BRICS countries have continued to make significant contributions to global economic growth, and seem likely set to do so for many decades to come.

Indeed, these economies are poised to become larger, in US dollar terms, than the G6.[3] Secondly, it is estimated that about three-fourths of the anticipated increase in GDP by the BRICS and MIST economies is likely to come from higher-end real growth. Both the BRICS and MIST countries are already playing important roles in global financial development, exerting significant influences on economic growth throughout the global economy and markets. Visual inspection of the REER series for these two groups of countries: BRICS and MIST countries reveal significant upward and/or downward trends for most of the countries during this sample period. From these figures, for most of the series, there seems to be some nonlinear adjustment patterns.

[2] Reasons for the nonlinear adjustment are the presence of transactions costs that inhibit international goods arbitrage and official intervention in the foreign exchange market. For some other factors see Bahmani-Oskooee, *et al.* (2008).

[3] In the early report, only Brazil, Russia, India, and China constituted the BRIC group; South Africa was added the follow-up, giving the current version of BRICS. The G6 refers to the United States, the United Kingdom, Japan, Germany, France, and Italy.

3. Methodology[4]

As mentioned above, our method is based on a non-linear panel unit root test. Such test has already been introduced by Ucar and Omay (2009) who combined the nonlinear framework in Kapetanios, *et al*. (2003, KSS) with the panel unit root testing procedure of Im, *et al*. (2003) as in equation (1):

$$\Delta X_{i,t} = \xi_i + \delta_i X_{i,t-1}^3 + \sum_{j=1}^{k} \theta_{i,j} \Delta X_{i,t-j} + \nu_{i,t} \qquad (1)$$

where the null of linear nonstationarity $H_0 : \delta_i = 0$, for all i is tested against alternative of nonlinear stationarity $H_0 : \delta_i < 0$, for some i. Bahmani-Oskooee, *et al*. (2013) then incorporate a Fourier function into (1) and arrive at equation (2):

$$\Delta X_{i,t} = \xi_i + \delta_i X^3{}_{i,t-1} + \sum_{j=1}^{k1} \theta_{i,j} \Delta X_{i,t-j} + a_{i,1} \sin(\frac{2\pi kt}{T}) + b_{i,1} \cos(\frac{2\pi kt}{T}) + \varepsilon_{i,t} \qquad (2)$$

where $t = 1,2,....,T$. The rationale for selecting $[\sin(2\pi kt/T), \cos(2\pi kt/T)]$ is based on the fact that a Fourier expression is capable of approximating absolutely integrable functions to any desired degree of accuracy. In (2) k represents the frequency selected for the approximation, and $[a_i, b_j]'$ measures the amplitude and displacement of the frequency component. It also follows that at least one frequency component must be present if there is a structural break.[5]

Again, following Bahmani-Oskooee, *et al*. (2013) we apply the Chortareas and Kapetanios's (2009) SPSM procedure to equation (2) by taking the following steps: First, we estimate equation (2) for the entire panel. If the unit-root null is rejected, we accept that the series in the panel are stationary and move to the second step. In the second step, we remove the series with the minimum KSS statistic since it is identified as being stationary. Finally, we go back to the first step for the remaining series, or stop the procedure if all the series are removed from the panel. The final outcome is separation of the whole panel into sets of stationary and nonstationary series.

4. Empirical Results

Before applying the above method we first apply several univariate time series unit root tests so that we can examine the null hypothesis of a unit root in each country's real effective exchange rate (natural log REER). Based on the results in Table 1, there is no question that three univariate unit root tests—the Augmented Dickey and Fuller (1981, ADF), the Phillips and Perron (1988, PP), and the Kwiatkowski, *et al*. (1992, KPSS) tests all lead us to conclude that the REERs of the most of the countries contain unit roots and reject the PPP.[6] This outcome is consistent with that of the

[4] This section closely follows Bahmani-Oskooee, *et al*. (2013).

[5] Enders and Lee (2012) suggest that the frequencies in Equation (2) should be obtained via the minimization of the sum of squared residuals. Their Monte Carlo experiments suggest that no more than one or two frequencies should be used because of the loss of power associated with a larger number of frequencies.

[6] With some exceptions, we found that the unit root null hypothesis was rejected for India, Indonesia, and South Africa when the ADF test was used. The PP test also rejected the unit root hypothesis for both India and Indonesia. The KSPP test also fails to reject the stationary null hypothesis for both India and South Korea (see Table 1).

existing literature and may be due to the low power of these three univariate unit root tests. Failure to support the PPP could also be due to the fact that movement of the real effective exchange rates could be non-linear in nature.

Table 1. Univariate unit root tests

	Level			1st difference		
	ADF	**PP**	**KPSS**	**ADF**	**PP**	**KPSS**
Brazil	-1.548(2)	-1.556(4)	0.413[11] **	-9.629(1) ***	-9.737(4) ***	0.117[4]
China	-2.476(1)	-2.510(1)	0.574[11] **	-10.746(0) ***	-10.507(5) ***	0.235[1]
India	-2.931(1)**	-2.607(3)*	0.267[11]	-11.004(1) ***	-11.911(11) ***	0.079[5]
Indonesia	-2.824(1)**	-2.608(1)*	0.911[11] ***	-12.862(0) ***	-12.749(5) ***	0.046[3]
South Korea	-2.384(2)	-2.418(5)	0.209[11]	-10.797(1) ***	-8.171(22) ***	0.049[6]
Mexico	-1.757(6)	-2.403(4)	0.354[11] *	-9.220 (1) ***	-12.234(10) ***	0.084[6]
Russia	-2.033(3)	-1.823(6)	1.183[11] ***	-6.837(2) ***	-9.795(0) ***	0.054[5]
South Africa	-2.644(1)*	-2.551(4)	0.740[11]***	-11.419(0) ***	-11.459(1) ***	0.076[3]
Turkey	-2.217(2)	-1.952(3)	1.653[11] ***	-10.009(1) ***	-10.407(6) ***	0.052[4]

Notes: *, ** and *** indicate significance at the 10%, 5% and 1% level, respectively. The number in parenthesis indicates the lag order selected based on the recursive t-statistic, as suggested by Perron (1989). The number in the brackets indicates the truncation for the Bartlett kernel, as suggested by the Newey-West test (1994).

As mentioned before, to increase power we shift to panel-based unit root tests and allow cross-sectional and temporal dimensions to be combined. Tables 2 and 3 on the following pages report the results for the first generation and second generation panel-based unit root tests. Three first generation panel-based unit root tests—LLC (Levin, *et al*., 2002), MW (Madalla and Wu, 1999), and the Im-Pesaran-Shin (Im, *et al*., 2003) test, all yield the same results, indicating that REERs are stationary in the BRICS and MIST countries.

A serious drawback of the first generation panel-based unit root tests is that they do not take (possible) cross-sectional dependencies into account in the panel-based unit root test procedure. O'Connell (1988) points out that failure to consider contemporaneous correlations among data will bias the panel-based unit root test toward rejecting the joint unit root hypothesis. Cross-sectional dependencies are taken into account by the second generation panel unit root tests. Hence, these methods offer a superior way to study the long run behavior of the REERs. Four second generation panel-based unit root tests of Bai and Ng (2004), Choi (2002), Moon and Perron (2004), and Pesaran (2007) are used in our study.

Table 3 reports the results of these four second generation panel-based unit root tests. Results from these four tests indicate that REERS are all stationary in the BRICS and MIST countries. Our results signify that REERs are stationary and PPP holds in these countries. As we stated earlier, panel-based unit root tests are joint tests of a unit root for all members of a panel and that are incapable of determining the mix of I(0) and I(1) series in a panel setting. Furthermore, if we fail to incorporate the structural breaks in the model, the outcome would be biased. Hence, we proceed to test the stationarity of REERs by using the SPSM procedure mixed with the Panel KSS unit root test with a Fourier function.

As a benchmark, we first report the results of the Panel KSS unit root test without a Fourier function. Table 4 reports the results of Panel KSS unit root test without a Fourier function on the REERs where we give a sequence of the Panel KSS statistics with their bootstrap p-values on a reducing panel, the individual minimum KSS statistic, and the stationary series identified by this procedure each time. As we can see from Table 4, the null hypothesis of a unit root in natural log of REER is rejected when the Panel KSS unit root test was first applied to the whole panel, producing a value of -2.409 with a p-value of 0.000.

Table 2. First Generation Panel Unit Root Tests

Levin, Lin and Chu (2002)	t_ρ^*	$\hat{\rho}$	t_ρ^{*B}	t_ρ^{*C}	
	-2.934***	-0.031***	-3.419***	-3.373***	
	(0.002)	(0.000)	(0.000)	(0.000)	
Im, Pesaran and Shin (2003)	t_bar_{NT}	$W_{t,bar}$	$Z_{t,bar}$	$t\_bar_{NT}^{DF}$	$Z_{t,bar}^{DF}$
	-2.259	-2.543***	-2.642***	-1.998	-1.631**
		(0.005)	(0.004)		(0.051)
Maddala and Wu (1999)	P_{MW}	Z_{MW}			
	32.481*	2.414**			
	(0.019)	(0.008)			

Notes:

Levin, Lin and Chu (2002): t_p^* denotes the adjusted t-statistic computed with a Bartlett kernel function and a common lag truncation parameter given by $\overline{K} = 3.21T^{1/3}$ (Levin and Lin, 2002). Corresponding p-value is in parentheses. $\hat{\rho}$ is the pooled least squares estimator. Corresponding standard error is in parentheses. t_p^{*B} denotes the adjusted t-statistic computed with a Bartlett kernel function and individual bandwidth parameters (Newey and West, 1994). t_p^{*C} denotes the adjusted t-statistic computed with a Quadratic Spectral kernel function and individual bandwidth parameters. Finally, t_p^{*C} denotes the adjusted t-statistic computed with a Bartlett kernel function and a common lag truncation parameter. Corresponding p-value is in parentheses. *, ** and *** indicate significance at the 10%, 5% and 1% level, respectively.

Im, Pesaran and Shin (2003): $t\_bar_{NT}^{DF}$ (respectively t_bar_{NT}) denotes the mean of Dickey Fuller (respectively Augmented Dickey Fuller) individual statistics. $Z_{t,bar}^{DF}$ is the standardized $t\_bar_{NT}^{DF}$ statistic and associated p-values are in parentheses. $Z_{t,bar}$ is the standardized t_bar_{NT} statistic based on the moments of the Dickey Fuller distribution. $W_{t,bar}$ denotes the standardized t_bar_{NT} statistic based on simulated approximated moments (Im, *et al*., 2003, table 3). The corresponding p-values are in parentheses. * indicates significance at the 5% level.

Maddala and Wu (1999): P_{MW} denotes the Fisher's test statistic defined as $P_{MW} = -2\sum \log(p_i)$; where p_i are the p-values from ADF unit root tests for each cross-section. Under H_0; P_{MW} has χ^2 distribution with 2N of freedom when T tends to infinity and N is fixed. ZMW is the standardized statistic used for large N samples: under H0; Z_{MW} has a N (0, 1) distribution when T and N tend to infinity.

Table 3. Second Generation Panel Unit Root Tests

Bai and Ng (2004)	$\hat{r}$	$Z_{\hat{e}}^{c}$	$P_{\hat{e}}^{c}$	MQ_c	MQ_f
	5	3.001*** (0.001)	36.004*** (0.007)	3	3
Moon and Perron (2004)	t_a^*	t_b^*	$\hat{\rho}_{pool}^*$	t_a^{*B}	t_b^{*B}
	-14.15*** (0.000)	-4.574*** (0.000)	0.954	-14.17*** (0.000)	-4.54*** (0.000)
Choi (2002)	P_m	Z	L^*		
	8.809*** (0.000)	-5.866*** (0.000)	-6.422*** (0.000)		
Pesaran (2007)	P^*	$CIPS$	$CIPS^*$		
	8	-2.930*** (0.010)	-2.930*** (0.010)		

Notes:

Bai and Ng (2004): $\hat{r}$ is the estimated number of common factors, based on IC criteria functions. $P_{\hat{e}}^{c}$ is a Fisher's type statistic based on p-values of the individual ADF tests. $Z_{\hat{e}}^{c}$ is a standardized Choi's type statistic for large N samples. P-values are in parentheses. The firrst estimated value $\hat{r}_1$ is derived from the filtered test MQ_f and the second one is derived from the corrected test MQ_c. *, ** and *** indicate significance at the 10%, 5% and 1% level, respectively.

Moon and Perron (2004): t_a^* and t_b^* are the unit root test statistics based on de-factored panel data (Moon and Perron, 2004). Corresponding p-values are in parentheses. $\hat{\rho}_{pool}^*$ is the corrected pooled estimates of the auto- regressive parameter. t_a^{*B} and t_b^{*B} are computed with a Bartlett kernel function in spite of a Quadratic Spectral kernel function.

Choi (2002): the P_m test is a modified Fisher's inverse chi-square test. The Z test is an inverse normal test. The L^* test is a modified Logit test. p-values are in parentheses.

Pesaran (2007): $CIPS$ is the mean of individual Cross sectionally augmented ADF statistics (CADF). $CIPS^*$ denotes the mean of truncated individual CADF statistics. Corresponding p-values are in parentheses. P^* denotes the nearest integer of the mean of the individual lag lengths in ADF tests.

After implementing the SPSM procedure, we also found South Korea is stationary with the minimum KSS value of -2.905 among the panel. Then, South Korea was removed from the panel and the Panel KSS unit root test was implemented again to the remaining set of series. After that, we found that the Panel KSS unit root test still rejected the unit root null with a value of -2.348 (p-value of 0.000), and India was found to be stationary with the minimum KSS value of -2.641 among the panel this time. Then, India was removed from the panel and the Panel KSS unit root test was implemented again to the remaining set of series. After that, we found that the Panel KSS unit root test still rejected the unit root null with a value of -2.306 (p-value of 0.010), and Indonesia was found to be stationary with the minimum KSS value of -2.594 among the panel this time. Then, Indonesia was removed from the panel and the Panel KSS unit root test was implemented again to the remaining set of series. The procedure was continued until the Panel KSS unit root test failed to reject the unit root null hypothesis at the 10% significance level, and finally we found that this procedure stopped at the sequence 7, when the REERs for 7 countries (i.e., South Korea, India, Indonesia, Turkey, China, Russia, and South Africa) were removed from the panel. To check the robustness of our test, we continued the procedure until the last sequence. We found that the Panel KSS statistic all failed to reject the unit root null hypothesis for the rest of sequences. Apparently, the SPSM procedure using the Panel KSS unit root test without a Fourier function provided evidence supporting the long-run validity of PPP for 4 out of 5 BRICS countries and 3 out of 4 MIST countries being studied. This leads us to the conclusions that PPP holds for most of the countries, with the exception of 2 countries (i.e., Mexico and Brazil) under study.

Table 4. Results of KSS test on PPP

Sequence	OU statistic	Min. KSS statistic	Series
1	**-2.409(0.000)**	**-2.905**	**South Korea**
2	**-2.348(0.000)**	**-2.641**	**India**
3	**-2.306(0.010)**	**-2.594**	**Indonesia**
4	**-2.258(0.010)**	**-2.582**	**Turkey**
5	**-2.193(0.030)**	**-2.512**	**China**
6	**-2.114(0.080)**	**-2.414**	**Russia**
7	**-2.013(0.080)**	**-2.281**	**South Africa**
8	-1.879(0.330)	-1.963	Mexico
9	-1.797(0.180)	-1.797	Brazil

Notes: OU statistic is the invariant average KSS $t_{i,NL}$ statistic (Ucar and Omay, 2009). Entry in parenthesis stands for the bootstrap p-value. The significance level is 10%. The maximum lag is set to be 8. The bootstrap replications are 5000.

Finally, to account for structural breaks, we rely upon the Panel KSS unit root test with a Fourier function as in equation (2). First, a grid-search is performed to find the best frequency, as there is no a priori knowledge concerning the shape of the breaks in the data. We estimate equation (2) for each integer $k = 1, ...,5,$ following the recommendations of Enders and Lee (2012) that a single frequency can capture a wide variety of breaks. The residual sum of squares (RSSs) indicates that a single frequency *(k=1)* works best for most of the series, with the exception of sequence 9 we found the best frequency to be *(k=3),* and for the sequences of 3 and 5, we found the best frequency to be (*k*=5) (see the fourth column at the Table 5).

Table 5 reports the results of Panel KSS unit root test with a Fourier function on the natural log of REERs where we also give a sequence of the Panel KSS statistics with their bootstrap p-values on a reducing panel, the individual minimum KSS statistic, and the stationary series identified by this procedure each time. As we can see from Table 5, the null hypothesis of unit root in REER was rejected when the Panel KSS unit root test was first applied to the whole panel, producing a value of -3.092 with a very small p-value of 0.000. After implementing the SPSM procedure, we also found Brazil is stationary with the minimum KSS value of -3.894 among the panel. Then, Brazil was removed from the panel and the Panel KSS unit root test was implemented again to the remaining set of series. After that, we found that the Panel KSS unit root test still rejected the unit root null with a value of -2.992 (p-value of 0.000), and Turkey was found to be stationary with the minimum KSS value of -3.501 among the panel this time. Then, Turkey was removed from the panel and the Panel KSS unit root test was implemented again to the remaining set of series. After that, we found that the Panel KSS unit root test still rejected the unit root null with a value of -2.919 (p-value of

0.000), and Russia was found to be stationary with the minimum KSS value of -3.493 among the panel this time. Then, Russia was removed from the panel and the Panel KSS unit root test was implemented again to the remaining set of series. The procedure was continued until the Panel KSS unit root test failed to reject the unit root null hypothesis at the 10% significance level, and finally we found that this procedure stopped at the last sequence of 9, when the REERs for all of the 9 countries (i.e., Brazil, Turkey, Russia, South Korea, Mexico, China, India, Indonesia, and South Africa) were removed from the panel. Apparently, the SPSM procedure using the Panel KSS unit root test with a Fourier function provided strong evidence favoring the long-run validity of PPP for both BRICS and MIST countries being studied.[7]

Table 5. Results of KSS with Fourier test on PPP

Sequence	OU statistic	Min. KSS	Fourier(K)	Series
1	**-3.092(0.000)**	**-3.894**	1	**Brazil**
2	**-2.992(0.000)**	**-3.501**	1	**Turkey**
3	**-2.919(0.000)**	**-3.493**	5	**Russia**
4	**-2.823(0.000)**	**-3.308**	1	**South Korea**
5	**-2.726(0.000)**	**-3.154**	5	**Mexico**
6	**-2.619(0.000)**	**-2.763**	1	**China**
7	**-2.572(0.010)**	**-2.759**	1	**India**
8	**-2.478(0.020)**	**-2.541**	1	**Indonesia**
9	**-2.414(0.050)**	**-2.414**	3	**South Africa**

Notes: OU statistic is the invariant average KSS $t_{i,NL}$ statistic (Ucar and Omay, 2009). Entry in parenthesis stands for the asymptotic p-value. The significance level is 5% or less. The maximum lag is set to be 8. The asymptotic p-values are computed by means of Bootstrap simulations using 5000 replications.

5. Conclusions

Purchasing Power Parity (PPP) Theory is one of the oldest theories that tries to establish the link between nominal exchange rate and relative prices. Old studies tried to test this theory by regressing the nominal exchange rate on relative prices. They were criticized on the ground that the results suffered from a spurious regression problem. Combining the nominal exchange rate and relative prices together yields only one variable, i.e., the real exchange rate. More recent studies, therefore, have investigated the mean reverting properties of the real exchange rates as a test of PPP. If the real exchange rate crosses its mean very frequently, it is said to be stationary, supporting the PPP. Otherwise, it may contain a unit root and reject the PPP.

Univariate unit root tests were criticized for their low powers. Panel unit root tests are proposed as an alternative. However, standard panel unit root tests yield only one answer that implicates every member of the panel equally. In this paper we apply a method that classifies the

[7] For some other exchange-related and PPP issues see Moosa (1994), Beach, *et al*. (1993), Bleaney (1992), Horne (2004), Baffoe-Bonnie (2004), Arize (2003), Holmes (2002), Apergis (1998), Jung (1995), Hojman (1989), and Sjolander (2007).

real effective exchange rates of all members within a panel to stationary and non-stationary series. The method is known as the Sequential Panel Selection Method (SPSM) proposed by Chortareas and Kapetanios (2009). We apply this procedure to test the PPP for a group of BRICS (Brazil, Russia, India, China, and South Africa) and MIST (Mexico, Indonesia, South Korea and Turkey) countries, using monthly real effective exchange rate (REER) data from January 1994 to June 2012.

While several standard panel unit root tests give us mixed results, SPSM classifies the whole panel into a group of stationary series and a group of non-stationary series and clearly identifies how many and which series in the panel are stationary processes. Empirical results form the SPSM using the Panel KSS unit root test with a Fourier function indicate that mean-reversion in REER holds true for these two groups of countries under study.

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