

## ***Does Purchasing Power Parity Hypothesis Hold for Latin American Countries?<sup>1</sup>***

*Satın Alma Gücü Paritesi Hipotezi Seçilmiş Latin Amerika Ülkeleri için Geçerli midir?*

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### **ABSTRACT**

This paper investigates the validity of Purchasing Power Parity utilizing Fourier unit root tests for the period of 2000m1-2015m2 for Brazil, Chile, Colombia and Mexico. The findings show that the Purchasing Power Parity is valid in Brazil and Colombia in case of considering structural breaks. Additionally, Purchasing Power Parity holds for all countries in case of structural breaks and nonlinearity.

**Keywords:** Purchasing power parity hypothesis, Structural breaks, Fourier series

### **ÖZET**

Satın Alma Gücü Paritesi'nin geçerliliğinin incelenmesi uluslararası para ekonomileri ve siyasi nedenler açısından önem taşımaktadır. Bu çalışma, Brezilya, Şili, Kolombiya ve Meksika'da Satın Alma Gücü Paritesi hipotezinin geçerliliğini Fourier birim kök testleri ile 2000m1-2015m2 dönemi için test etmektedir. Elde edilen sonuçlara göre, yapısal kırılmaların dikkate alınması durumunda Brezilya ve Kolombiya için SAGP hipotezi geçerli iken hem yapısal kırılmanın hem de doğrusal olmayan yapıların dikkate alınması durumunda Satın Alma Gücü Paritesi hipotezi tüm ülkeler için geçerlidir.

**Anahtar Kelimeler:** Satın Alma Gücü Paritesi Hipotezi, Yapısal Kırılmalar, Fourier Serileri

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## 1. Introduction

Purchasing power parity (PPP) is one of the most important theories of exchange rate determination in international economics. The law of one price constitutes that a homogenous good must have the same price anywhere under perfect competition (Sarno and Taylor, 2003). It is important to test the validity of PPP for both providing an insight into international monetary economy and political issues. The criticality of this hypothesis stretches away to a great number of financial stability plans, structural adjustment schemes and economic reform policies since its validity is in immediate association with exchange rate parity and policy adjustment. Moreover, international competitiveness of any given country is usually considered in a framework where PPP is an effective tool to correlate exchange rates to competitiveness. According to Baharumshah et al. (2013) PPP may be employed to compare average costs of commodities as well as to create monetary policy formulations aimed at monetary policies and inflation or exchange rate targeting.

Therefore economists and policy makers closely monitor PPP-related data. Real exchange rate of any given country must be a fixed exchange rate or rate having a strong inclination to move to the average so that PPP hypothesis can work solidly. PPP would be invalid if real exchange rate is characterized by frequent fluctuations. To put it differently, PPP hypothesis can hold in the long run only if real exchange rate is steady. If a long-term time series data for the real exchange rate involve unit root, then there would be persistent deviations from the mean, overruling PPP hypothesis.

The purpose of this study is to examine the validity of PPP hypothesis for four Latin American countries. In this context, we applied both traditional ADF unit root test and KSS unit root tests in order to include non-linear forms of series. We also utilized Fourier functions which contain smooth transitions of these tests. The paper is designed as the following: this introduction is followed by a literature review in the second part, the third part indicates data and methodology, the fourth part presents empirical results, and the fifth involves concluding remarks.

## 2. Selected Literature Review for Latin American Countries

The existing literature hosts a great variety of unit root tests aimed at testing PPP hypothesis. A series of real exchange rate going back to a constant mean is in keeping with PPP, while PPP becomes invalid in case the series suffers from non-stationarity. As long as real exchange rate is fixed, it will not move away from the average value, and make PPP hypothesis valid (Sarno and Taylor, 2003). On the other hand, PPP would be invalid if shocks in real exchange rate become invariable, preventing long-run convergence of nominal exchange rates to relative price levels, in which case it would be unfeasible to propose any monetary policy to steer the change (Yılanıcı and Eriş, 2013:21). The results may differ based upon the econometric tools and data ranges employed. In addition, co-integration tests for testing long-term validity of PPP are employed. These tests focus on uncovering the co-integration relationship between

nominal exchange rate and domestic and international prices. The existence of co-integration relationship proves the validity of PPP hypothesis.<sup>1</sup> This study also endeavors to elaborate on the most recent studies that make use of modern economic techniques.

There are an abundant literature to test PPP hypothesis utilizing time series and panel data methods for Latin American countries. Cheng et al, (2008) test the version of PPP applying the panel cointegration method 61 countries including Latin American countries, namely, Chile, Colombia, Costa Rica, Dominican Republic, Ecuador, El Salvador, Guatemala, Haiti, Honduras, Jamaica, Mexico, Paraguay, Trinidad and Tobago, Uruguay, and Venezuela for the period of January 1976 to December 2005. The results provide evidence in the version of weak PPP for Latin American countries. Divino et al. (2009) examines the validity of PPP over the period of January 1981 to December 2003 for all Latin American countries using time series and panel data unit root tests. They found strong evidence in favor of PPP in Latin-America. Chang et al. (2010) test PPP for 10 Latin American countries for the period 1980m1 to 2008m9 utilizing panel SURKSS tests. Tests results demonstrate that PPP holds for some Latin American countries. Ralph Lu et al. (2011) investigate PPP hypothesis for 16 Latin American countries using the SURADF tests over the period of January 1995 to December 2007. While panel unit root tests results show that PPP does not hold for all countries, panel SURADF tests results exhibit that PPP holds for El Salvador, Peru and Suriname. Yang-Cheng et al. (2013) examine PPP for selected Latin American countries utilizing the threshold unit root test for the period of December 1994 to February 2010. The results show that PPP is valid only for six countries. Bahmani-Oskooee et al. (2013) test the validity of long-run PPP for selected Latin American countries for period of 1994m12 to 2010m2. They found that PPP holds for all countries except for Ecuador, Bolivia, Paraguay, Honduras. Liu and Chang (2013) the Purchasing Power Parity hypothesis for selected Latin American countries between period of 1995m1 to 2010m2. The results show that PPP holds for all of the Latin American countries. He et al. (2014) examine PPP for Latin American countries for the period of 1994m12 to 2010m2. Panel SURKSS test results show that PPP is valid for selected Latin American countries except for Honduras. Vasconcelos and Júnior (2016) test the validity of PPP utilizing unit root tests for Latin American countries. While the linear unit root tests results reveal that PPP is valid for Chile and Peru the non-linear unit root tests results show that PPP holds for Mexico. This study makes a

<sup>1</sup> For more discussions of PPP, please view the works of MacDonald and Taylor (1992), Taylor (1995), Doğanlar (1999) Taylor and Sarno (1998), Taylor and Taylor (2004), Lothian and Taylor (2000), Lothian and Taylor (2008) and the references cited there in.

contribution by determination of PPP hypothesis for four Latin American countries. As can be seen from the literature, according to the econometric techniques and span of data set used, the results differ from the Latin American countries.

### 3. Data and Methodology

This study utilizes monthly data from 2000m1 to 2015m2 for selected Latin America countries (Brazil, Chile, Colombia and Mexico) to investigate the existence of purchasing power parity hypothesis. For this purpose, the real exchange rates of countries are computed with using following equation;

$$\log RER_t = \log NER_t + \log P_t^f - \log P_t^d \quad (1)$$

where  $RER$  is the real exchange rate,  $NER$  is the nominal exchange rate,  $P^f$  indicates the foreign price level and  $P^d$  indicates the domestic price level. In addition, the consumer price indices are used as foreign and domestic price levels (2010=100). The data obtained from International Financial Statistics (IFS). We examine the stationarity property of real exchange rates of countries utilizing four unit root test to compare the test results. Classical unit root test (ADF) which ignores both nonlinearity and structural breaks, KSS unit root test developed by Kapetanios et al. (2003) which allows nonlinearity form, Fourier ADF (FADF) developed by Christopoulos and Ledesma (2010) which allows structural breaks and Fourier KSS (FKSS) unit root tests developed by Christopoulos and Ledesma (2010) which allows structural breaks and nonlinearity form. Christopoulos and Ledesma (2010) use trigonometric functions to capture large deviations in the deterministic terms of variables. The main advantage of these tests is to account the plurality of temporary smooth structural breaks (Yilanci and Eris, 2013:23; Gumus and Zeren, 2014:223). The main econometric model of FADF and FKSS unit root tests as follows;

$$y_t = \gamma_0 + \gamma_1 \sin\left(\frac{2\pi kt}{T}\right) + \gamma_2 \cos\left(\frac{2\pi kt}{T}\right) + v_t \quad (2)$$

where  $t$  refers to trend term.  $T$ ,  $\gamma_1$ ,  $\gamma_2$  and  $k$  indicates the sample size, the Fourier coefficients and the used frequency value to obtain optimal value of ( $\hat{k}$ ) which minimizes the sum of squares residuals (SSR), respectively. In addition,  $k$  value is determined between 1 to 5 and  $\pi=3.1416$ .

First, the Eq. 2 is estimated by ordinary least squares (OLS) with using optimal  $k$  value to obtain the residuals of OLS estimation as follows;

$$v_t = y_t - \left[ \gamma_0 + \gamma_1 \sin\left(\frac{2\pi kt}{T}\right) + \gamma_2 \cos\left(\frac{2\pi kt}{T}\right) \right] \quad (3)$$

and obtained residuals by Eq. 3 are used in following regressions;

$$\Delta v_t = a_1 v_{t-1} + \sum_{j=1}^p \beta_j \Delta v_{t-j} + u_t \quad (4)$$

$$\Delta v_t = \delta_1 v_{t-1}^3 + \sum_{j=1}^p \beta_j \Delta v_{t-j} + u_t \quad (5)$$

where  $u_t$  is the noise term. Finally, the model of Eq. 4 is called as Fourier ADF (FADF) test and the model of Eq. 5 is called as Fourier KSS test. The null hypotheses of both tests indicate unit root process ( $a_1 = 0$  ve  $\delta_1 = 0$ ) and tested with  $t$ -statistic, the alternative hypothesis of FADF test implies stationarity process with linear form ( $a_1 < 0$ ); the alternative hypothesis of FKSS test implies stationarity process with nonlinear form ( $\delta_1 < 0$ ) and tested with critical values of Christopoulos and Ledesma (2010). The significancy of trigonometric terms is tested by using  $F$ - test ( $F(\hat{k})$ ) with critical values of Becker et al. (2006). Using  $F$ -test, the null hypothesis is tested against the alternative of nonlinearity.

#### 4. Empirical Results

This study explores the validity of Purchasing Power Parity hypothesis (PPP) by investigating the stationarity properties of the real exchange rates because of it is widely accepted that stationary exchange rates indicate the validity of PPP. In recent years, the stationarity of real exchange rates is examined with proportionally, exponentially and linear changes. For this purpose, ADF unit root test, KSS unit root test and Fourier forms of these methods utilized.

**Table 1. Results of ADF and KSS Unit Root Tests**

Country	ADF	KSS
Brazil	-1.1561 (7)	-0.9982 (15)
Chile	-2.4971 (0)	-4.3163*** (16)
Colombia	-1.7314 (0)	-4.1961*** (0)
Mexico	-2.1497 (8)	-1.3687 (10)

Note: \*\*\* indicates the significance 10 percent level. Numbers in parenthesis show the optimal lag length. Optimal lag lengths are determined by using general to specific  $t$ -significance method developed by Schwert (1989).

Table 1 presents ADF and KSS unit root tests results which ignore the structural breaks. According to the results of ADF test, the null of unit root cannot be rejected therefore the PPP hypothesis is rejected for all sample countries. On the other hand, the null of unit root can be rejected for two countries. Therefore, it can be said that PPP hypothesis cannot be rejected for Chile and Colombia with using the KSS unit root test.

**Table 2. Results of Fourier ADF and Fourier KSS Unit Root Tests**

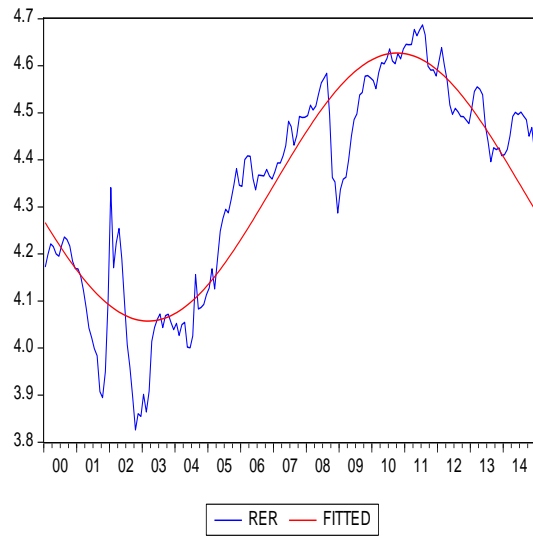
Country	Min. SSR	$\hat{k}$	FADF	FKSS	$F(\hat{k})$
Brazil	1.5368	1	-3.6883* (1)	-3.6589** (15)	429.9817
Chile	0.4543	1	-2.6536 (16)	-6.3786*** (2)	77.8156
Colombia	0.7807	1	-3.8306** (0)	-6.6057*** (2)	327.5634
Mexico	0.5615	1	-2.9493 (8)	-3.7556** (8)	79.3742

Note: \*, \*\*, \*\*\* indicate the significance 10, 5 and 1 percent level respectively. Numbers in parentheses show the optimal lag length. Optimal lag lengths are determined by using general to specific  $t$ -significance method developed by Schwert (1989).

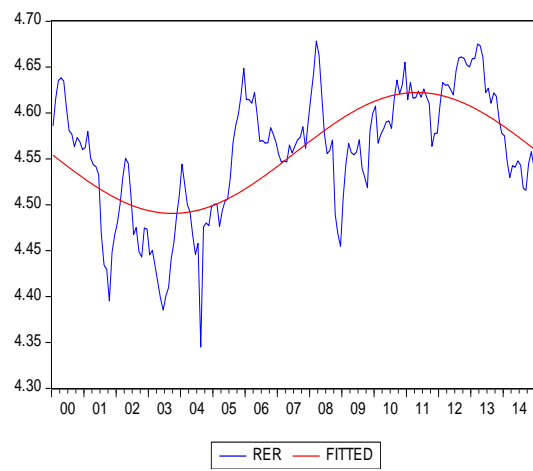
Table 2 shows the results of FADF and FKSS unit root tests. Before the computation, the optimal frequency must be determined for each integer. The third column of Table 2 exhibits that the best frequency is 1 for all countries and the second column of Table 2 shows the minimum sum of squares using with  $k=1$ . FADF test results show that the PPP hypothesis is valid for Brazil and Colombia while the FKSS test shows that the PPP hypothesis is valid for all countries. On the other hand, the real exchange rates of Chile and Mexico are found stationary only when using FKSS test. This result means the real exchange rates of Chile and Mexico have nonlinear stationary process around infrequent multiple temporary mean changes. The nonlinear stationarity of real exchange rate can be sourced from intervention policies of central banks of these countries (Taylor, 2004:1; 2005:74-77). The other reasons of nonlinear stationarity are explained with transaction costs and trade restrictions (Yilanci and Eris, 2013:26).

The  $F(\hat{k})$  statistics are shown in sixth column of Table 2. It seems all statistics are statistically significant when compared with critical values of Becker et al. (2006). Therefore, the trigonometric terms should be added to estimated models. Figure 1 shows the time path of the real exchange rates and fitted nonlinearities. As seen from the Figure 1 shows that Fourier functions seem to adapt well the large swings in real exchange rates.

a) Brazil



b) Chile



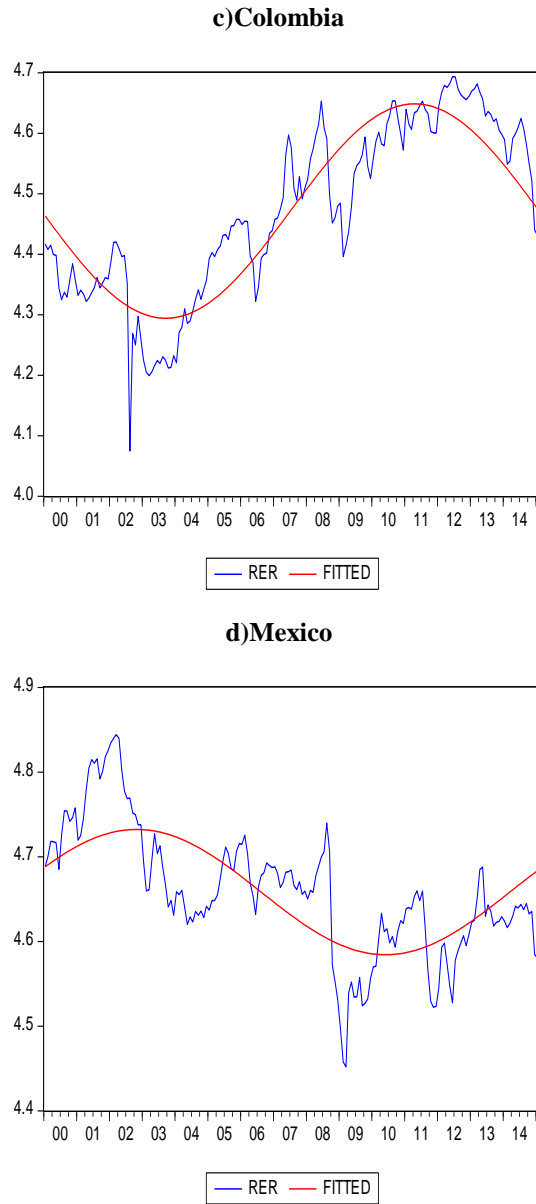


Figure 1. Real exchange rates vs. fitted nonlinearities



## 5. Conclusion

In this study the validity of the PPP hypothesis was investigated for long-run validity for Brazil, Chile, Colombia and Mexico. PPP was tested by stationarity of the real exchange rate series by employing Fourier unit root tests which take into account structural breaks and nonlinearity for the period of 2000m1-2015m2 for the countries stated above. Given the span of the dataset and the econometric techniques employed, the results show that the PPP hypothesis is valid for Brazil and Colombia in case of structural breaks while the validity of hypothesis is confirmed for all countries in case of considering both structural breaks and nonlinearity.

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