



## IS THE EXCHANGE RATE OF BANGLADESH MEAN REVERTING? A PANEL UNIT ROOT APPROACH



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### ABSTRACT

*This paper evaluates whether the exchange rate of Bangladesh is mean reverting or not by applying first-generation and second-generation panel unit root test approaches. The paper considers annual data from 1986 to 2011 of major twenty-two trading partners of Bangladesh. Although some inconclusive outcomes emerge from the first-generation tests, the second-generation test reconciles the controversy and confirms that the weak form of PPP is relevant for Bangladesh. Consequently, the bilateral exchange rate of Bangladesh is mean reverting and the PPP hypothesis can be considered as an exchange rate determinant in the long-run.*

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### Contribution/ Originality

This study uses newly developed panel data approaches in the framework of purchasing power parity (PPP) in the context of Bangladesh. Unlike prior studies on the PPP theory of Bangladesh, this paper incorporates a number of panel unit root tests to obtain unambiguous outcome.

### 1. INTRODUCTION

The Purchasing Power Parity (PPP) hypothesis postulates that in the long-run exchange rate between two currencies is equal to the ratio of corresponding national price indices, i.e., the movements in the nominal exchange rate should be proportional to the ratio of national price indices. The theory has a long historical background of several centuries, for instance, Wheatley (1807) and Ricardo (1821). Afterward of the First World War, the theory has emerged in a specific form in Cassel (1918;1922;1928) for determining the nominal exchange rates among the developed economies in the presence of large-scale inflations. Moreover, the post-Bretton woods, period, analysis of the PPP gets more concentration. At that time a large number of studies have been done to investigate whether the PPP truly holds or not in the real world, for instance, Dornbusch (1976); Dornbusch and Krugman (1976); Frenkel (1976) and Frenkel (1981); Frenkel and Johnson (1976) and Roll (1979). The studies on PPP conducted in the 1970s have found little evidence for purchasing power parity in the long-run. However, from the 1980s, the unit root approach has been inaugurated in testing the theory. Seemingly, due to the low power of the test, the econometricians failed to reject the null hypothesis of a unit root for major industrialized economies or did not provide strong

empirical support for the theory, for instance, Adler and Lehmann (1983); Taylor (1988) and Mark (1990). From the beginning of the 1990s, panel unit root approaches have been applied to test stationarity of the real exchange rate. However, a large number of studies provide empirical evidence for the strict form of the PPP theory by incorporating the panel unit root test, such as Wu (1996); Frankel and Rose (1996); Papell (1997); Meier (1997); Kalyoncu and Kalyoncu (2008). However, the results vary with sample periods, perfection of money market, integration of economies and underlying assumptions of the panel unit root test.

Although PPP theory is frequently reevaluating all over the world using panel unit root approaches from 1990s, there is no seminal study on the theory of PPP incorporating such techniques in the context of Bangladesh.<sup>1</sup> To cover the literature gap, this paper attempts to reexamine the PPP theory in the perspective of Bangladesh using panel unit root approaches. Here both first-generation and second-generation tests are incorporated to obtain an impartial result. To conduct the study, major twenty-two trading partners of Bangladesh are considered.

In the next section, theoretical framework of the PPP theory is developed. The subsequent section presents data sources and methodology. The empirical results are presented in the fourth section and finally the fifth section covers the concluding remarks.

## 2. THEORETICAL FRAMEWORK

The bilateral real exchange rate of Bangladesh ( $RER$ ) with respect to its trading partner  $i$  is constructed using the following formula:

$$RER_{i,t} = NER_{i,t} (P_{i,t}^* / P_t) \quad (2.1)$$

Where,  $RER_{i,t}$  is the real exchange rate,  $NER_{i,t}$  is the nominal exchange rate,  $P_t$  is consumer price index (CPI) for Bangladesh and  $P_{i,t}^*$  is CPI for trading partner  $i$ . Taking the natural log in both sides, we have,

$$rer_{i,t} = ner_{i,t} + p_{i,t}^* - p_t \quad (2.2)$$

The PPP would hold if the series of  $rer_{i,t}$  is stationary at level. If the unit root exists, the real exchange rate would not be mean reverting and the weak form of PPP hypothesis would not hold. More specifically, the mean reverting real exchange rate model can be developed as

$$rer_{i,t} = \alpha + \beta rer_{i,t-1} + \varepsilon_t \quad (2.3)$$

Where  $\varepsilon_t$  is a mean zero covariance stationary process and  $\alpha$  specifies possible deterministic factors e.g., as a constant or trend. If the estimated value of  $\beta$  is not statistically significant, the weak form of PPP would not hold.

## 3. DATA SOURCE AND METHODOLOGY

### 3.1. Data Source

In this paper, the major twenty-two trading partners of Bangladesh are considered, more specifically, Australia, Belgium, Brazil, Canada, China, Denmark, France, Germany, Hong Kong, India, Ireland, Italy, Japan, Malaysia, Netherlands, Pakistan, Poland, Singapore, Sweden, Turkey, United Kingdom, and the United States. The nominal exchange rate of Bangladesh, nominal exchange rates of the twenty-two trading partners against the US dollar and consumer price indices of all economies were obtained from World Development Indicators (WDI) published by the World Bank over the sample period 1986 to 2011. International Financial Statistics (IFS) CD-ROM published by the

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<sup>1</sup> A large number of studies have already done in the context of Bangladesh following time series properties, for instance, Ahmed (2005); Shams and Murad (2010). By using cointegration approach, these studies fail to provide any evidence for the PPP theory of Bangladesh. Furthermore, a few papers provide some empirical support for the theory in the perspective of Bangladesh e.g., Chowdhury (2007). By introducing nonlinear econometric approach and covering four trading partners during the time span 1994-2002, the paper shows strong evidence for the long run PPP of Bangladesh. However, the time duration, considered in [ibid.](#) is not sufficient to examine the validity of the PPP theory of an economy.

IMF was also used in some cases where data was not available in the WDI. The cross exchange rate formula was incorporated to obtain the bilateral exchange rate between Bangladesh and its trading partners.

### 3.2. Methodology

The unit root approach in panel data is an extension of the univariate unit root tests of time series analysis. Since univariate unit root tests have low power in rejecting the null hypothesis of a unit root, applied researchers, nowadays, are inclined to panel unit root approaches. In this paper, the Levin *et al.* (2002) (hereafter write LLC) test, the Im *et al.* (2003) (hereafter write IPS) test, the Breitung (2000) test, the Hadri (2000) (hereafter write H-LM) test and the Pesaran (2007) (cross-sectionally augmented IPS, hereafter write CIPS) test are incorporated. To begin with, let us assume the following simple panel data model for real exchange rate ( $rer_{i,t}$ ) with a standard autoregressive (AR(1)) component:

$$rer_{i,t} = \phi_i rer_{i,t-1} + \alpha_i d_{i,t} + \varepsilon_{i,t} \quad (3.1)$$

where,  $i = 1, 2, \dots, N$  is the cross-section dimension;  $t = 1, 2, \dots, T$  is the time dimension;  $\varepsilon_{i,t}$  is a stationary error term the  $d_{i,t}$  term may contain vector of panel-specific means, panel-specific means and a time trend, or nothing, depending on the options specified in the panel unit root tests and  $\alpha_i$  indicates corresponding vector of coefficients of  $d_{i,t}$ . Equation (3.1) can be expressed as

$$\Delta rer_{i,t} = \rho_i rer_{i,t-1} + \alpha_i d_{i,t} + \varepsilon_{i,t} \quad (3.2)$$

Therefore, the null hypothesis is  $H_0: \rho_i = 0 \forall i$  for all  $i$  and the alternative hypothesis  $H_a: \rho_i < 0 \forall i$ . However, Hadri (2000) H-LM test instead assumes the null hypothesis that all panels are stationary while the alternative is that at least some of the panels suffer from unit root problems. Among the five panel unit root tests, Breitung test, H-LM test and LLC test use common unit root approach, IPS test and CIPS test use individual unit root approach.

#### 3.2.1. The LLC Test

Since the individual unit root test has limited power against the alternative hypothesis with highly persistent deviation from equilibrium, LLC incorporates common unit root process. The null and alternative hypotheses of the test are respectively  $H_0: \rho_i = 0 \forall i$  and  $H_a: \rho_i = \rho < 0 \forall i$ .

The LLC test proceeds in three main steps:

First, augmented Dickey-Fuller (ADF) test is occupied for each cross-section by extending the model (3.1) and (3.2) with additional lags of the dependent variable:

$$\Delta rer_{i,t} = \rho_i rer_{i,t-1} + \alpha_i d_{i,t} + \sum_{j=1}^p \theta_{i,j} \Delta rer_{i,t-j} + \varepsilon_{i,t} \quad (3.3)$$

In the second step, two auxiliary regressions are estimated:

- $\Delta rer_{i,t}$  on  $\Delta rer_{i,t-j}$  (for  $j = 1, \dots, p_i$ ) and  $d_{i,t}$  to obtain the residuals  $\hat{\varepsilon}_{i,t}$  and
- $rer_{i,t-1}$  on  $\Delta rer_{i,t-j}$  and  $d_{i,t}$  to find out the residuals  $\hat{v}_{i,t-1}$ .

To control the panel-level heterogeneity across  $i$ , measure

$$\tilde{\varepsilon}_{i,t} = \hat{\varepsilon}_{i,t} / \hat{\sigma}_{\varepsilon_i} \quad (3.4)$$

$$\tilde{v}_{i,t-1} = \hat{v}_{i,t-1} / \hat{\sigma}_{\varepsilon_i} \quad (3.5)$$

Where  $\hat{\sigma}_{\varepsilon_i}$  denotes estimated standard error from each ADF regression for  $i = 1, \dots, N$ .

In the third step, the pooled OLS regression is run:

$$\tilde{\varepsilon}_{i,t} = \rho \tilde{v}_{i,t-1} + \tilde{\varepsilon}_{i,t} \quad (3.6)$$

The standard  $t$ -statistic for  $\rho$  is measured as

$$t_\rho = \hat{\rho} / se_{(\hat{\rho})} \tag{3.7}$$

in addition, the adjusted test statistic is computed as

$$t_\rho^* = \frac{t_\rho - N\bar{T}\hat{S}_N se_{(\hat{\rho})} \mu_{\bar{T}}^*}{\sigma_{\bar{T}}^*} \Rightarrow N(0,1) \tag{3.8}$$

where  $\mu_{\bar{T}}^*$  and  $\sigma_{\bar{T}}^*$  are adjustment terms of the mean and standard deviation,  $\bar{T} = T - \bar{p} - 1$  with  $\bar{p} = \sum_{i=1}^N \frac{p_i}{N}$ , and  $\hat{S}_N = N^{-1} \sum_{i=1}^N \hat{\delta}_i$  with  $\hat{\delta}_i = \hat{\sigma}_{rer_i} / \hat{\sigma}_{\varepsilon_i}$ .

### 3.2.2. The IPS Test

The LLC test is more restrictive in the sense that it requires that  $\rho$  to be homogeneous across  $i$ , which may not conform economic principle (Banerjee *et al.*, 2005). Im *et al.* (2003) realize such drawback found in the LLC test and allow heterogeneous autoregressive parameter  $\rho$  in a panel. Such case frequently appears in empirical studies. The econometric framework of the IPS test can be started from the following ADF regression for each cross section:

$$\Delta rer_{i,t} = \rho_i rer_{i,t-1} + \alpha_i d_{i,t} + \sum_{j=1}^{p_i} \theta_{i,j} \Delta rer_{i,t-j} + \varepsilon_{i,t} \tag{3.9}$$

The null hypothesis  $H_0: \rho_i = 0 \forall i$  for all  $i$  and the alternative hypothesis permits some panels to have unit roots, i.e.,

$$H_a \begin{cases} \rho_i < 0, & i = 1, 2, \dots, N_1 \\ \rho_i = 0, & i = N_1 + 2, \dots, N \end{cases} \tag{3.10}$$

The group-mean  $t$ -bar statistic can be constructed as the average of the individual augmented Dickey-Fuller statistics as follows:

$$\varphi_{\bar{t}} = N^{-1} \sum_{i=1}^N t_i T_i(p_i) \tag{3.11}$$

Where  $t_i T_i$  is the individual  $t$ -statistic for testing  $H_0: \rho_i = 0 \forall i$ ,  $\varphi_{\bar{t}}$  after adjustment for mean and variance for all  $i$  in (3.10) and  $p_i$  denote lag lengths.

In the general case where  $p_i \neq 0$  for some cross-sections, Im *et al.* (2003) show that a standardized  $\varphi_{\bar{t}}$  has an asymptotic standard normal distribution:

$$W_{\varphi_{\bar{t}}} = \frac{\sqrt{N}(\varphi_{\bar{t}} - N^{-1} \sum_{i=1}^N E(\varphi_{\bar{t}}(p_i)))}{\sqrt{N^{-1} \sum_{i=1}^N Var(\varphi_{\bar{t}}(p_i))}} \Rightarrow N(0,1) \tag{3.12}$$

Where mean and variance of the ADF regression  $t$ -statistics,  $E(\varphi_{\bar{t}}(p_i))$  and  $Var(\varphi_{\bar{t}}(p_i))$ , are provided by Im *et al.* (2003) for various values of  $T$  and  $p$ .  $W_{\varphi_{\bar{t}}}(p)$  has standard normal limiting distribution as  $T \rightarrow \infty$  followed by  $N \rightarrow \infty$  while very negative values generate doubt on  $H_0$ .

### 3.2.3. The Breitung (2000) Test

There are several shortcomings found in the LLC and IPS tests. These tests require  $N$  should be small enough relative to  $T$ . Im *et al.* (2003) found that both LLC and IPS have size distortions when  $N$  becomes larger relative to  $T$ . It was also found that both tests suffer from a dramatic loss of power if individual-specific trends are included (Baltagi, 2005). However, Breitung develops an approach that does not occupy a bias adjustment and since Breitung incorporates Monte Carlo experiments, the power of the test is significantly higher than the power of the LLC and the IPS tests. Furthermore, the Breitung test ensures good power even at lower  $N$  and  $T$ .

The Breitung test statistics can be obtained from the following steps:

When the number of lags is specified and the trends are not included, the regressions of  $\Delta rer_{i,t}$  and  $rer_{i,t}^\dagger$  on  $\Delta rer_{i,t-1}, \dots, \Delta rer_{i,t-p}$  are run, where  $rer_{i,t}^\dagger = rer_{i,t-1} - rer_{i,p+1}$ . Here standard deviation would be

$$\sigma_i^2 = \frac{1}{T-p-2} \sum_{t=p+2}^T (\Delta rer_{i,t})^2 \tag{3.13}$$

$$\lambda = \frac{\sum_{i=1}^N \sum_{t=p+2}^T reri_{i,t}^\dagger \Delta reri_{i,t}}{\sqrt{\sum_{i=1}^N \sum_{t=p+2}^T (reri_{i,t}^\dagger)^2 / \sigma_i^2}} \quad (3.14)$$

$\lambda$  is asymptotically distributed  $N(0,1)$  as  $T \rightarrow \infty$  followed by  $N \rightarrow \infty$ .

In case of with trend option and when the number of lags is specified, then

$$\lambda = \frac{\sum_{i=1}^N \sum_{s=1}^{T-p-1} \omega_{i,s}^\dagger \Delta \omega_{i,s}}{\sqrt{\sum_{i=1}^N \sum_{s=1}^{T-p-1} (\omega_{i,s}^\dagger)^2 / \sigma_i^2}} \quad (3.15)$$

where 
$$\Delta \omega_{i,s} = \sqrt{\frac{T-p-s-1}{T-p-s}} \left( \Delta \epsilon_{i,s} - \frac{1}{T-p-s-1} \sum_{j=s+1}^{T-p-1} \Delta \epsilon_{ij} \right)$$

$$\omega_{i,s}^\dagger = \epsilon_{i,s}^\dagger - \epsilon_{i,1}^\dagger - (T-p-1) \bar{\Delta} \epsilon_i$$

$$\Delta \epsilon_{i,s} = \Delta reri_{i,s} - \sum_{j=1}^p \hat{\beta}_{i,j} \Delta reri_{i,s-j}$$

and 
$$\epsilon_{i,s}^\dagger = reri_{i,s-1} - \sum_{j=1}^p \hat{\beta}_{i,j} reri_{i,s-j-1}$$

$\lambda$  is asymptotically distributed  $N(0,1)$  as  $T \rightarrow \infty$  followed by  $N \rightarrow \infty$  and very negative values of  $\lambda$  generate doubt on  $H_0$ .

### 3.2.4. Hadri (2000) Test

The H-LM test is a residual-based Lagrange multiplier (LM) test, which converts the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test from time series data to panel data.

To find out the approach of the H-LM test considers the following regression model:

With trend: 
$$reri_{i,t} = \alpha_i + \eta_i t + \vartheta_{i,t} \quad (3.16a)$$

Without trend: 
$$reri_{i,t} = \alpha_i + \vartheta_{i,t} \quad (3.16b)$$

Since  $\hat{\vartheta}_{i,t}$  are the estimated residuals obtained from (3.16a) and (3.16b), then

$$\widehat{LM} = \frac{N^{-1} \sum_{i=1}^N T^{-2} \sum_{t=1}^T S_{i,t}^2}{\hat{\sigma}_\vartheta^2} \quad (3.17)$$

where 
$$S_{i,t} = \sum_{j=1}^t \hat{\vartheta}_{i,j}$$

$$\hat{\sigma}_\vartheta^2 = \frac{1}{NT} \sum_{i=1}^N \sum_{t=1}^T \hat{\vartheta}_{i,t}^2$$

and  $\hat{T} = T - 2$  when the trend is specified and  $\hat{T} = T - 1$  otherwise. Subsequently,

$$Z = \frac{\sqrt{\hat{T}(\widehat{LM} - \psi)}}{\gamma} \Rightarrow N(0,1) \quad (3.18)$$

where  $\psi = 1/15$  and  $\gamma = 11/6300$  if the model incorporates trend and  $\psi = 1/6$  and  $\gamma = 1/45$  otherwise.  $Z$  is asymptotically distributed  $N(0,1)$  as  $T \rightarrow \infty$  followed by  $N \rightarrow \infty$  and very positive values of  $Z$  generate doubt on  $H_0$ .

To get a variant of the test that is robust to the heteroscedasticity and serial correlation across panels, in (3.17)  $\hat{\sigma}_\vartheta^2$  would be

$$\hat{\sigma}_\vartheta^2 = N^{-1} \sum_{i=1}^N \left( \frac{1}{\hat{T}} \sum_{t=p+1}^T \hat{\vartheta}_i^2 + \frac{2}{\hat{T}} \sum_{j=1}^m K(j, m) \sum_{t=j+1}^T \hat{\vartheta}_{i,t} \hat{\vartheta}_{i,t} \right) \quad (3.19)$$

In this paper,  $\hat{\sigma}_\vartheta^2$  is calculated according to (3.19) to eliminate the impact of heteroscedasticity and serial correlation across the panels and subsequently  $Z$  is denoted as  $Z^*$ .

3.2.5. (Pesaran, 2007) Test

Pesaran augmented the conventional ADF regression model with the lagged cross-sectional average and its first difference to obtain the cross-sectionally augmented Dickey-Fuller (CADF) test:

$$\Delta rer_{i,t} = \alpha_i + \rho_i^* rer_{i,t-1} + d_0 \overline{rer}_{t-1} + d_1 \Delta \overline{rer}_t + \varepsilon_{i,t} \tag{3.20}$$

Where  $\overline{rer}_t$  is the mean at time  $t$  of all  $N$  observations. If serial correlation present in  $\varepsilon_{i,t}$  of (3.20), then (3.20) must be augmented in the following fashion:

$$\Delta rer_{i,t} = \alpha_i + \rho_i^* rer_{i,t-1} + d_0 \overline{rer}_{t-1} + \sum_{j=0}^p d_{j+1} \overline{rer}_{t-j} + \sum_{k=1}^p c_k \Delta \overline{rer}_{i,t-k} + \varepsilon_{i,t} \tag{3.21}$$

From estimating the CADF regression for each cross-sections,  $t$ -statistics are obtained and subsequently the CIPS statistic can be found from the mean value of the  $t$ -statistics:

$$CIPS = \frac{1}{N} \sum_{i=1}^N CADF_i \tag{3.22}$$

The CIPS test yields more precise and reliable results in the presence of cross-sectional dependence than those of the first generation tests discussed earlier in the section.

4. EMPIRICAL RESULTS

Since there are some drawbacks found in different approaches, only one approach may mislead findings of the paper. Therefore, in order to obtain comprehensive results, several panel unit root approaches have been employed in this paper. The empirical results are presented in Table 1, 2 and 3. Table 1 presents results that are not considered cross sectional dependence, while Table 2 presents results considering the cross sectional dependence. Table 3 shows the CIPS test results.

Table-1. First Generation Panel Unit Root Test Results: Disregarding Cross-Sectional Dependence

Method	Without Trend		With Trend	
	Statistic	Probabilities	Statistic	Probabilities
Ho: Panels contain unit roots		Ha: Panels are stationary		
Breitung (2000) ( $\lambda$ )	-2.012	0.022	-1.511	0.065
LLC Test ( $t_\rho$ )	-9.835	-----	-12.017	-----
LLC Test ( $t_\rho^*$ )	-3.690	0.000	-3.461	0.000
Ho: All panels contain unit roots		Ha: Some panels are stationary		
(Im et al., 2003) ( $W_{\varphi_{\bar{r}}}$ )	-3.085	0.001	-4.374	0.000
Ho: All panels are stationary		Ha: Some panels contain unit roots		
Hadri (2000) ( $Z^*$ )	6.9855	0.000	4.4016	0.000

Note: Akaike Information Criterion (AIC) determines optimal lag lengths with a maximum lag length of five for the LLC test and the IPS test. For the Breitung test and H-LM test, lag length is automatically selected by *xtunitroot*, which is available in the Stata software. Width of Bartlett-kernel window set to five.

According to Table 1, the Breitung test, the LLC test and the IPS test provide evidence that  $rer_{i,t}$  are stationary at level with intercept at 1% or 5% significance level. The tests also provide evidence that  $rer_{i,t}$  are also stationary with intercept and trend at 1% or 5% except the Breitung test. The test rejects the null hypothesis of common unit root at 10% significance level rather than 1% or 5%. However, contrary to the prior three results, the H-LM test rejects the null hypothesis i.e., all panels are stationary with intercept as well as with intercept and trend at 1% significance level. Since among the major trading partners have many analogous features, the obtained results presented in Table 1 may be influenced by the cross-sectional correlation in real exchange rate. To eliminate such impact, the cross-sectional means may be subtracted from time series data.<sup>2</sup>

<sup>2</sup> Suppose,  $\hat{rer}_{i,t}$  is a demeaned series, where,  $\hat{rer}_{i,t} = rer_{i,t} - \overline{rer}_t$  and  $\overline{rer}_t$  is the cross-sectional means.

Table-2. First Generation Panel Unit Root Test Results: Considering Cross-Sectional Correlation

Method	Without Trend		With Trend	
	Statistic	Probabilities	Statistic	Probabilities
Ho: Panels contain unit roots		Ha: Panels are stationary		
Breitung (2000) ( $\lambda$ )	-2.121	0.017	-1.481	0.069
Levin <i>et al.</i> (2002) ( $t_\rho$ )	-11.188	-----	-11.776	-----
Levin <i>et al.</i> (2002) ( $t_\rho^*$ )	-5.244	0.000	-2.913	0.002
Ho: All panels contain unit roots		Ha: Some panels are stationary		
Im <i>et al.</i> (2003) ( $W_{\rho\tau}$ )	-5.185	0.000	-2.995	0.001
Ho: All panels are stationary		Ha: Some panels contain unit roots		
Hadri (2000) ( $Z^*$ )	6.093	0.000	6.012	0.000

**Note:** Akaike Information Criterion determines optimal lag lengths with a maximum lag length of five for the LLC test and the IPS test. For the Breitung test and H-LM test, lag length is automatically selected by *xtunitroot*, which is available in the Stata software. Width of Bartlett-kernel window set to five.

Table 2 shows the results regarding cross-sectional dependence. However, the results obtained from demeaned version again produce inconclusive outcomes i.e., the Breitung test, the LLC test and the IPS test provide evidence that the foreign exchange rate of Bangladesh is mean reverting while the H-LM test does not support it. Hlouskova and Wagner (2006) using their large scale simulation study found that the H-LM test seems to reject the null hypothesis often even when true and may contradict the findings those obtained from other tests. Baltagi (2005) also found that the H-LM test contradicted other findings obtained from the three tests. Therefore, ignoring the findings obtained from the H-LM test, the rest of the tests assert that the bilateral real exchange rate of Bangladesh is mean reverting and deviation of domestic and foreign price indices are reflected in nominal exchange rate movements.

Although the first-generation tests (for instance, the LLC test, the IPS test, the H-LM test and the Breitung test) are not capable to meet all potential problems of exchange rate dynamics, the second-generation tests (for instance, the Pesaran (2007)) test) are able to deal well and yield more reliable and precise result. Therefore, Pesaran (2007) CIPS test is incorporated in the paper to eliminate the controversy arises from Table 1 and 2.

Table-3. Second Generation Panel Unit Root Test Results

Method	Without Trend		With Trend	
	Statistic	Probabilities	Statistic	Probabilities
Ho: All panels contain unit roots		Ha: Some panels are stationary		
Pesaran (2007)	-1.862	0.031	-2.134	0.016

**Note:** The optimum lag length is one.

According to the Pesaran CIPS test result presented in Table 3, the null hypothesis of all panels contain unit roots is rejected at the 5% significance level. The result straightens the findings of the Breitung test, the LLC test and the IPS test that *at least* the weak form of PPP theory holds for Bangladesh. The result is comparable to Chowdhury (2007) where the author postulates that the PPP theory holds for Bangladesh.

## 5. CONCLUSIONS

The paper attempts to reappraise the empirical evidence of the weak version of the PPP for Bangladesh with her twenty-two major trading partners over the period of 1986 to 2011. The devastating rejection of heterogeneous versions of the PPP theory, excluding some exception, is frequently appeared in the prior studies. This paper has tried to reconcile the controversies by inaugurating panel unit root approach and considering large panels.

Although some ambiguous results have been appeared in the first-generation tests, the second-generation test resolves the ambiguity and confirms that the exchange rate of Bangladesh is mean reverting and disturbance of the price level ratio of Bangladesh and her trading partner is reflected in the nominal exchange rate movements. Therefore, the PPP theory can be considered as a determinant of the exchange rate of Bangladesh in the long-run.

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