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TESTING THE ABSOLUTE PURCHASING POWER PARITY HYPOTHESIS UNDER NON-NORMAL ERRORS: RALS-LM AND RALS-ADF UNIT ROOT TESTS

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Abstract

This paper scrutinized the validity of the Purchasing Power Parity (PPP) hypothesis for the Turkish Lira along with the Euro (19), the Dollar, the Ruble and GBP for the period between 2002 and 2018. In the related literature, the conventional unit root test procedures are often used in examining the validity of the PPP hypothesis. However, the conventional unit root procedures require normally distributed residuals. But the real exchange rate series rarely satisfy this condition. Hence, this paper investigates the validity of the purchasing power parity (PPP) relying on the RALS-LM unit root procedure, which stretches the assumption of normality. The RALS-LM (one and two trend shift) test findings revealed that PPP hypothesis holds just for the dollar and the GBP. This paper has two vital results in terms of the current PPP literature. Firstly, conventional unit root test procedures are not appropriate for testing the real exchange rate series and secondly, even though appropriate unit root testing procedures were used the results are still very sensitive to the chosen data range.

Key Words: Purchasing Power Parity, Turkish Economy, Real Exchange Rate.

Jel Codes: E48, E53, F00.

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HATA TERİMLERİNİN NORMAL DAĞILMAMASI DURUMUNDA SATIN ALMA GÜCÜ PARİTESİ HİPOTEZİNİN SINANMASI: RALS-LM VE RALS-ADF BİRİM KÖK TESTİ

Öz

Bu çalışmada, Türk lirası için Satın Alma Gücü Paritesi (PPP) hipotezinin geçerliliği 2002-2018 dönemi için Euro, Dolar, GBP (Sterlin) ve Ruble için araştırılmıştır. Literatürde PPP hipotezinin geçerliliğinin sınanmasında geleneksel birim kök testleri kullanılmaktadır. Ancak geleneksel birim kök testleri, normal dağılıma uyan kalıntıları gerektirir. Bununla birlikte, reel döviz kuru serilerinin birim kök analizlerinde hata terimi genellikle normal dağılmamaktadır. Bu bağlamda, çalışmada hata terimlerinde normallik varsayımını genişleten RALS-LM birim kök testi stratejisine dayanarak PPP hipotezinin geçerliliği sınanmıştır. Elde edilen bulgulara göre, PPP hipotezi ABD Doları ve GBP (Sterlin) için geçerlidir. Bu çalışmadan elde edilen bulgular iki açıdan PPP hipotezi literatürü için önem taşımaktadır. Birincisi, reel döviz kuru serileri geleneksel birim kök test prosedürleri için uygun değildir ve ikincisi, normallik varsayımı gerektirmeyen testler kullanılsa bile reel döviz kuru serilerinde durağanlık araştırılan döneme oldukça duyarlıdır.

Anahtar Kelimeler: Satın Alma Gücü Paritesi Hipotezi, Türkiye Ekonomisi, Reel Döviz Kuru

Jel Kodları: E48, E53, F00

INTRODUCTION

Comparing different countries and/or regions in terms of some economic measures require some sort of conversion of the measures into a common currency or price. The purchasing power parity (PPP) is frequently used to compare the absolute purchasing power of different country currencies. Two different versions namely, the absolute and the relative PPP are used in the related literature. In absolute terms the PPP theory states that in the equilibrium of the exchange rate between any two currencies, the purchasing power of these currencies should be equal. Thus, the price of a particular commodity basket in a country will be the same when expressed with the current exchange rate. This notion of PPP has been expected to hold for tradable goods and services. However, for non-tradable goods and services and, for goods with high transportation costs and trade barriers, the parity in absolute terms will be distorted. Assuming the price of one basket to be equal in different countries is a very strong assumption and it is very difficult to hold. So, in practice usually another more workable definition of PPP is preferred. Unlike the PPP in absolute terms the relative PPP compare the appreciation or the depreciation in the exchange rates and the relative changes in prices in the foreign and home country. According to the relative PPP metric, changes in relative prices will set the necessary adjustment in the exchange rates (Balassa, 1964:584). Consequently, the exchange rates should be expected to deviate from the old parities in proportion to the inflation of each country

(Cassel, 1918:2). To test the validity of absolute PPP for the Euro (19), the US Dollar, the Ruble, and the GBP comparison, we calculate real exchange rate parities via nominal exchange rate parity as the ratio of consumer price indexes for any pair of countries. Turkey carries out 90% of its exports in terms of the Euro, the US Dollar, and the Ruble. Thus, whether the purchasing power parity holds for these currencies has crucial policy implications such as exchange rate parity adjustment mechanisms, structural adjustment policies and financial stability strategies. Turkey has been relied on dirty floated exchange rate policy since the 2001 economic crisis. At the same time, the Central Bank of the Republic of Turkey altered its main policy stance through inflation targeting. Until 2006, Turkey applied implicit inflation targeting policy and then after, Turkey switched to open inflation targeting. All these policy shifts, along with the global financial crisis of 2008, have the potential to affect the exchange rates adjustment mechanisms. Therefore, the aim of this study is to test the validity of PPP hypothesis for Turkey.

Although there exist many empirical studies in the literature, there has not been a consensus on the validity of PPP hypothesis since exchange rate series are very sensitive to the econometric modelling techniques. While some studies directly test for any co-integration relationship among the nominal exchange rate, the domestic and foreign prices; others use unit root test(s) to prove the validity of the PPP. In studies using unit root tests, if the real exchange rate is stationary, it means that in the face of a shock, the variable will tend to return to its trend value. Then the conclusion is the nominal exchange rate and domestic and foreign prices should tend to move together. Moreover, conventional unit root test procedures assume that the residuals are normally distributed, however; empirical studies affirm that the residuals in the real exchange rate series are usually not normally distributed. To overcome this normality problem, we use a recently developed econometric technique, namely the Residual Augmented Least Squares (RALS) procedures. Kalyoncu (2009) examined the validity of PPP using different unit root tests for Turkey and the US, Germany, Japan, France, Netherlands, and the UK. The findings revealed that the real exchange rate series are very sensitive to both the base country choice and different unit root test procedures. Telatar and Kazdağlı (2009) examines the long run PPP using cointegration techniques for Turkey. Yet, they could not find any long-run relationships between Turkey and, France, Germany, the UK, and the US. The validity of the long run PPP hypothesis between Turkey and the US is also supported by Sarno (2000), Erlat (2004) and Özdemir (2008). Tıraşoğlu and Yıldırım (2014) analyzed the validity of purchasing power parity theory for 18 OECD member countries for the period between 1993: Q1 and 2011:

Q1 by using the traditional ADF unit root and the unit root tests with structural break. According to the test results, Canada and Mexico's real exchange rate series are stationary and the purchasing power parity is valid for these countries. Şener et al. (2015) investigated different versions of the purchasing power parity (PPP) hypothesis for the Turkish economy over the period between January 1980 and December 2012. The test results they obtained show that the purchasing power parity is not valid for Turkey. However, by employing unit root tests which allow structural breaks in both the intercept and the trend, they conclude that Qualified PPP and Qualified-Trend PPP with structural breaks is valid. Bilgin (2018) investigated the absolute and the relative PPP hypothesis for Turkey by using time series methods for the quarterly data between 1986Q1 and 2017Q4. The findings of the unit root and cointegration tests revealed that the absolute form of the PPP has not been supported while the relative version of PPP supported. Coşkun (2020) investigates the PPP hypothesis for the fragile five during the period between 1994:01 and 2018:11. The findings reveal that the PPP hypothesis is not valid for Turkey.

The rest of the study planned as follows. Following this introduction, in section 2, the data used, and the definition of the real exchange rate are described. Section 3 clarify the RALS-LM test procedure. In section 4 empirical analyses are displayed. Finally, we conclude with policy recommendations.

1. DATA

The PPP theory specify a relationship between the relative prices of the home and foreign country along with the nominal exchange rate. The market (nominal) exchange rates are taken from the database of the Central Bank of the Republic of Turkey and the consumer price indexes are extracted from the OECD databases. Due to the high volatility of the market exchange rates since the mid of 2018, we ended up the data series in two different time ranges. The first data range ended in January 2018 and second data range ended in December 2018. As it mentioned in the previous section, the exchange rate series are very sensitive to the econometric modelling techniques used and to the data range. The extraordinary trend begun in the middle of 2018 and the excessive fluctuation in exchange rate series had been started in 2019. Besides, immediately after the pandemic period break out at the beginning of 2020, and real exchange rate series still have not balanced. Therefore, the large dataset ends at 2018:12. For this reason we use two different monthly data range in investigating the PPP hypothesis to detect the sensitivity of the data in terms of the beginning date of shocks. In the large data range, all series except the Ruble,

are between January 2002 and December 2018. Starting date of the Ruble series is April 2010 for either the long or the short data ranges. In the short data range, except the Russian Ruble, others belong to the period between 2002 January to 2018 January. These currencies are approximately comprised 90 percent of the total export in 2017 (Table 1). Following Gerber (1999), the real exchange rates are obtained by multiplying nominal exchange rates with the ratio of the relative prices, that is the ratio of each country's CPI to the Turkish CPI. Absolute PPP based on the law of one price, and in the literature, the CPI series are the most used indices for prices of the commodity basket. Nominal exchange rates are converted into real exchange rates by using the consumer price indexes as follows:

$$R_t = E_t\left(\frac{P_t^*}{P_t}\right) \tag{1}$$

where, R is the real exchange rate, E is the nominal exchange rate and P* and P are the foreign and domestic price indexes, respectively, the subscript t represents the time.

Table 1. Exports by currencies

Currency	Thousand US $	Share	Large Data Set	Number of Obs.	Small Data Set	Number of Obs.
Euro-19 (Euro)	30000000	0.47	2002:01-2018:12	204	2002:01-2018:01	193
United States US Dollar	26000000	0.4	2002:01-2018:12	204	2002:01-2018:01	193
GBP	1830437	0.03	2002:01-2018:12	204	2002:01-2018:01	193
Russian Ruble (Ruble)	69366.9	0	2010:04-2018:02	105	2002:01-2018:01	94
Total of Top 4	57899804	0.9				
Total of Other Countries	6399950	0.1				
All	64299753.9	1				

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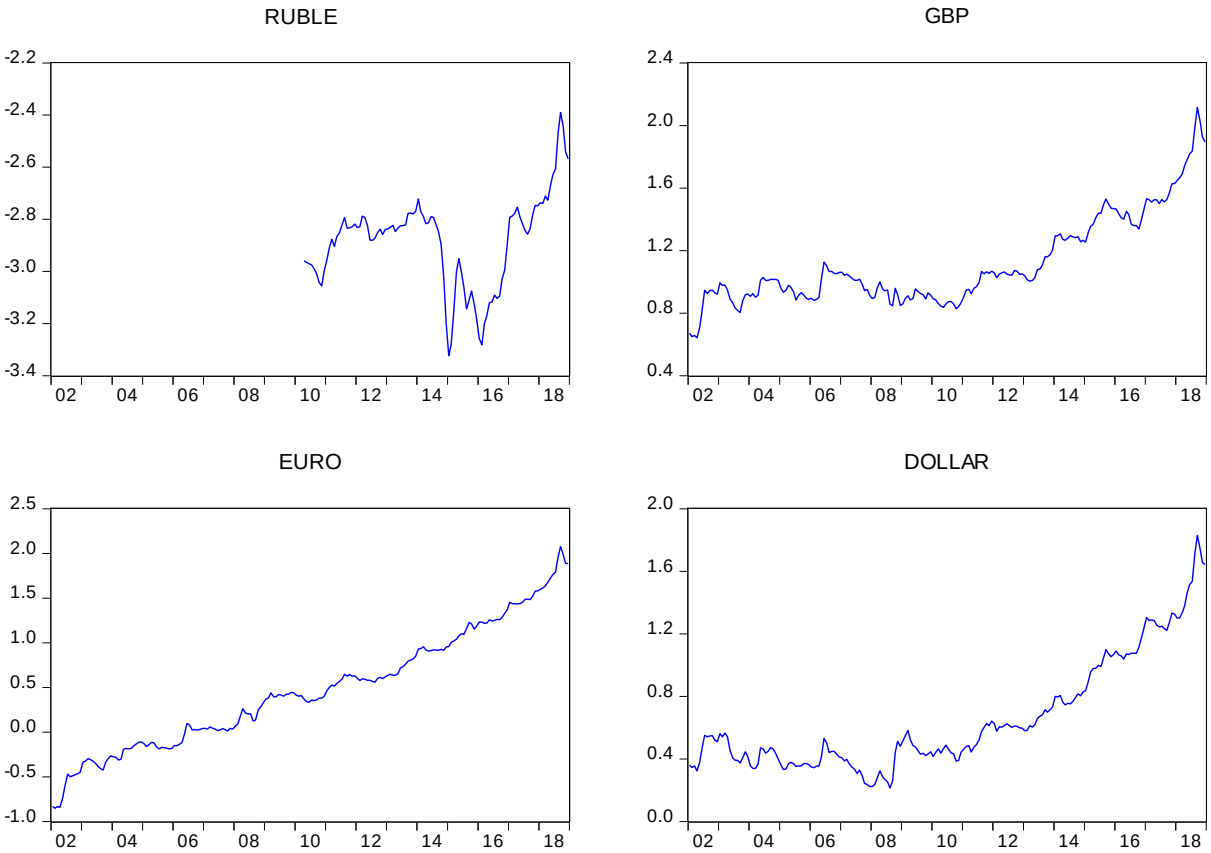

Figure 1. The Real Effective Exchange Rate Series and GBP

The logarithmic forms of the real effective exchange rate series of the sample countries are displayed in Figure 1. In the graph a trend shift occurs for the period between 2008 and 2010 in US Dollar, GBP and the Euro. The potential breaks in the US Dollar seems to be in the years of 2006, 2008 and 2011. The Ruble has a different story than other currencies; it has sharp declines from 2013 to 2015 and then rises quite rapidly. The figure provides some clues about the break dates of the series. Bai and Perron Global Break Point Test is very useful to investigate the presence of multiple breaks and detect the break points. The null hypothesis of the Bai & Perron Global Break test states that there is no significant break against the alternative break point is significant. This test procedure supposes that the break points number m is known. If the first statistically significant break point is identified, then the sample splits into two subsamples. For each subsample, a one-break model is estimated and then second break point is chosen. This process continues until the m break points are selected or rejected the alternative hypothesis (Bai and Perron, 1998:64 and 2003). Bai and Perron Global Break test supports the graphs of the series in Figure 1 and the real exchange rate series have at least two statistically

significant break points when setting the maximum break number as 3 (m=3) (see Appendix). Table 2 illustrates the descriptive statistics of the sample.

Table 2. Descriptive Statistics (2002:01-2018:12)

	Euro	GBP	Ruble	US Dollar
Mean	0.48	1.12	-2.88	0.66
Median	0.42	1.02	-2.84	0.52
Maximum	2.08	2.11	-2.39	1.83
Minimum	-0.85	0.64	-3.32	0.21
Std. Dev.	0.66	0.29	0.18	0.36

The highest average belongs to the GBP with 1.12 and the lowest mean belongs to the Ruble with -2.88. The highest standard deviation value belongs to the Euro.

2. METHODOLOGY

If any data series are stationary in levels, then, in the face of any positive or a negative external shock it will tend to return to its mean level. Therefore, if the real exchange rates are stationary, then the nominal exchange rates and the domestic and foreign prices should tend to move together. However, one of the significant outcomes of the related literature is that the real exchange rate series are not normally distributed and, the conventional unit root test procedures are not applicable. Ignoring the normality assumption leads to β (Type II) error (i.e., accepting an incorrect hypothesis). If the assumption of normality were not satisfied, then the power of the test would be weak, and the results are insignificant. To overcome this problem, in this paper we make use of a residual augmented least squares unit root test (RALS). There are two versions of RALS test: LM based, and DF based. The RALS based LM test have better properties than the RALS based DF test when the error term is asymmetrically distributed. Yet, both RALS versions are much more unbiased than the conventional unit root tests when the error terms are highly asymmetric or have fat tails with unknown forms of non-normal distributions (Meng et al, 2013).

Schmidt and Phillips (1992) suggest an LM unit root test in which the null hypothesis implies $\beta = 1$, against $\beta < 1$. ψ and ξ denote the level and the deterministic trend, respectively.

$$y_t = \psi + \xi t + x_t \tag{2}$$

$$x_t = \beta x_{t-1} + e_t \qquad t = 1,...,T \tag{3}$$

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Denoting the ML estimates from the LM procedure as $\tilde{\psi}$ and $\tilde{\xi}$, de-trending form of y_t as follows:

$$\tilde{y}_t = y_t - \tilde{\psi} + \tilde{\xi} t \,. \tag{4}$$

If z_t is the deterministic component in the model, then we can rewrite equation 2 as follows:

$$y_t = z_t^{'} + x_t \tag{5}$$

$$x_t = \beta x_{t-1} + e_t \tag{6}$$

The definition of z_t is the deterministic component and if there is no break it can be represented as $z_t = [1, t]^{'}$. However, if we have one or multiple breaks, it can be defined as $z_t = [1, t, D_{it}, DT_{it}]^{'}$ where if $t \geq T_{Bi} + 1$ and zero otherwise; $DT_{it} = t - T_{Bi}$ for $t \geq T_{Bi} + 1$ and zero otherwise. T_{Bi} is the break date for $i = 1,..., R$. Same critical values with the usual LM test (without breaks) can be used even in the case of multiple breaks. LM unit root test statistic can be obtained from the following regression by using the LM principle:

$$\Delta y_t = \delta' z_t + \phi \tilde{y}_{t-1} + e_t \tag{7}$$

$$\tilde{y}_t = y_t - \tilde{\psi} - z_t \tilde{\delta} \text{ , t=2,3,…,T} \tag{8}$$

Then, the following LM regression should be estimated:

$$\Delta y_t = \delta' \Delta z_t + \phi \tilde{y}_{t-1} + \sum_{j=1}^{p} c_j \Delta \tilde{y}_{t-1} + e_t \tag{9}$$

$\tilde{\delta}$ is the vector of coefficients in the regression of Δy_t on ΔZ_t, and $\tilde{\psi}$ is the restricted MLE of $\tilde{\psi}$ given by $y_1 = z_1 \delta'$.

Letting $m_j = \frac{1}{T} \sum_{t=1}^{T} \hat{e}_t^{\,j}$ for $j = 2,3,..., \rho$ (10)

$$\hat{w}_t = \left[\hat{e}_t^2 - m_2, \hat{e}_t^3 - m_3 - 3 m_{2t} \hat{e}_t^2 \right]^{'} \tag{11}$$

RALS-LM procedure requires substituting the term w_t in equation (9) as follows:

$$\Delta y_t = \delta' \Delta z_t + \phi \tilde{y}_{t-1} + \sum_{j=1}^{p} g_j \Delta \tilde{y}_{t-1} + \hat{w}_t' \gamma + e_t \tag{12}$$

To compute RALS- LM test statistics we need to calculate $\hat{\rho}$. $\hat{\sigma}_A^2$ is the estimation of the error variance in the LM regression (9) and is the usual estimate of the error variance RALS-LM regression (12).

$$\hat{\rho} = \frac{\hat{\sigma}_A^2}{\hat{\sigma}^2} \tag{13}$$

$$\tau_{RLM} \Rightarrow \rho \tau_{RLM} + \sqrt{1-\rho^2}\, N(0,1) \tag{14}$$

where τ_{RLM} denotes the limiting distribution of the t-statistic for the LM estimator in regression (9), and ρ is the correlation between e_t and $\psi(e_t)$.

3. EMPIRICAL RESULTS

The assumption that the error terms should be normally distributed in traditional unit root tests is quite restrictive. For this reason, this section is started with the ADF unit root test proposed by Dickey and Fuller 1979 and 1981 to investigate the distribution of the error terms. Moreover, Figure 1 and Table 2 point out to structural breaks in the series of the real exchange rate. Non-normal distribution of the error terms and the presence of structural breaks in the series are two important flaws that may lead to biased results in the conventional ADF type tests. Both reasons lead to a weak performance of the conventional unit root tests (Perron, 1989; Meng et al. 2015 and 2017). Following Im et al. (2014) and Meng et al. (2013, 2014, 2015 and 2017) we computed a more powerful RALS-LM one-break and two-break unit root tests with non-normally distributed errors to examine the validity of the PPP hypothesis.

When the trend and the constant terms are tested, both the intercept and the trend terms are significant for the series. Therefore, the stationarity properties of the series are tested by assuming models both with intercept and with intercept and trend. ADF test results are given in Table 3.

Table 3. ADF Unit Root Test Results

	Intercept (2002:01-2018:12)		Trend & intercept (2002:01-2018:12)		Intercept (2002:01-2018:01)		Trend & intercept (2002:01-2018:01)	
	t stat	Prob	t stat	Prob	t stat	Prob	t stat	Prob
Euro	-0.04	0.95	-2.16	0.50	-0.67	0.84	-3.44	0.05

Dollar	1.47	0.99	-0.51	0.98	0.49	0.98	-1.23	0.89
GBP	0.39	0.98	-0.85	0.95	-0.45	0.89	-1.53	0.81
Ruble	-1.44	0.55	-1.56	0.80	-2.03	0.27	-1.98	0.60
5% critical value (t-statistic)	-2.87		-3.43		-2.87		-3.43	
5% critical value for Ruble (t-statistic)	-2.89		-3.46		-2.89		-3.46	
Jarque-Bera of the residuals for Euro	66.84	0	94.82	0	24.16	0	23.93	0
Jarque-Bera of the residuals for Dollar	169.95	0	194.43	0	65.74	0	64.16	0
Jarque-Bera of the residuals for GBP	52.11	0	65.86	0	21.02	0	26.28	0
Jarque-Bera of the residuals for Ruble	5.09	0.08	3.48	0.17	1.38	0.49	1.35	0.50

The results of the models with only the intercept and with both the intercept and trend indicated that the real exchange rate series are not stationary at the 5 percent significance level for the data range between 2002:01 and 2018:12. On the other hand, the results of the model with only intercept and with intercept and trend revealed that the real exchange rate series are not stationary at the 5 percent significance level (except the Euro) for the data range between 2002:01 and 2018:01. Moreover, for both the long and the short-range data sets, Jarque-Bera test of the residuals revealed that error terms of the series are not normally distributed except for the Ruble. Due to the violation of the normality assumption, the power of the conventional ADF unit root test becomes weak, and the results are biased. The results of the RALS- ADF test are illustrated in Table 4. According to both data (range) set, the null hypothesis of the existence of unit roots cannot be rejected at the 5 percent significance level. Table 5 contains RALS-LM test results. As in the case for the RALS-ADF, also in the RALS-LM test, the null hypothesis cannot be rejected at the 5 percent level for both data ranges.

Table 4. RALS-ADF Test Results

Drift	**(2002:01-2018:12)**				**(2002:01-2018:01)**			
	Euro	US Dollar	GBP	Ruble	Euro	US Dollar	GBP	Ruble
DF	2.05	1.79	2.28	-1.44	1.18	1.86	1.5	-1.34
RALS-ADF	1.63	1.68	1.55	-1.80	2.22	1.61	1.38	-1.84
ρ2	0.80	0.79	0.86	0.94	0.79	0.85	0.89	0.76
Lag*	14	6	14	2	12	6	12	0
Critical Values (%5)	-2.78	-2.78	-2.84	-2.84	-2.78	-2.78	-2.84	-2.78
Trend								
DF	0.09	-0.8	0.32	-1.50	-2.53	-1.64	0.41	-1.27
RALS-ADF	-1.53	-1.2	-0.48	-1.93	-2.23	-1.06	-0.77	-1.81

ρ2	0.79	0.76	0.85	0.94	0.8	0.82	0.87	0.76
Lag*	14	6	14	2	7	6	12	0
Critical Values (%5)	-3.30	-3.30	-3.30	-3.38	-3.30	-3.30	-3.38	-3.30
*Akaika Information Criteria (AIC) is selected breaks.								

Table 5. RALS-LM Test Results

Constant with no break	(2002:01-2018:12)				(2002:01-2018:12)			
	Euro	US Dollar	GBP	Ruble	Euro	US Dollar	GBP	Ruble
LM	-1.99	-1.85	-1.82	-2.51	-2.09	-1.93	-1.86	-2.59
RALS-LM	-2.67	-2.32	-2.63	-2.61	-3.16	-1.88	-2.54	-3.14
ρ2	0.75	0.8	0.82	0.96	0.75	0.85	0.8	0.96
Lag*	1	1	1	1	1	1	1	1
Critical Values (%5)	-2.94	-2.94	-2.94	-3.06	-2.95	-2.95	-2.95	-3.06
*Akaika Information Criteria (AIC) is selected breaks.								

RALS-LM one break and two breaks (one break in constant, two breaks in constant, one break in trend, two breaks in trend) unit root tests are performed since Bai Perron test results indicate the significance of break points, which is supported also by Figure 1. RALS-LM level shift test results are illustrated in Table 6. The results of RALS-LM level shift test revealed that the null hypothesis cannot be rejected at the 5 percent level for real exchange rate series. Therefore, RALS-LM, RALS-LM level shift with one break and RALS-LM level shift with two break test results have similar outcomes.

Table 6. RALS-LM Level Shift Test Results

level Shift (with one break) (**2002:01-2018:12**)					**(2002:01-2018:01)**			
	Euro	US Dollar	GBP	Ruble	Euro	US Dollar	GBP	Ruble
LM	-2.11	-1.57	-1.53	-2.44	-2.28	-2.04	-2.26	-2.79
RALS-LM	-2.69	-2.34	-2.70	-2.17	-3.29	-1.85	-2.68	-2.63
ρ2	0.81	0.77	0.75	0.92	0.79	0.83	0.83	0.96
Break Date	21	78	79	63	21	55	21	62
Lag*	6	2	1	2	6	2	6	2
Critical Values (%5)	-2.94	2.94	-2.89	-3.01	-2.96	-2.96	-2.96	-3.01
Level Shift (with two break)								
LM	-2.53	-2.32	-2.30	-2.55	-2.61	-2.49	-2.51	-2.66
RALS-LM	-2.72	-3.25	-3.21	-2.87	-3.49	-2.50	-2.99	-2.98
ρ2	0.82	0.74	0.73	0.84	0.74	0.81	0.73	0.94
Break Date-1	21	55	79	56	21	55	21	57
Break Date-2	28	87	179	72	79	87	79	72
Lag*	6	6	6	2	6	6	6	2
Critical Values (%5)	-2.94	-2.89	-2.89	-2.96	-2.89	-2.94	-2.89	-3.01
*Akaika Information Criteria (AIC) is selected breaks.								

Table 7. RALS-LM Trend Shift Test Results

Trend Shift (with one break) (**2002:01-2018:12)**					**(2002:01-2018:01)**			
	Euro	US Dollar	GBP	Ruble	Euro	US Dollar	GBP	Ruble
LM	-3.84	-4.28	-3.77	-4.33	-3.52	-4.58	-3.90	-4.50
RALS-LM	-2.90	*-3.93*	*-4.50*	-4.23	-3.57	-5.35	-3.67	-4.14
ρ2	0.79	0.73	0.782	0.97	0.76	0.78	0.74	0.89
Break Date	22	144	78	72	128	67	79	55
Lag*	6	6	6	1	6	1	6	1
Critical Values (%5)	-3.51	-3.43	-3.51	-3.71	-3.51	-3.51	-3.43	-3.71
Trend Shift (with two break)								
LM	-3.52	-4.85	-4.64	-3.65	-2.54	-3.93	-3.01	-3.87
RALS-LM	-3.19	-3.09	-3.83	-3.93	-3.96	-4.40	-3.95	-4.51
ρ2	0.71	0.65	0.71	0.84	0.71	0.77	0.77	0.76
Break Date-1	176	178	178	76	154	150	135	77
Break Date-2	178	180	181	79	156	152	147	79
Lag*	6	6	6	1	6	6	6	1
Critical Values (%5)	-3.86	-3.86	-3.86	-3.97	-3.91	-4.04	-4.04	-4.25
*Akaika Information Criteria (AIC) is selected breaks.								

The RALS-LM level shift with one break and two breaks test results are presented in Table 7. The null hypothesis of the existence of the unit root is rejected at the 5 percent level for all exchange rate series and both data set range. On the other hand, the trend shifts with two break test results revealed that the US Dollar and GBP series are stationary at level for both data ranges. However, for the short data sets the null hypothesis cannot be rejected at the 5 percent significance level. These findings contradicted the results of RALS-LM, RALS-LM one and two break tests as well. According to Figure 1, US Dollar and GBP series have trend and trend shifts and after 2018:01 there seems to be a speculative attack to the Turkish lira. Therefore, RALS-LM trend shift test results are more unbiased than the other test results. Thereby, the findings revealed that PPP holds for the US Dollar and GBP.

CONCLUSION

There is an ongoing debate about the validity of the PPP hypothesis because the exchange rate series are very sensitive to the type of econometric techniques used and to the range of the series. The mostly preferred method in examining the validity of the PPP hypothesis is the test for unit roots. If the real exchange rates series are stationary, then the nominal market exchange rates and, the domestic and foreign prices should tend to move together. However, traditional unit root tests require the normality assumption of the residuals. Therefore, in testing the

validity of the PPP hypothesis; we use two different data set ranges (2002:01-2018:01 and 2002:01-2018:12) and to overcome the problems about the normality assumption in the traditional unit root tests, we use RALS-LM test procedure, which is more powerful under the case for non-normally distributed residuals. Since the graphs of the series and the Bai Perron test results put forth break point(s), RALS-LM one break and two breaks (one break in constant, two breaks in constant, one break in trend, and two breaks in trend) unit root tests are carried out in the analysis.

ADF, RALS-LM, RALS-LM level shift with one break and RALS-LM level shift with two breaks test results have the similar outcomes that the PPP hypothesis does not hold for the US Dollar, the Euro, the GBP, and the Ruble. On the other hand, the RALS-LM trend shift with one and two breaks test revealed that the PPP holds for the US dollar and GBP in the extended data range.

This paper has two important results in terms of the current PPP literature. First, the real exchange rate series are inappropriate for the use of conventional unit root tests since conventional unit root procedures requires the normality assumption in the residuals. That could be the potential reason for the ambiguous results about the validity of the PPP hypothesis in the related literature. Second, different real exchange rate data series with different time ranges may also deliver different results even though the same procedures applied. Therefore, the Turkish exchange rate series are very sensitive to the econometric techniques and range of the data used.

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Appendix. Bai and Perron Multiple Break Point Test (2002:01-2018:12)

	Estimated break dates:
	Intercept and trend Shift
Euro	3*: 2005M02, 2012M05, 2016M07
US Dollar	2*: 2008M10, 2013M07
GDP	3*: 2006M06, 2010M02, 2016M07
Ruble	2*: 2014M11, 2016M10
	Intercept Shift
Euro	3*: 2008M03, 2013M08, 2016M07
US Dollar	3*: 2011M07, 2014M01, 2016M07
GDP	3*: 2011M07, 2014M01, 2016M07
Ruble	3*: 2011M07, 2014M11, 2016M12
	Trend Shift
Euro	3*: 2004M07, 2008M10, 2015M05
US Dollar	3*: 2004M07, 2007M02, 2015M03
GDP	3*: 2004M10, 2007M06, 2009M12
Ruble	3*: 2011M07, 2013M06, 2016M12

* Liu, Wu and Zidek (1997) (LWZ) criterion is selected breaks