

## **The Impact of Structural Break(s) on the Validity of Purchasing Power Parity in Turkey: Evidence from Zivot-Andrews and Lagrange Multiplier Unit Root Tests**

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**ABSTRACT:** This study examines the validity of the purchasing power parity (PPP) in Turkey for annual data from 1953 to 2009. While results from both the ADF unit root and the DF-GLS unit root test indicate mixed results, PPP holds for Turkey with the presence of structural breaks which are obtained by Zivot and Andrews and Lagrange Multiplier unit root tests.

**Keywords:** Purchasing power parity; PPP; Structural Breaks; Turkish Economy.

**JEL Classifications:** C22; F31

### **1. Introduction**

The purchasing power parity (PPP) theory has been one of the more controversial topics in international macro economics given that its empirical validity is still subject to examination. The theory, which is a generalization of the law of one price, assumes that all goods are identical and transportation costs and trade barriers are very low in both countries. The absolute version of the theory asserts that under these conditions, the same basket of goods and services should cost the same when expressed in terms of the same currency. In order to investigate the validity of PPP, unit root testing has become a very popular approach. If the real exchange rate includes a unit root, the shocks should have permanent effects and the variable will never return to its long run equilibrium. On the other hand, if the real exchange rate is stationary, shocks tend to die out in the long run and the equilibrium is achieved some time after the shock has occurred (Cuestas and Regis, 2008). The validity of PPP is significant to policymakers for two motivations. One of them is that PPP can be used to forecast exchange rate to conclude whether a currency is overvalued or undervalued. Whether a currency is over or undervalued is mainly significant for especially developing countries and also for those experiencing large differences between domestic and foreign inflation rates. The other motivation is the notion of PPP which is used as the foundation on which many theories of exchange rate determination are built. Therefore, the validity is important to those policymakers in developing countries who base their adjustment on the PPP (Chang et al., 2010).

While the validity of PPP is important for developing countries, empirical evidence for developing countries mixed (Telatar and Kazdagli, 1998; Bahmani-Oskooee and Mirzai, 2000; Tastan, 2005; Kalyoncu, 2009). These mixed results can be due to the use of ADF type models that they do not allow researchers to model the impact of structural changes in the economy. These structural changes, which could be a result of shocks, do impact macroeconomic variables. It follows that failure to incorporate structural changes in testing for the unit root property of macroeconomic variables is likely to proffer spurious conclusions (Narayan, 2006). Exchange rates that might be affected by internal or external shocks caused by structural changes may be subject to substantial short-run variation. It is significant to know whether or not the real exchange rate has any tendency to settle down to a long-run equilibrium level, as PPP hypothesis requires that real exchange rate evolves around a constant or a time trend. If real exchange rate is found stationary by using unit root test with structural break(s), the effects of shocks such as real and monetary shocks that cause deviations around a mean value or deterministic trend are only temporary (Yavuz, 2009).

The aim of this paper is to investigate PPP for Turkey and the period of analysis is set from 1953 to 2009. For this purpose, we employ ADF and DF-GLS tests. In order to test the unit root hypothesis taking into account the possibility of structural breaks in the data, we perform the Zivot and Andrews and Lagrange Multiplier (LM) unit root tests developed by Lee and Strazicich (2004). The purpose is to show that how sensitive our results are to structural changes. Unlike previous studies, we focus one and two structural breaks with the largest data set for Turkey.

The paper is organized as follows. In Section 2, we describe the dataset and methodology. In Section 3, we present empirical results the time series. The main conclusions of the analysis are summarized in Section 4.

## 2. Data and Methodology

$$RER = NER \frac{P^*}{P} \quad (1)$$

Where RER is the real exchange rate, NER is the nominal exchange rate and P\* and P are the foreign and domestic prices, respectively. In logarithmic form, the real exchange rate can be represented by

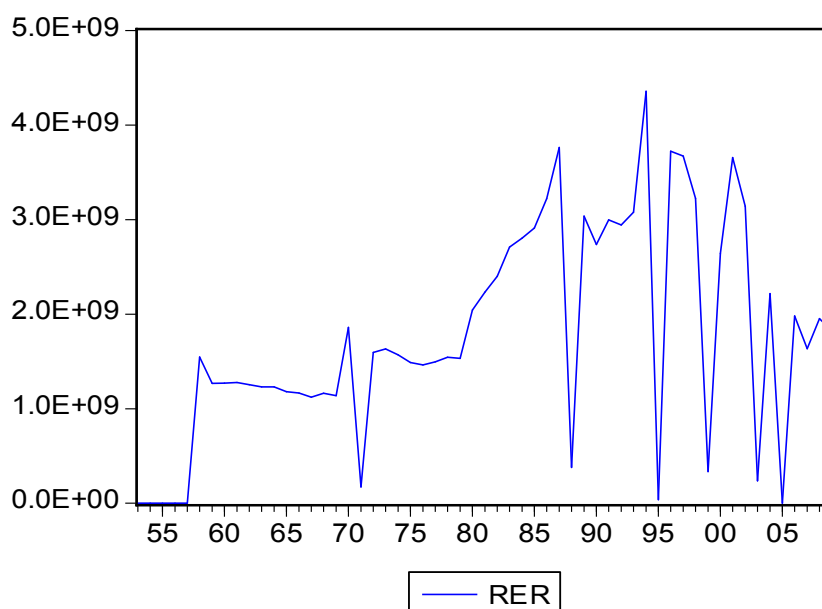
$$\log(RER) = \log(NER) + \log(P^*) - \log(P) \quad (2)$$

Following equation shows the model of mean reverting real exchange rate

$$\log(RER)_t = \alpha + \beta \log(RER)_{t-1} + \varepsilon_t \quad (3)$$

Where  $\alpha$  and  $\varepsilon$  are constant and error term respectively. PPP suggest that real exchange rate series should be stationary. If real exchange rate is stationary this exhibit that any percentage changes in the price level between two countries would be offset by an equal depreciation/appreciation of the nominal exchange rate. If there is a unit-root in the real exchange rate this implies that shocks to the real exchange rate are permanent and PPP does not exist between two countries.

**Figure 1. Turkey Real Exchange Rate for the period of 1953-2009.**



Exchange rates and price levels are taken from the International Monetary Fund's International Financial Statistics (IMF-IFS) database and are defined as the logarithm of the price ratio generated by Turkey's consumer price index (CPI) divided by the US CPI.

### 3. Empirical Results

We start to apply ADF to test validity of PPP and to achieve an increase in power of the standard ADF test; we also apply its variant test proposed by Elliott et al. (1996), the DF-GLS test.

ADF and DF-GLS test results are presented in Table 1. While ADF test with trend support the validity of PPP, DF-GLS does not confirm the validity of PPP. Perron (1989) shows that failure to allow for an existing breaks leads to a bias that reduces the ability to reject a false unit root null hypothesis. To overcome this problem, the author proposes allowing for a known or exogenous structural break in the Augmented Dickey-Fuller (ADF) tests.

**Table 1. Augmented-Dickey-Fuller and Dickey-Fuller GLS**

	Without trend	With trend
Augmented Dickey-Fuller test statistic	-2.364667 (3) [-3.560019]	-6.465837 (0) [-4.130526]
Elliott-Rothenberg-Stock DF-GLS test statistic	-0.942369 (3) [-2.609324]	-1.655811 (3) [-3.758600]

**Note:** Optimal lag selection is based on SIC.

Following this development, many authors, including Zivot and Andrews (1992) and Perron (1997) proposed determining the break point ‘endogenously’ from the data. In addition to ADF and DF-GLS test, two unit root tests with structural breaks, namely the Zivot-Andrews (1992) and Lagrange Multiplier (LM) unit root tests with one and two structural breaks (Lee and Strazicich 2004) are employed in this article. The Zivot and Andrews test adopts an endogenous sequential test that uses different dummy variables to identify each possible break in the full sample (Table 2).

**Table 2. Zivot-Andrews Unit Root Test**

Intercept			Trend			Both		
k	Min t	TB	K	Min t	TB	k	Min t	TB
0	-3.189	2000	0	-4.087	1997	0	-4.680	1994

**Critical values – intercept:** -5.43 (1%), -4.80 (5%); **trend:** -4.93 (1%), -4.42 (5%); **both:** -5.57 (1%), -5.08 (5%)

The Zivot and Andrews test was employed to test the stationarity of the variables with one structural break by selecting optimal lag via t-test.

On the other hand, Zivot and Andrews test was criticized for its treatment of breaks under the null hypothesis. Given the breaks were absent under the null hypothesis of unit root there may be tendency for these tests to suggest evidence of stationarity with breaks (Lee and Strazicich, 2003). Lee and Strazicich (2003) propose a two break minimum Lagrange Multiplier (LM) unit root test in which the alternative hypothesis unambiguously implies the series is trend stationary (Glynn et al, 2007). To avoid problems of bias and spurious rejections, the endogenous break LM unit root test derived in Lee and Strazicich (2003) is employed in PPP testing. In contrast to the ADF-type tests, size properties of the break LM test are unaffected by breaks under the null (Table 3).

The break minimum LM unit root can be described as follows. According to the LM principle, a unit root test statistic can be obtained from the following regression:

$$\Delta r_{it} = \delta' \Delta Z_t + \phi \bar{S}_{t-1} + \mu_t \tag{4}$$

Here,  $\Delta$  is the first difference operator;  $\bar{S}_t = r_t - \hat{\Psi}_x - Z_t \hat{\delta}_t \quad t = 2, \dots, T$ ;  $\hat{\delta}$  are coefficients in the regression of  $\Delta r_t$  on  $\Delta Z_t$ ;  $\hat{\Psi}_x$  is given by  $r_t - Z_t \hat{\delta}$ .

If real exchange rate has a unit root for country  $i$  then  $\phi t = 0$ , which is the null hypothesis tested using the  $t$ -test against the alternative hypothesis that  $\phi t < 0$ . 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  $LM_i^\tau$

$$LM_{barNT} = \frac{1}{N} \sum_{i=1}^N LM_i^\tau \quad (5)$$

**Table 3. Lagrange Multiplier (LM) unit root tests**

Without structural break	One Break	Two Breaks
-2.867* (8)	-7.198*** (8) [2000]	-6.966*** (8) [1989, 1997]
The 1, 5 and 10% critical values for the LM test without a break are -3.63, -3.06, -2.77; one break critical values for the LM test statistic from Lee and Strazicich (2004) at the 10%, 5% and 1% significance levels are -3.211, -3.566, -4.239. *, ** and *** denote statistical significance at the 10%, 5% and 1% levels respectively. The 1, 5 and 10% critical values for the minimum LM test with two breaks are -4.545, -3.842 and -3.504, respectively.		

Overall results, we concluded that PPP is valid for Turkey for the largest period from 1953-2009. The outcome of the break dates has some important tools for PPP hypothesis. For example, The East Asian currency crisis (1997) forced many economies in the region to shift away from *de facto* dollar-pegged regimes to more flexible exchange rate regimes. The dollar had played a dominant role as an international anchor currency until the outbreak of the crisis in the summer of 1997. In addition, Turkey experienced severe financial crises in 1994 and 2000 which affect Turkey exchange rate.

#### 4. Conclusion

The analysis of PPP has probably been one of the most controversial topics of the last decades within macro economics. This paper investigates the impact of structural break on the validity Purchasing Power Parity in Turkey. We concluded that while unit root test without structural break illustrate mixed results, PPP holds for Turkey with the presence of structural breaks which are 1997 (Asian crisis), 1994 and 2000 (financial crises in Turkey).

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