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Are Bilateral Real Exchange Rates Stationary? Empirical Evidence from Nigeria

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Abstract

The paper examines the validity of the PPP for Nigeria real exchange rate with its 28 trading partner countries for the period spanning between 1960-2011. Using the Ng and Perron unit root test, the Lagrange multiplier (LM) unit root test with one structural break, and the LM unit root test with two structural breaks, results show that Nigeria's exchange rate vis-a-vis 26 out of 28 countries is stationary and this support the validity of the PPP. Also, using the panel unit root test that accounts for cross-section independence, the t-bar test shows there is evidence of PPP condition, by contrast the CIPS panel unit test that accounts for cross-section dependence fail to reject the null of unit root. Using the ILT(2005), panel unit root test with structural breaks we found robust evidence supporting the PPP condition in Nigeria relative to her 28 trading partners. Thus, the purported support for the PPP hypothesis using the panel unit root without structural breaks could be spurious.

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1 Introduction

The purchasing power parity (PPP) condition has been a major topical issue over the years and a huge amount of empirical work has been done in both developed and developing countries. The major reasons for this huge concentration on this subject matter are the implications it has on trade and capital movements. Over the years, the evidence on the empirical literature has been mixed, these can be explained by the difference in the choice of methodology, use of different time frame and that structural break and regime shift were ignored.

There is plethora of empirical studies on the PPP hypothesis. For example, Grilli and Kaminsky (1991), Flynn and Boucher (1993), Doganlar et al. (2009), Oguanobi et al (2010), Aslan (2010) and Bakare and Olubokun (2011) examined the PPP condition using the univariate time series but arrived at different conclusions. For example, Grilli and Kaminsky (1991), Oguanobi et al (2010) and Bakare and Olubokun (2011) find support for PPP whereas Doganlar et al. (2009) and Flynn and Boucher (1993) did not find support for PPP. However, Frankel and Rose (1996), O'Connell, (1998), Fleissig and Strauss (2000), Taylor (2002) used the panel unit root to test for the validity of the PPP condition and their findings generally support the PPP hypothesis. Taylor et al. (2001), Kilian and Taylor (2003), Sarno et al. (2004), Bahmani-Oskooee and Gelan (2006), and Yilanci and Eris (2013) examined the PPP hypothesis using nonlinear unit root techniques and results indicates that there is evidence of nonlinear mean reversion. Mahdavi and Zhou (1994), Kargbo (2006), Liew and Tang (2010) applied symmetric cointegration tests to examine the relationship between nominal exchange rate and the domestic and foreign prices levels and found evidence of the PPP hypothesis. Enders and Dibooglu (2001), Holmes and Wang (2006) and Karoglou and Morley (2012), on the other hand, used asymmetric cointegration techniques to look into the relationship between nominal exchange rate and the domestic and foreign prices levels. They have also found evidence supportive of PPP hypothesis.

This study tests for the PPP hypothesis in Nigeria with her twenty eight major trading partner's countries. The major contribution of this paper is in six strands. First, we examine the numeraire currency in validating the PPP condition by expressing the Nigeria naira with her twenty eight trading partners countries as the base currency using annual data from 1960 to 2011. Second, we test the PPP by using the Ng and Perron unit root tests. The rationale for using this test is that the traditional ADF and PP unit root tests suffer from three problems and they are; (i) The ADF and PP unit root tests have low power when the root of the autoregressive polynomial is close to, but less than unit (DeJong et al., 1992). (ii) Most of the tests suffer from severe size distortions when the moving-average polynomial of the first differences series has a large negative autoregressive root (Schwert, 1989). (iii) implementing the unit root tests often implies the selection of an autoregressive truncation lag, k, which is strongly associated with size distortions and/or the extent of power loss (Ng and Perron, 1995). Third, we examine the possibility of structural breaks using the LM one and two structural breaks of Lee and Strazicich (2003, 2004). Fourth, the study employed the Im, Pesaran and Shin (2003) test, which tests whether or not the average augmented Dickey-Fuller (ADF) statistic is based on a heterogeneous panel of real exchange rates with respect to the 28 major trading partners countries base currency is significantly different from zero or not. Fifth, the paper examined the issue of cross-section dependence using the CIPS unit root test of Pesaran (2007). Sixth, the study examined panel unit root test that account for structural breaks. Here we employed the innovative approach of Im, Lee and Tieslau (2005).

Using the LM with structural breaks there is overwhelming evidence in support of the PPP for Nigeria's bilateral exchange rate with its major trading partner countries for 26 out of 28 countries. Also, using the panel unit root test that accounts for cross-section independence, the t-bar test shows there is evidence of PPP condition. However, using the CIPS panel unit test that accounts for cross-section dependence we fail to reject the null of unit root. However, based on the Im, Lee and Tieslau (2005) panel unit root test that account for structural breaks we found evidence in favour of the PPP hypothesis in Nigeria relative to her trading partners.

The rest of the study is structured as follows. The following section outlines the methodology. Section 3 of the study discusses the analysis and interpretation of results, and section 4 concludes.

2 Methodology

2.1 LM Structural Break Tests

The major weakness of the traditional unit root test is the failure to reject the unit root hypothesis if the series has a structural break. This implies that series that are found to be I(1) may in fact be stationary around the structural break; that is, I(0) but mistakenly classified as I(1). Perron (1989) shows that failure to allow for break leads to a bias that reduces the ability to reject a false unit root hypothesis. To overcome this problem, Perron proposed allowing for a known or exogenous structural break in the Augmented Dickey-Fuller (ADF) tests. Based on the short coming of this approach, Zivot and Andrews (1992) and Perron (1997) propose determining the break point 'endogenously'. Lumsdaine and Papell (1997) extended the Zivot and Andrews (1992) model to accommodate two structural breaks. However, Lee and Strazicich (2003) criticized the endogenous break point tests for their treatment of breaks under the null hypothesis. Lee and Strazicich (2003) propose a two break minimum Lagrange Multiplier (LM) unit root test for structural breaks both under the null and the alternative hypothesis that do not suffer from the spurious rejection of the null hypothesis and their procedure corresponds to Perron's (1989) exogenous structural break (Model C and CC) with change in the level and the trend.

To avoid problems of bias and spurious rejections, the study utilizes the endogenous one and two breaks LM unit root test derived in Lee and Strazicich (2003).

The LM unit root test can be explained using the following data generating process:

$$RER_t = \delta' Z_t + X_{t,} \quad X_t = \beta X_{t-1} + \varepsilon_t \tag{1}$$

RER is the bilateral real exchange rate, Z_t consists of exogenous variables and ε_t is an error term that follows the classical properties. In the case of the Model C, one break unit root test, $Z_t = (1, t, D_{1t}, DT_{1t})$ and in the case of the Model CC, two-break unit root test, $Z_t = (1, t, D_{1t}, D_{2t}, DT_{1t}, DT_{2t})$ where $D_{jt} = 1$ for $t \geq T_{BJ} + 1, \ j = 1, 2, and$ 0 otherwise, and T_{BJ} represents the break date. Lee and Strazicich (2003, 2004) use the following regression to obtain the LM unit root test statistic:

$$\Delta RER_t = \delta^{'} \Delta Z_t + \phi \tilde{S}_{t-1} + \mu_t \tag{2}$$

where $\tilde{S}_t = y_t - \hat{\psi}_x - Z_t \hat{\delta}_t, \ t = 2, ..., T$; $\hat{\delta}$ are coefficients in the regression of ΔRER_t on ΔZ_t; $\hat{\psi}_x$is given by $RER_t - Z_t \delta$; and RER_1 and Z_1 represent the first observations of RER_t and Z_t respectively. The LM test statistic is given by: $\bar{\tau} = t-$statistic for testing the unit root null hypothesis that $\phi = 0$. The location of the structural break (T_B) is determined by selecting all possible break points for the minimum $t-$statistic as follows:

$$Inf \tilde{\tau}(\bar{\lambda}_i) = \ln_\lambda f \tilde{\tau}(\lambda) \qquad where \ \lambda = \frac{T_B}{T}$$

The search is carried out over the trimming region (0.15T, 0.85T), where T is the sample size. Critical values for the one-break case are tabulated in Lee and Strazicich (2004), while critical values for the two break case are tabulated in Lee and Strazicich (2003). The asymptotic distribution of this test is unaffected by the presence of structural breaks and is standard normal.

2.2 IPS and CIPS Panel Unit Root Tests

Panel unit root tests have been used in the empirical literature mainly to test the validity of the purchasing power parity (PPP) hypothesis. This is important because of the lack of power of unit root tests applied to individual series. Reliance on long time series covering five decades or more years of data in order to enhance the power of single-series unit root tests have also been faced with changes in exchange rate regimes and the incidence of structural breaks. Thus, the need for panel unit root application. The IPS test for a case III that includes cross-sectional intercept and trend which is based on individual ADF regression is given as;

$$\Delta y_{it} = a_i + b_i y_{i,t-1} + \sum_{r=1}^{p_i} d_{ir} \Delta y_{i,t-r} + \varepsilon_{it} \quad (3)$$

where $i = 1, ..., N$ cross section units, and $t = 1, ..., T$ time observations.The null hypothesis to test the presence of a unit root $H_0 : c_i = 0$ for all i, against the alternative that at least one of the individual series in the panel is stationary, that is $H_1 :< 0$ for at least one i . The IPS test averages the ADF statistics obtained in equation (4) across the N cross-sectional units of the panel and is given as;

$$IPS = (N)^{-1} \sum_{I=1}^{N} ADF_i \quad (4)$$

where ADF_i is the augmented Dickey and Fuller statistic based on the regression t statistic for $H_0 : c_i = 0$ in equation 3.

The IPS test is based on the assumption of cross sectional independence across the individual time series in the panel, as the test suffers from size distortions in the presence of cross section dependence. In order to solve this, Pesaran (2007) adjust equation (4) with the cross section averages of lagged level and lagged first-differences of the individual series in the panel. Thus, the test is based on the following p^{th} order cross-sectionally augmented Dickey and Fuller regressions:

$$\Delta y_{it} = a_i + b_i y_{i,t-1} + \sum_{r=1}^{p} d_{ir} \Delta y_{i,t-r} + f_i \bar{y}_{t-1} + \sum_{r=0}^{p} g_{ir} \Delta \bar{y}_{t-r} + \varepsilon_{it} \quad (5)$$

where $\bar{y}_t$ is the cross section mean of y_{it}, defined as $\bar{y}_t = (N)^{-1} \Sigma_{i=1}^{N} y_{it}$. The cross sectionally augmented version of the IPS test statistic (CIPS) is then given as:

$$CIPS = (N)^{-1} \sum_{I=1}^{N} CADF_i \tag{6}$$

where $CADF_i$ is the cross-sectionally augmented Dickey and Fuller t statistic for testing $H_0 : c_i = 0$ in equation 3.

2.3 ILT Panel Unit Root Test with Structural Breaks

Consider a model which tests for stationarity of real exchange rate:

$$RER_{it} = \delta' X_{it} + \mu_{it} \qquad \mu_{it} = k_i \mu_{i,t-1} + \varepsilon_{it} \tag{7}$$

where i represents the cross-section of countries $(i = 1, \ldots, N)$, t represents the time period $(t = 1, \ldots., T)$, μ_{it} the error term and X_{it} is a vector of exogenous variables. The test for the unit root null is based on the parameter k_i, while ε_{it} is a zero mean error term that allows for heterogeneous variance structure across cross-sectional units but assumes no crosscorrelations. The parameter k_i allows for heterogeneous measures of persistence. A structural break is incorporated in the model by specifying X_{it} as $[1, t, D_{it}, DT_{it}]'$ where D_{it} is a dummy variable that denotes a mean shift and DT_{it} denotes a trend shift. If a structural break for country i occurs at TB_i, then the dummy variable $D_{it} = 1$ if $t > TB_i$, zero otherwise and TB represents the break dates

Following Im *et al* (2005), the panel LM test statistic is obtained by averaging the optimal univariate LM unit root t-test statistic estimated for each country. This is denoted as i LM$_i^\tau$:

$$LM_{barNT} = \frac{1}{N} \sum_{I=1}^{N} LM_i^\tau \tag{8}$$

Im et al. (2005) then construct a standardized panel LM unit root test statistic by letting $E(L_T)$ and $V(L_T)$ denote the expected value and variance of LM_i^τ, respectively under the null hypothesis. Im et al. (2005) then compute the following expression:

$$\psi LM = \frac{\sqrt{N}[LM_{barNT} - E(L_T)]}{\sqrt{V(L_T)}} \tag{9}$$

The numerical values for $E(L_T)$ and $V(L_T)$ are provided by Im et al (2005). The asymptotic distribution of this test is unaffected by the presence of a structural break and is standard normal.

3 Data and Results

3.1 Data

The data set is annually covering the period from 1960 to 2011 for Nigeria's real exchange rate for 28 trading partners countries. The countries includes Australia, Canada, Columbia, Cote D'Ivoire, France, Iceland, India, Israel, Italy, Japan, Kenya, Malaysia, Mexico, Morocco, Netherlands, New Zealand, Norway, Pakistan, Peru, South Africa, Spain, Switzerland, Syria, Thailand, Turkey, the United Kingdom, Uruguay and the USA. The bilateral real exchange rate is constructed from the bilateral nominal exchange rate using the consumer price indices. Since most countries exchange rates are expressed in dollars, we convert the Nigeria bilateral exchange rates in relation to other countries as Nigeria exchange rates in dollars multiplied by other countries exchange rates expressed in dollars. The data are sourced from the World Bank Development Indicators.

3.2 Results

The study begins the analysis, by testing for the order of integration of the bilateral real exchange rates. The modified version of the Dickey-Fuller and Phillips-Perron tests proposed by Ng and Perron (2001) were used to circumvent the problems of the conventional unit root tests. DeJong et al (1992), Schwert (1989) and Ng and Perron (1995) argues that most traditional unit root tests suffer from three problems. First, they have low power when the root of the autoregressive polynomial is close to, but less than unit (DeJong et al., 1992). Second, most of the tests suffer from severe size distortions when the moving-average polynomial of the first differences series has a large negative autoregressive root (Schwert, 1989). Third, implementing the unit root tests often implies the selection of an autoregressive truncation lag, k, which is strongly associated with size distortions and/or the extent of power loss (Ng and Perron, 1995).

Trying to circumvent these problems, Ng and Perron (2001) proposed a methodology which is robust against the three problems noted above. This consists of a class of modified tests, M_{α}^{GLS} and MZ_{t}^{GLS} using the modified Akaike information criterion.

Table 1 shows the results of the two tests, M_{α}^{GLS} and MZ_{t}^{GLS} for the bilateral exchange rates. As shown in the table, the null hypothesis of non stationarity for the bilateral exchange rates in levels cannot be rejected in nineteen out of the twenty-eight countries examined. This implies that the PPP condition only holds in nine countries under investigation were the series were stationary at level and the countries are; Cote D'Ivoire, Iceland, India, Japan, Mexico, Morocco, Norway, Switzerland and Uruguay.

Next, the study considered the possibility of a structural break using the LM test one and two structural breaks and this is reported in Table 2. In addition to the four countries where the Ng and Perron test indicates evidence of PPP, the LM test with one structural break is able to reject the unit root null hypothesis for six additional countries. The countries are; France, Israel, Italy, Malaysia, Spain and the USA. However, we are unable to reject the null when Nigeria's exchange rate is specified relative to Australia, Canada, Columbia, Kenya, Netherlands, New Zealand, Pakistan, Peru, South Africa, Syria, Thailand, Turkey and the United Kingdom, indicating presence of unit root.

Using the LM unit root test with two structural breaks, we reject the null of non-stationarity for 25 countries. The countries are Australia, Canada, Cote D'Ivoire, France, Iceland, India, Israel, Italy, Japan, Kenya, Mexico, Morocco, Netherlands, New Zealand, Norway, Peru, South Africa, Syria, Thailand, Turkey, United Kingdom, Uruguay and the US. However, we are unable to reject the unit root null hypothesis for Nigeria's exchange rate relative to Columbia, Malaysia[1] and Pakistan using the LM two structural breaks. In sum, the univariate tests for the bilateral real exchange rate indicate that there is evidence for PPP with respect to Nigeria's exchange rate with 26 of her trading partners.

The structural break dates were shown to have taken place mostly between the late seventies and nineties and this period is identified by various external shocks, as well as changes in the institutional framework. Other reasons might be traced to the volatility of oil prices, deregulation of the financial sector, exchange rate regime changes, global recession and devaluation of the currency all of which may cause non-stationarity of economic variables.

This study also used panel unit root test to examine the PPP hypothesis. the rationale for using this approach is based on the relative lack of power of the unit root tests to individual series and also because of the presence of structural breaks. Also, O'Connel (1998) pointed out that panel unit root tests can lead to spurious results if there is significant degrees of positive error cross-section dependence. To account

[1] It should be noted that Malaysia does not reject the null using the LM two structural breaks, but it will still be totalled because it rejected the null under the LM one structural break.

for this, we computed the cross section correlation coefficients and the cross-section dependence (CD) test statistics of Pesaran (2004). Table 3 shows that the average cross-section error correlation coefficient is sufficiently high at around 77 per cent and the CD statistics are statisitically significant at 1 per cent level.

Next, we examined the IPS unit root test that does not allow for cross-section dependence and the CIPS test that allows for cross-section dependence and this is reported in Panel A of Table 4. The IPS shows that the null is rejected for all values of p. This implies that the PPP hypothesis holds in Nigeria for all her 28 trading partners. However, due to the large correlation coefficient and the CD statistics in real exchange rates reported in Table 3, the conclusion might be unsafe, thus we consider the CIPS test that allows for cross-section dependence. The CIPS test could not reject the null at any value of p. Thus, we conclude that the purported support for the PPP hypothesis using the IPS test could be spurious. This result is consistent with Harris *et al.* (2004) and Choi and Chue (2007).

A major limitation observed from the CIPS test is that it does not account for structural breaks and as such the results obtained might be spurious. Based on this, the study employed the Im, Lee and Tieslau (2005) panel unit root test that account for structural breaks and this is reported in Panel B of Table 4. Result shows that the PPP holds in Nigeria for all her 28 trading partners at 1 per cent level of significance.

4 Conclusions

This paper examines the validity of PPP in Nigeria relative to her 28 trading partners. In this paper we contributed to the literature based on six strands. First, the validity of the PPP tests for Nigeria with its major trading partners. Second, we examine the PPP hypothesis using the Ng and Perron unit root tests that circumvent the problems of the traditional unit roots. Third, we test for the bilateral real exchange rates using the Lagrange multiplier unit root test that allows for two structural breaks. Fourth, we examine the PPP hypothesis using panel unit root test that allows for cross-section independence and dependence. Lastly, we examine the PPP condition using panel unit root test that allow for structural breaks. The Ng-Perron unit root test rejects the null of unit root in Cote D'Ivoire, Iceland, India, Japan, Mexico, Morocco, Norway, Switzerland and Uruguay, implying that PPP holds. When we apply the LM unit root with one structural break we obtained evidence for the validity of the PPP in ten countries. Applying the LM unit root test with two structural breaks, we were able to reject the we reject the null of nonstationarity for 25 countries. In sum, the results show evidence of the PPP hypothesis in 26 countries out of 28 countries. The panel unit root test that does not allow for cross-section dependence shows that the PPP hypothesis holds, but due to the high significant level of the CD statistics, the CIPS unit root which accounts for cross-section dependence could not reject the null of unit root. However, using the ILT panel unit root test that account for structural breaks, we found overwhelming evidence in support of the PPP. Thus, we conclude that using a panel unit root that does not account for structural breaks could lead to spurious results. A major policy implication of these findings is that for Nigerian policy makers to stabilize domestic prices, reduce the high inflation rates and increase export competitiveness among her trading partner countries, efforts must be made to implement the appropriate exchange rate policies because the PPP condition provides a bench mark for monitoring exchange rate movements.

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Table 1: Ng-Perron test of unit roots

Countries	MZ_α	MZ_t
Australia	-8.539	-2.047
Canada	-13.618	-2.603
Columbia	-7.616	-1.914
Cote D'Ivoire	-21.133**	-3.250**
France	-7.684	-1.946
Iceland	-17.806**	-2.980**
India	-15.370*	-2.750*
Israel	-12.186	-2.463
Italy	-5.931	-1.689
Japan	-20.956**	-3.230**
Kenya	-6.606	-1.786
Malaysia	-10.328	-2.196
Mexico	-15.274*	-2.763*
Morocco	-16.502*	-2.871*
Netherlands	-9.502	-2.178
New Zealand	-7.628	-1.945
Norway	-17.684**	-2.973**
Pakistan	-7.987	-1.980
Peru	-5.478	-1.655
South Africa	-9.535	-2.178
Spain	-6.666	-1.800
Switzerland	-19.585**	-3.129**
Syria	-8.160	-2.019
Thailand	-9.401	-2.163
Turkey	-13.012	-2.535
United Kingdom	-12.449	-2.494
Uruguay	-19.909**	-3.150**
USA	-13.524	-2.600

Note: The autoregressive truncation lag, k, has been selected using the modified Akaike information criterion, as proposed by Perron and Ng (1996). The critical values are taken from Ng and Perron (2001), Table 1.

*,** and *** indicate level of significance at 10, 5 and 1 per cent respectively.

Table 2: Structural breaks in Nigeria bilateral real exchange rates

Countries	LM Test with 1 break			LM Test with 2 breaks				*Conclusion*
	TB	$LM-Stat$	k	$TB1$	$TB2$	$LM-Stat$	k	TS/DS
Australia	1998	-3.563	5	1984	1998	-6.327**	5	TS
Canada	1985	-3.800	2	1984	1998	-6.472**	5	TS
Columbia	1985	-4.130	2	1984	1993	-5.163	8	DS
Cote D'Ivoire	1999	-3.777	1	1984	1994	-7.409***	6	TS
France	1984	-4.406*	7	1985	1997	-7.048***	8	TS
Iceland	1985	-4.977**	8	1984	1998	-6.146**	5	TS
India	1976	-4.172*	7	1984	1998	-5.546*	5	TS
Israel	1985	-4.179*	2	1984	1993	-6.368**	5	TS
Italy	1997	-7.363***	8	1985	1997	-10.609***	8	TS
Japan	1985	-3.816	1	1984	1994	-6.652***	6	TS
Kenya	1985	-3.695	5	1984	1998	-6.384**	5	TS
Malaysia	1983	-4.171*	1	1983	1997	-5.003	5	TS
Mexico	1985	-5.021**	7	1978	1985	-5.405*	7	TS
Morocco	1981	-3.695	1	1984	1998	-5.681*	5	TS
Netherlands	1982	-3.681	1	1984	1998	-5.829**	5	TS
New Zealand	1981	-3.224	1	1984	1994	-6.699***	6	TS
Norway	1998	-3.648	5	1984	1998	-6.705***	5	TS
Pakistan	1977	-3.575	1	1984	1998	-4.754	5	DS
Peru	1985	-3.576	2	1980	1987	-5.447*	5	TS
South Africa	1986	-3.589	1	1984	1994	-6.350**	6	TS
Spain	1997	-5.984***	8	1985	1997	-9.749***	8	TS
Switzerland	1986	-3.588	1	1984	1994	-6.642***	6	TS
Syria	1985	-4.148	2	1984	1994	-5.872**	6	TS
Thailand	1981	-3.337	1	1984	1994	-5.416*	4	TS
Turkey	1981	-3.758	3	1984	1998	-5.697*	5	TS
United Kingdom	1986	-4.086	3	1979	1990	-6.019**	3	TS
Uruguay	1986	-4.361*	1	1973	1986	-5.771**	2	TS
USA	1985	-4.197*	2	1984	1998	-5.667*	5	TS

Note:K is the optimal number of lagged first-differenced terms included in the unit root test to correct for serial correlation.
***, ** and * denote significance at the 1, 5 and 10 per cent levels, respectively.
DS = difference-stationary, TS = trend-stationary.
TB1, TB2 denote the first and second structural breaks, respectively.
Source: Author's calculations.

Table 3: Average correlation coefficients and cross sectional dependence test

Variable	$CD\ Test$	$P-value$	$Correlation$
RER	108.03	0.000	0.77

Note: CD is the cross sectional dependence test and it based on the null hypothesis of cross-section independence

Table 4: Panel Unit Root Tests

Panel A

$Test$	$p = 1$	$p = 2$	$p = 3$
IPS	-3.785***	-3.001***	-3.010**
CIPS	-2.114	-1.869	-1.978

Panel B

ILT	-50.153***

Note: Panel A: All statistics are based on univariate AR(p) specifications in the level of the variables with p less than or equal to 3 including an intercept and trend term. The respective 1, 5 and10 per cent critical values are -2.44, -2.36 and -2.32 for IPS and -2.63, -2.56 and -2.49 for CIPS.

Panel B: ILT stands for Im,Lee, and Tieslau (2005). The critical values are -5.365, -4.661 and -4.336 for 1, 5 and 10 per cent respectively.

***, ** and * denotes rejection of the non-stationary null at the 1, 5 and10 per cent significance level respectively.