

# Do the Exchange Rates of the Countries of Freely Floating Exchange Rate Regimes Mean Reverting?

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## Abstract

The aim of this study is to estimate whether the exchange rates are mean reverting or not in the twenty-three countries, where the free-floating exchange rate system is followed. The study used annual data set over the period of 1961 to 2014. In this study, we have incorporated both first generation panel unit root tests, i.e., the LLC test, the IPS test and the ADF-Fisher test, as well as second-generation panel unit root test, for instance, the Pesaran CIPS test. Some ambiguous results have been appeared in the first-generation tests. However, the second-generation test has failed to resolve the ambiguity. Hence, one cannot firmly assert from the results of this study that the PPP theory is valid in the freely floating exchange regime countries. Since, the exchange rates do not mean reverting, demand-side factors cause shocks in the market rather than the supply-side. Furthermore, relative change of the price levels of two trading partners is not properly reflected in the relative change of the nominal exchange rate movements. Consequently, the relative PPP theory would not be a complete theory for determining the exchange rates in the long-run for the countries belong to the floating exchange rate regimes.

**Keywords:** Freely floating exchange rate regime; Panel unit root test

## 1. Introduction

The real exchange rate (RER) behavior has been a cornerstone in the international economics for developing theoretical and empirical models. The real exchange rates must be mean reversion to validate the purchasing power parity (PPP) theory. It implies that the impact of shocks should be a short-run phenomenon and the RER should move back towards its mean value, if any other shock does not affect the economy. According to Campa and Wolf (1997), most of the prior studies rejected the absolute PPP theory. Consequently, using longer time series data and modern econometric techniques, recent empirical studies try to find out whether the RER is mean reverting or not.

A large number of empirical studies have been completed on the mean reverting real exchange rate along with absolute and relative PPP theories. To find the legitimacy of PPP hypothesis for 6 Asian countries, Nusair (2003) used quarterly data from 1973:Q2 to 1999:Q4. The results found that the null of unit root was rejected for Indonesia, Korea and Thailand and the null of stationary was not rejected for Singapore. Steigerwald (1996) applied standard unit-root tests to real exchange rates to examine on purchasing power parity (PPP) account for the possible presence of unit roots in nominal exchange rates and relative price indices. They considered annual data covering 1927-1990 (64 years) and 15 different country pairs. The results of the paper provide that purchasing power parity holds across developed countries. Using quarterly data spanning from 1980:Q1 to 2005:Q4, Kalyoncu and Kalyoncu (2008) showed the validity of Purchasing Power Parity for 25 OECD countries. ADF unit root test with single time series was used to test stationary of the real exchange rate and IPS (Im, Pesaran and Shin, 1997) panel unit root test was used to improve the power property of the test. They found that ADF unit root test showed all the sample countries exchange rate series were exposed to unit root and the IPS panel unit root test showed the real exchange rates in the OECD countries were mean reverting and supported the long run PPP hypothesis.

Lai and Cheung (1998) concentrated on a view is that the post-Bretton Woods period is far too short to reveal any significant parity reversion in individual series of real exchange rates. They applied two efficient univariate unit-root tests to uncover parity reversion. They showed that if an efficient unit-root test is applied, parity reversion can be revealed over the modern float. Chortareas and Kapetanios (2009) found out that Sequential Panel Selection Method (SPSM) gave strong evidence of mean reversion in real exchange rate and supported for the validity of the PPP hypothesis. For 25 OECD countries Wickremasinghe (2009) investigated the mean reversion of real exchange rates of Papua New Guinea (PNG) using a panel consisting of four exchange rates, such as-Australian Dollar/Kina, US Dollar/Kina, Japanese Yen/Kina and UK Pound/Kina and applying six different panel unit root tests. It was found that the PPP hypothesis did not support Papua New Guinea. Using monthly data for eight Pacific Basin countries for the period of 1980M1 to 1996M8, Wu and Chen (1999) did a similar panel unit root tests. They found that the real exchange rate series was nonstationary and did not support the PPP hypothesis. Noman (2009) also found that SAARC countries real exchange rates are nonstationary using yearly data from 1971 to 2006 as well as univariate unit root tests (ADF and KPSS) and panel unit root tests (IPS and Hadri LM test, 2000). Ahmed and Islam (1999) investigated the Purchasing Power Parity (PPP) for Korea and U.S. exchange rate and prices using cointegration and causality tests. Here quarterly time series data were used and the results supported partially for the PPP hypothesis for Korea.

Taylor and Taylor (2004) examined on the purchasing power parity controversy using data for a large number of countries over the period 1970–1998. The results provided that exchange rates do revert to a certain level determined by the price level in the long run as well as the half-life of this reversion is short enough. Wooi and Babanunshab (2006) found ASEAN-5 currencies revert to their PPP equilibrium over the long run. In addition, they also documented several nonlinear behaviors of the ASEAN-5 currencies as well as showing that the nonlinear models outdo the linear model in modeling PPP. Purchasing power parity holds in Turkey (Gozgor, 2011). He used panel unit root tests. Using monthly observation panel data of nine major country's currencies dated January 2003 through April 2010, he found that panel unit root tests did not reject the mean-reversion of real exchange rates.

Wooi, Lee and Haw (2011) examined on the mean reversion behavior of three Japanese real exchange rates during January 1980–January 2010. The findings of this paper did not support the PPP hypothesis. Banerjee and Hoque (2012) examined on purchasing power parity on garment export - oriented developing Countries, namely- Bangladesh, India, Pakistan and Sri Lanka. They found that the real exchange rates of Bangladesh, India, Pakistan and Sri Lanka are not constant. The result indicated that the long - run PPP did not hold for the sample countries. Murad (2016) applied first-generation and second-generation panel unit root test approaches to find out whether the exchange rate of Bangladesh is mean reverting or not. The paper studied annual data from 1986 to 2011 of major twenty-two trading partners of Bangladesh. Though some questionable results arise from the first-generation tests, the second-generation test reconciles the controversy and confirms that the weak form of PPP is relevant for Bangladesh. Accordingly, the real exchange rate of Bangladesh is mean reverting and the PPP hypothesis can be considered as an exchange rate determinant in the long-run.

In the earlier studies, some empirical studies have been conducted on different countries. However, we found no paper that had studied on such countries, which were followed the freely floating exchange rate regimes. Therefore, the objective of this study is to estimate whether the exchange rates are mean reverting or not in the twenty-three countries, where the free-floating exchange rate system is followed. These countries are Australia, Austria, Belgium, Canada, Chile, Cyprus, Finland, France, Germany, Greece, Ireland, Italy, Japan, Luxembourg, Malta, Mexico, Netherlands, Norway, Portugal, Spain, Sweden, Somalia, and the United Kingdom.

The outline of this paper is as follows. Section I covers both introduction and literature review, while Section II presents the data sources, theoretical framework and the econometric methods. Section III reports the empirical results. Finally, the concluding remarks are provided in section IV.

## 2.1 Data Source

In this paper, the consumer price indexes and the nominal exchange rates of the twenty-three countries against the US dollar are obtained from the World Development Indicators (WDI) published by the World Bank over the sample period 1961 to 2014. The International Financial Statistics (IFS) CD-ROM published by the IMF was also used in some cases where data was not available in the WDI. In some cases, the data of GDP deflator are used instead of CPI due to unavailability of CPI data in the WDI and IFS. For the states of the Eurozone, this study covers the data until introducing the common currency euro.

## 2.2 Theoretical Model

The real exchange rate of each country  $i$  ( $RER_i$ ) with respect to US dollar is constructed using the following formula:

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

where,  $RER_{i,t}$  is the real exchange rate,  $NER_{i,t}$  is the nominal exchange rate,  $P_{i,t}$  is consumer price index (CPI) of the respective country and  $P_t^{US}$  is CPI of the United States. 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 econometric model of the mean reverting real exchange rate can be developed as follows:

$$rer_{i,t} = \alpha + \beta rer_{i,t-1} + \varepsilon_t \quad (2.2)$$

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.

## 2.3 Methodology

The unit root approach in panel data is an extension of the univariate unit root tests of time series analysis. The unit autoregressive root tests of time series data have lower power to reject the null hypothesis of a unit root. Therefore, applied researchers, nowadays, are inclined to panel unit root approaches. In this paper, the first generation panel unit root tests, for instance, the Levin *et al.* (2002) (hereafter write LLC) test, the Im *et al.* (2003) (hereafter write IPS) test, the ADF-Fisher test, the PP-Fisher test (developed by Choi, 2001), and the

second generation panel unit root test - the Pesaran (2007) (cross-sectional augmented IPS, hereafter write CIPS) test are incorporated.

### 3. Empirical Results

Table 1 presents four unit root tests results of the panel data. The  $H_0$  of the LLC test assumes common unit root process, while  $H_0$  of rest of the three tests, namely, IPS test, ADF-Fisher test and PP-Fisher test, assume individual unit root process. For each of these three tests, to account for various possible ways that the data could have been generated, two variants of the tests were run - with constant (intercept) and with constant and linear trend.

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

Method	With Intercept		With Intercept and Trend	
	Statistic	Probabilities	Statistic	Probabilities
Ho: Unit root (assumes common unit root process)				
LLC Test ( $t_\rho^*$ )	-4.52037	0.0000	-2.56202	0.0052
Ho: Unit root (assumes individual unit root process)				
IPS Test ( $W_{\varphi_{\tau}}$ )	-4.82490	0.0000	-4.28735	0.0000
ADF-Fisher Test ( $\chi^2$ )	91.8293	0.0001	87.7546	0.0002
PP-Fisher Test ( $\chi^2$ )	62.8313	0.0500	36.5102	0.8404

Note: Schwarz information criterion (SIC) determines optimal lag lengths with a maximum lag length of four.

According to Table 1, considering the first generation tests, i.e., LLC, IPS and ADF-Fisher tests, almost all test statistics, whether with the specification of an intercept alone or with intercept and trend, showed that the datasets are stationary in nature. However, contrary to the prior three results, in case of the PP-Fisher test, if the specification is changed to include a linear trend, this dataset is indicated to be non-stationary. Except the finding obtained from the PP-Fisher test, the rest of the tests support that the real exchange rates of the considered countries are mean reverting and the deviation of domestic and foreign price indices are reflected in nominal exchange rate movements.

According to Murad (2016), the first-generation tests (i.e., the LLC test, the IPS test, the ADF-Fisher test and the PP-Fisher test) are not capable to meet all potential problems of exchange rate dynamics, the second-generation tests (e.g., the Pesaran test, 2007) are able to deal well and provide more reliable and accurate result. From this standpoint, Pesaran (2007) CIPS test is incorporated in this paper to eliminate the controversy arises in the first generation test.

Table 2. 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)	-2.271	0.012	-1.124	0.130

Note: The optimum lag length is one.

Table 2 presents the outcome of the Pesaran CIPS test. According to the Pesaran CIPS test, the null hypothesis of all panels contain unit roots is rejected at the 5% significance level in case of the specification of an intercept alone. However, contrary to the result, if the specification is changed to include a linear trend, this dataset is indicated to be non-stationary even at 10% significance level. The result supports the result of the PP-ADF test. Like the PP-ADF test, the result completely overturns once a linear trend is added and the real exchange rate is no longer stationary. It lends no support in favor of the validity of the mean-reverting property of the real exchange rate. Hence, the real exchange rates of the countries, where the floating exchange rate system is practiced, do not follow the PPP hypothesis.

### 4. Conclusion

In the early researchers, they had studied on the mean reverting exchange rate in the context of different economic regions to justify the validity of the PPP hypothesis in the long run. However, none of the prior studies analyze the validity of the PPP theory in the perspective of the countries following freely-floating exchange rate regime. For this reason, the paper studies on the countries where the freely floating exchange rate regime is maintained.

This paper examined to test whether the real exchange rates are mean reverting of 23 countries, which follow the freely floating exchange rate system. Several panel unit root tests that account for cross sectional dependence using a common factor structure have been proposed in the literature recently. In this study, we have incorporated both first generation as well as second-generation panel unit root tests.

Some ambiguous results have been appeared in the first-generation tests. However, the second-generation

test has failed to resolve the ambiguity. Hence, one cannot firmly assert from the results of this study that the PPP theory is valid in the freely floating exchange regime countries.

Since, the exchange rate is not mean reverting, demand-side factors cause shocks in the market rather than the supply-side. Furthermore, relative change of the price levels of two trading partners are not properly reflected in the relative change of the nominal exchange rate movements. Consequently, the relative PPP theory would not be a complete theory for determining the exchange rates in the long-run for the countries belong to the floating exchange rate regimes.

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