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Validity of the Purchasing Power Parity Hypothesis for Türkiye: Evidence from Flexible Fourier Unit Root Tests

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Abstract

The purchasing power parity (PPP) hypothesis suggests that the prices of similar goods in different countries will be the same. In other words, it is stated that prices will remain stable worldwide. In this context, this study is important in terms of price stability. The aim of this study is to determine whether the PPP hypothesis is valid or not in Türkiye. In this context, it is aimed to provide policymakers with a perspective in terms of the monetary policy to be implemented. The data range of the study covers the period between 1994:1 and 2025:8 and monthly observation values are used. The study differs from the studies in the literature in terms of the methods applied. As a method, flexible Fourier unit root tests that take into account soft structural breaks are applied. According to the findings of the study, the SGP hypothesis is found to be valid for the Turkish economy when soft structural breaks are taken into account. In other words, the effect of shocks to the real effective exchange rate series is transitory. Furthermore, according to the results obtained, inflation targeting policy has no effect on the real exchange rate. This result is important for policymakers.

Keywords
PPP Hypothesis, Real Effective Exchange Rate, Structural Breaks, Flexible Fourier Unit Root Tests

JEL Classification
B22, C32, F31

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Satınalma Gücü Paritesi Hipotezinin Türkiye İçin Geçerliliği: Esnek Fourier Birim Kök Testlerinden Kanıtlar

Öz

Satınalma gücü paritesi (SGP) hipotezi, farklı ülkelerdeki benzer malların fiyatlarının da aynı olacağını öne sürmektedir. Bir başka ifadeyle tüm dünyada fiyatların istikrar sergileyeceği ifade edilmektedir. Bu bağlamda bu çalışma fiyat istikrarı açısından önem arz etmektedir. Bu çalışmanın amacı, Türkiye'de SGP hipotezinin geçerli olup olmadığının belirlenmesidir. Bu bağlamda politika yapıcılara uygulanacak para politikası açısından bir perspektif sunulması hedeflenmektedir. Çalışmanın veri aralığı 1994:1-2025:8 yılları arası dönemi kapsamakta olup, aylık gözlem değerleri kullanılmıştır. Çalışma, uygulanan yöntemler açısından literatürdeki çalışmalardan farklılık arz etmektedir. Yöntem olarak yumuşak yapısal kırılmaları dikkate alan esnek Fourier birim kök testleri uygulanmıştır. Çalışmadan elde edilen bulgulara göre yumuşak yapısal kırılmalar dikkate alındığında Türkiye ekonomisi için SGP hipotezi geçerli bulunmuştur. Bir başka ifadeyle reel efektif döviz kuru serisine gelen şokların etkisi geçicidir. Ayrıca ulaşılan sonuçlara göre enflasyon hedeflemesi politikası reel döviz kuru üzerinde etkili değildir. Bu sonuç politika yapıcılar açısından önem arz etmektedir.

Anahtar Kelimeler
SGP Hipotezi,
Reel Efektif Döviz Kuru,
Yapısal Kırılma,
Esnek Fourier Birim Kök Testleri

JEL Kodu
B22, C32, F31

1. Introduction

The purchasing power parity (PPP) hypothesis was first developed by Cassel (1918). The hypothesis remains a concept of significance today. (Taylor and Taylor, 2004: 135). One of the problems faced today, when international trade is so vital, is the difference in exchange rates. With purchasing power parity, price differences between countries are eliminated and more reliable results are obtained (Aslan and Kanbur, 2007: 14).

Purchasing power parity explains that similar price levels will occur for similar goods in the absence of any barriers and transportation costs for goods subject to international trade. In cases of scarcity and abundance in goods caused by various differences such as valuable resource reserves, climatic conditions, etc., the arbitrage system operates and the prices of goods converge. For this reason, purchasing power parity theory is based on the law of one price. In other words, the law of one price means that the price of a good will be at the same level in other countries when expressed in the same currency. PPP is an extended form of the law of one price by addressing exchange rate analysis (Akçay and Erataş, 2015: 83; Ay, 2021: 181). The theory is also called the "inflation theory of exchange rates" because it emphasizes changes in the price level as the dominant determinant of exchange rate movements (Dornbusch, 1985: 1).

The purpose of this study is to examine the validity of the SGP hypothesis for the Turkish economy. Within this framework, the aim is to reveal the effect of the real exchange rate on price

stability. It can be stated that the most important aspect distinguishing this study from the literature is the econometric methods applied. Traditional and structural break unit root tests have generally been used in studies in the literature. In this study, however, flexible Fourier unit root tests were applied. In this context, it was also possible to take soft breaks into account. The second section of the study, following the introduction, explains the theoretical framework related to the subject. The third section presents studies in the literature. The fourth section introduces the data set and explains the methods applied. The fifth section summarizes the findings obtained from the study, and the final section is devoted to the conclusions.

2. Theoretical Framework

Purchasing power parity has various contributions reflected in the economic literature. Contributions such as revealing the degree of exchange rate mismatches between countries, eliminating inflation differences for comparing income levels, and explaining the reasons for movements in real exchange rates reveal the importance of PPP (Kasman and Ayhan, 2008: 2).

The PPP hypothesis is divided into absolute and relative. Absolute PPP can be represented as follows:

$$E_t = \frac{p_t}{p_t'} \tag{1}$$

In the formula given above, E_t is the nominal exchange rate, p_t is the domestic price level and p_t' is the foreign price level (Karaoğlu, 2022: 89). Absolute PPP explains that the purchasing power of a domestic currency corresponds to the same level in both currency countries when converted into foreign currency (Turgut and Uçan, 2024: 344).

Relative PPP contends that the percentage change in a country's price level will reflect the percentage change in its exchange rate (İmre, 2021: 275). Since the time element is included in this theory, it is argued that the exchange rate change in a certain period will be offset by the difference in inflation rates for the relevant countries in the same period (Taylor and Taylor, 2004: 137). The relative PPP can be shown as follows:

$$\Delta E_t = \Delta p_t - \Delta p_t' \tag{2}$$

In the formula given above, ΔE_t is the periodic change in the nominal exchange rate, Δp_t is the periodic percentage change in domestic prices and $\Delta p_t'$ is the periodic percentage change in international prices (Karaş Aydın and Zeren, 2023: 102).

Where absolute purchasing power parity is valid, relative purchasing power parity is also valid. However, absolute purchasing power parity does not necessarily apply where relative purchasing power parity applies (Taylor and Taylor, 2004: 137).

One issue to be taken into account with the PPP is that deviations may occur for various reasons. While some deviations are structural, others are temporary. The fact that the productivity growth experienced by countries makes their currencies more valuable than other countries in real terms is structural in nature. Digital transformation, changes in tastes and new regulations for trade are among the pillars that increase productivity and cause changes in the real exchange rate. On the other hand, factors such as capital flows, authorities' interventions in the economy through monetary and fiscal policy instruments are more likely to cause temporary deviations (Güney and Tunalı, 2015: 9).

The validity of the PPP hypothesis has important economic implications. The validity of the PPP hypothesis implies that arbitrage profits are not possible and the goods market is integrated (Liew et al., 2010: 1). Sarno and Taylor (2002) argue that the PPP hypothesis forms the basis of the open economy model and that this model loses its validity if the hypothesis is not met. In this regard, it may be claimed that one of the key factors influencing imports and exports in open economies is the real exchange rate. The stability of the real exchange rate is considered as an indicator of the competitiveness of national economies. Moreover, the validity of the PPP hypothesis indicates that the real exchange rate tends to revert to the mean and shocks to the real exchange rate series are not permanent.

In this context, the study aims to assess the stability of the exchange rate within the framework of the PPP hypothesis. The second section of the study after the introduction summarizes the related literature. In the third section, the data set of the study is introduced and the applied methods are explained. The fourth section presents the findings of the study and the last section is devoted to the conclusion.

3. Literature

The number of studies examining the relationship between purchasing power parity (PPP) and exchange rate has increased in recent years, and different unit root tests and analysis methods have been used primarily in studies on Türkiye. Büyükkantarcı and Kula (2020) examined the validity of PPP in Türkiye using ADF and PP unit root tests and obtained positive results. When the real exchange rate is stationary, the null hypothesis is rejected and there is no unit root, which means that purchasing power parity is valid. On the contrary, if the real exchange rate is non-stationary, the null hypothesis is accepted and there is no unit root, it means that purchasing power parity is not valid. According to the study's findings, purchasing power parity is valid in the relevant period.

Kaya and Çelik (2018), on the other hand, aiming to test real exchange rates for the 2002:M10-2017:M12 period within the framework of the ARFIMA model with long memory tests, similarly found that the PPP hypothesis is valid for Türkiye in the relevant period. It is found that both the dollar and euro real exchange rate series exhibit long memory properties.

Akçay and Erataş (2015) examined the validity of the PPP theory in G7 countries for the period 1995-2012. Within the scope of panel data analysis, the stationarity of the real exchange rate series is tested. While the first generation panel unit root test provides evidence that there is no unit root in the real exchange rate, the second generation unit root tests show that the series contains a unit root, that is, the PPP theory is not valid in G7 countries.

Mike (2018) examines the long-run validity of purchasing power parity for 15 emerging market economies using a real exchange rate model and a purchasing power parity model. The results show that purchasing power parity is not valid for these market economies. Therefore, it is emphasized that relative price movements are not an effective policy tool in determining the future values of exchange rates.

Aydın (2019) analyzed the validity of purchasing power parity for Türkiye with the help of Fourier unit root tests using monthly data for the period 1992:M1-2018:M12. The findings support the validity of the purchasing power parity hypothesis for Türkiye. Accordingly, the real exchange rates of Türkiye are stationary, and shocks to real exchange rates are transitory.

Coşkun (2020) tested the Purchasing Power Parity hypothesis for Türkiye, Brazil, India, Indonesia, and South Africa for the period 1994:M1-2018:M11. It was found that the Purchasing

Power hypothesis is valid for South Africa and India, while the Purchasing Power hypothesis is not valid for Brazil, Indonesia, and Türkiye.

Güney and Tunalı (2015) tested the validity of the purchasing power parity theory for the USD/TL exchange rate for the 1990-2014 period and found that both unit root tests and cointegration analyses resulted in favor of the purchasing power parity tests based on the producer price index. Accordingly, it is emphasized that although purchasing power parity shows short-term deviations, it is a valid theory for the USD/TL exchange rate in the long run and provides a general trend for exchange rate movements.

In their study, Şeker and Şimdi (2018) tested the validity of PPP in the period 2005:M1-2017:M3 and used the nominal exchange rate and domestic consumer price index of Türkiye and the consumer price index of the United States of America (USA). According to the results, there is a long-run relationship between the nominal exchange rate, the domestic consumer price index, and the US consumer price index in Türkiye.

Hacıimamoğlu (2021) used the BCIPS unit root analysis method to test the validity of the PPP hypothesis for the period 1970-2019 in nine N-11 countries. Real exchange rates for the N-11 countries are found to be stationary, and therefore, it is concluded that the PPP hypothesis is valid. In this context, it is emphasized that the effect of shocks on the real (effective) exchange rate in N-11 countries is transitory.

Sarno and Taylor (2001), assess the progress made by the profession in understanding real exchange rate behaviour through a selective and critical but nonetheless expository review of the literature. Our reading of the literature leads us to the main conclusions that purchasing power parity might be viewed as a valid long-run international parity condition when applied to bilateral exchange rates among major industrialized countries and that also means reversion in real exchange rates displays significant non-linearities.

Mohapatra and Biswas (1997), contends that if the equilibrium real exchange rate has shifted over time due to real shocks, then what is interpreted as the failure of the Purchasing Power Parity (PPP) may not actually be so. Econometric tests indicate that the variable trend/cointegration implication is broadly consistent with the quarterly movements of bilateral exchange rates for the period 1973Ql to 1993Q4 between the U.S. and other countries like Germany, Japan, U.K. and Switzerland.

Ghiba (2011) aims to analyse the behaviour of the real exchange rate between the EURO and the Romanian leu (RON) under the purchasing power parity paradigm. It used Augmented Dickey-Fuller and Phillips-Perron stationarity tests to check for deviations of the real exchange rate from purchasing power parity. The results of this study emphasise that PPP is not valid; the real exchange rate stationarity tests do not confirm stationarity, therefore, there is no relationship between these three variables. there is no equilibrium relationship.

Mishra and Sanjay (2011), examines the relationship between nominal exchange rate and prices as postulated by the Purchasing Power Parity hypothesis. The result of unit root test suggests that strict PPP does not hold. Also, the results from panel cointegration test suggest that the nominal exchange rate and relative prices do move together in the long-run, which apparently provides some support to weak PPP.

The unit root test results of Doğanlar and Özmen (2000) for 18 developing countries including Türkiye for the period 1986.1-1997.4 show that none of the real exchange rate series are stationary for these countries. Therefore, it is stated that Purchasing Power Parity is not valid for these countries when defined in terms of real exchange rates.

Behera (2019), examines the long-run purchasing power parity (PPP) by testing for unit roots in real exchange rates of 10 newly industrialized countries during the period 1980-2013. The Pesaran, unit root test results support the evidence of long-run PPP during the period 1980-1990; however, during the other sub-periods, the results invalidate the long-run PPP. The results suggest the mere evidence of strong PPP and also suggest that the speed at which the real exchange rates restore to equilibrium is relatively slow during the period 1991-2000.

Empirical studies of PPP and real exchange rates have found favourable results when the countries examined experienced periods of high inflation (Frenkel, 1978, 1981) or when the period under investigation was of long duration (Abuaf and Jorion, 1990; Kim, 1990). However, empirical studies of the recent floating exchange rate period cast doubt on the hypothesis that the PPP theory holds in the long-run for major industrial countries (Hondroyiannis and Papapetrou,1997).

Melvin and Norrbin (2017) examines the validity of both the short-run and long-run purchasing power parity (PPP) hypotheses in Japan using two estimation methods, namely, a unit root test and an Autoregressive Distributed Lag (ARDL) cointegration test. The first test reveals the mean

reversion of real exchange rate (RER) in the long-run. From the second test, it found that there is a strongly robust long-run PPP relationship but no significant short-run PPP relationship.

Turgut and Uçan (2024) investigated the validity of the PPP hypothesis in E7 countries for the period 1992-2022 in their study. The Bootstrap Hadri unit root test and Westerlund ECM cointegration test were applied as methods in the study. Findings from the study indicate that there is a cointegration relationship between the nominal exchange rate and the ratio of the domestic price level to the foreign price level. In this context, it was concluded that the SGP hypothesis is valid in the E7 countries.

Yardımcı (2024) examined the validity of the SGP hypothesis for the Turkish economy in his study. The data range of the study was set as the period 2013-2023. ADF, DF-GLS, Zivot-Andrews, and Lee-Strazicich unit root tests were applied as the method. According to the findings of the study, the SGP hypothesis was found to be valid in Turkey.

As seen in the literature, the methods applied generally stand out as traditional unit root tests and techniques that consider sudden structural breaks. The most significant contribution of this study to the literature is the application of flexible Fourier unit root tests. Unit root tests based on Fourier functions offer superiority in terms of their ability to capture soft structural changes. In this context, slow structural changes can also be taken into account, making it possible to obtain more reliable results.

4. Data Setting and Method

This study uses CPI-based real effective exchange rate data as the data set. The data range of the study covers the period between 1994:M1 and 2025:M8 and analyzes are conducted with monthly observation values. In this context, a wide range of dates is covered and it is aimed to provide a long-term perspective for the Turkish economy. The data set for the study was obtained from the Central Bank of the Republic of Türkiye (2025) database.

Unit root tests were used as the methodology in this study. In this context, the fact that the real effective exchange rate series follows a unit root process indicates that the PPP hypothesis is not valid. The stationarity result, on the other hand, indicates the validity of the PPP hypothesis. The first unit root test in the literature was developed by Dickey and Fuller (1979). The Dickey-Fuller (DF) unit root test is based on a first-order autoregressive model. Within the scope of the

test, the time series consisting of first difference values are taken as the dependent variable and the series consisting of one-period lagged values are taken as the independent variable. The null hypothesis that the independent variable parameter is equal to zero is tested against the alternative hypothesis that the coefficient is negative. If the test statistic is smaller than the critical values produced by Dickey and Fuller (1979), the null hypothesis is rejected and the series is stationary. However, time series may not always be suitable for a first-order autoregressive model. In this case, autocorrelation problem may occur among the error terms. In order to eliminate the autocorrelation problem, Dickey and Fuller (1981) suggested adding lagged values of the dependent variable to the right-hand side of the model. This process, defined as the Augmented Dickey-Fuller (ADF) test, is constructed with three different model specifications as follows.

$$\Delta Y_t = \delta Y_{t-1} + \sum_{i=2}^{p} \delta_i \Delta Y_{t-i+1} + \varepsilon_t \quad (3)$$

$$\Delta Y_t = \mu + \delta Y_{t-1} + \sum_{i=2}^{p} \delta_i \Delta Y_{t-i+1} + \varepsilon_t \quad (4)$$

$$\Delta Y_t = \mu + \beta t + \delta Y_{t-1} + \sum_{i=2}^{p} \delta_i \Delta Y_{t-i+1} + \varepsilon_t \quad (5)$$

The above models are named as model without constant, model with constant and model with constant-trend respectively. The test procedure is similar to the DF test.

The ADF unit root test assumes that the error terms obtained from models (1), (2), (3) are normally distributed. However, these error terms may not always follow a normal distribution. In this case, the results of the ADF test become controversial. In case the error terms do not conform to the normal distribution, it is possible to obtain stronger results from the Residuals Augmented Least Squares (RALS) type ADF unit root test developed by Im et al. (2014). In the RALS-ADF test process, models (3), (4) and (5) are first estimated by the least squares method and the error terms of the models are obtained. In the second stage, we use the non-normal distribution of the residuals to obtain the variables augmented with the residuals expressed as $\widehat{w_{2t}}$ and $\widehat{w_{3t}}$ which are calculated as follows.

$$\widehat{w_{2t}} = \widehat{\varepsilon_t}^2 - m_2 \quad (6)$$

$$\widehat{w_{3t}} = \widehat{\varepsilon_t}^2 - m_3 - 3m_2\widehat{\varepsilon_t} \quad (7)$$

The moment value m_j in equations (4) and (5) is calculated as follows.

$$m_j = \frac{\sum_{t=1}^{T} \varepsilon_t{}^j}{T} \quad (8)$$

In the next stage of the test, the residual-extended variables in equations (6) and (7) are added to the ADF conventional test regression and the following regression equations are obtained.

$$\Delta y_t = \mu + \delta y_{t-1} + \sum_{i=1}^{k} \alpha_i \Delta y_{t-i} + \theta_2 \widehat{w_{2t}} + \theta_3 \widehat{w_{3t}} + v_t \quad (9)$$

$$\Delta y_t = \mu + \beta t + \delta y_{t-1} + \sum_{i=1}^{k} \alpha_i \Delta y_{t-i} + \theta_2 \widehat{w_{2t}} + \theta_3 \widehat{w_{3t}} + v_t \quad (10)$$

Regression equations (9) and (10) above are defined as the model with constant and the model with constant and trend, respectively. Models (9) and (10) are estimated to obtain the test statistic calculated as follows.

$$\tau_{RALS-ADF} = \rho \tau_{ADF} + \sqrt{1 - \rho^2 Z} \quad (11)$$

In equation (11), Z denotes any variable with zero mean and constant variance. ρ is the correlation coefficient between the error terms of the ADF unit root test model and the error terms of the RALS ADF unit root test. The main and alternative hypotheses of the RALS-ADF test are constructed as follows.

$$H_0: \delta = 0 \quad (12)$$

$$H_1: \delta < 0 \quad (13)$$

If the absolute value of the calculated test statistic is smaller than the critical values produced by Im et al. (2014), the null hypothesis cannot be rejected and the series follows a unit root process.

ADF and RALS-ADF tests do not take structural breaks into account. Perron (1989) argued that in the presence of structural breaks, if these breaks are not included in the unit root test, results tending towards the acceptance of the null hypothesis of unit root can be obtained. The first unit root test that takes structural breaks into account was developed by Perron (1989). In this unit root test, it is assumed that the date of structural break is known in advance and only one structural break can be considered. Following the Perron unit root test, which was criticized in this context, various structural break unit root tests such as Zivot-Andrews (1992), Lumsdaine-Papell (1997), Perron (1997), Lee-Strazicich (2003, 2004), Kapetanios (2005), Carrion-i Silvestre et al. (2009), Narayan-Popp (2010) have been developed, which can take more than one structural break into account. However, these tests take into account sudden structural breaks and fail to capture smooth transitions. In this study, unit root tests based on Fourier functions that can take into account smooth

breaks are applied. For the integrity of the study, the Fourier ADF unit root test is first applied and compared with the traditional ADF and RALS-ADF test results. In the second stage, flexible Fourier unit root tests, a special form of Fourier unit root tests, were performed. In the first stage of the Fourier ADF test developed by Christopoulos and Leon-Ledesma (2010), the regression equation expressed as follows is estimated by the least squares method to obtain the error terms of the model.

$$y_t = \alpha + \gamma_1 \sin\left(\frac{2\pi kt}{T}\right) + \gamma_2 \cos\left(\frac{2\pi kt}{T}\right) + \varepsilon_t \quad (14)$$

In the above equation, T is the number of observations and k is the number of frequencies. It is important to determine the frequency number correctly. In this context, all frequency numbers from 1 to 5 are tested and the frequency number is determined at the point where the sum of residual squares is minimum. In the second stage of the test, the conventional ADF unit root test is applied to the error terms series. The null hypothesis of the test is that the series is unit rooted. The alternative hypothesis implies stationarity under soft breaks.

If the calculated Fourier ADF test statistic is less than the critical value in absolute terms, the null hypothesis cannot be rejected and the series is found to be unit rooted. Otherwise, the null hypothesis is rejected and the series is stationary under soft breaks. If the stationarity result is reached, the significance of the parameters related to the trigonometric terms should be tested with the F test. The critical values calculated by Becker et al. (2006) are taken into account in the F test. If both parameters of the trigonometric terms are not statistically significant, the test becomes a conventional ADF test. In the Fourier ADF test, only the model with constant term is used as shown in equation (12). However, in this study, the model with constant and trend is considered and the critical values calculated by Hepsağ (2021) are used.

This study also employs flexible Fourier unit root tests. First, the flexible Fourier unit root test developed by Enders and Lee (2012) is applied. In the first stage of the test, the following regression equations are estimated by the least squares method to obtain the error terms.

$$\Delta y_t = \alpha + \gamma_1 \sin\left(\frac{2\pi kt}{T}\right) + \gamma_2 \cos\left(\frac{2\pi kt}{T}\right) + \delta y_{t-1} + \varepsilon_t \quad (15)$$

$$\Delta y_t = \alpha + \beta t + \gamma_1 \sin\left(\frac{2\pi kt}{T}\right) + \gamma_2 \cos\left(\frac{2\pi kt}{T}\right) + \delta y_{t-1} + \varepsilon_t \quad (16)$$

Unlike the Fourier ADF test, the Enders-Lee test uses the difference series of the dependent variable as shown in equations (15) and (16). There is also a model with constant and trend. In the test regression (16), t denotes the trend. In the second stage of the test, DF type unit root test is applied to the residuals obtained in the first stage. Another difference of this test from the Fourier ADF test is that the F test is applied first. In other words, at least one of the parameters of the trigonometric terms must be statistically significant for the test process to be initiated. The null hypothesis of the test is unit rootedness while the alternative hypothesis is stationarity under soft breaks. If the test statistic calculated at the decision stage of the test is greater than the critical values in absolute value, the null hypothesis of unit root is rejected and the series is stationary under soft breaks.

The last unit root test applied in this study is the discrete flexible Fourier unit root test developed by Omay (2015). The difference of this test from other unit root tests based on Fourier functions is that the number of frequencies (k) does not have to be an integer. Omay (2015) states that allowing the number of frequencies to take fractional values increases the power of the test. The following regression equation is used in the testing process.

$$\Delta y_t = p y_{t-1} + c_1 + c_2 t + \beta t + c_3 \sin\left(\frac{2\pi k t}{T}\right) + c_4 \cos\left(\frac{2\pi k t}{T}\right) + \varepsilon_t \qquad (17)$$

In the above test regression, the frequency value (k) can take values between 0.1 and 2. In this test, at least one of the trigonometric terms must be statistically significant in order to start the testing process. Once this condition is met, the test for the existence of a unit root can proceed. The null hypothesis of the fractional flexible Fourier unit root test is a unit root while the alternative hypothesis is stationarity under soft breaks. If the test statistic calculated at the decision stage of the test is greater than the critical values in absolute value, the null hypothesis of unit root is rejected and the series is stationary under smooth breaks.

5. Findings

Unit root tests were utilized to investigate the validity of the PPP hypothesis. In this context, the conventional ADF unit root test was first applied to the CPI-based real effective exchange rate series and the test results are presented in Table 1.

Table 1

ADF Test Results

Optimal Lag Length	1
ADF Test Statistic	-2,70771
Critical Value (%1)	-3,982920
Critical Value (%5)	-3,421950
Probability	0,4721
Jarque Bera Test Statistic	144,175170
Probability (JB)	0,0000

As seen in Table 1, the calculated test statistic is greater than the critical values. The null hypothesis of unit root cannot be rejected. According to the ADF unit root test results, the null hypothesis of PPP is not valid. However, an important assumption of the ADF test is that the residual series obtained from the model conforms to the normal distribution. The last two rows of Table 1 present the results of the Jarque-Bera normality test applied to the residual series. The probability value less than 0.05 indicates that the residual series does not conform to a normal distribution. In this framework, since the ADF unit root test results are not reliable, the RALS-ADF unit root test, which takes into account the non-normal distribution of the residuals, is applied and the test results are presented in Table 2**.**

Table 2

RALS-ADF Unit Root Test Results

Optimal Lag Length	1
p^2	0,8
Test Statistic	-2,82527
Critical Value (%1)	-2,950
Critical Value (%5)	-2,995

As seen in Table 2, the calculated test statistic is greater than the critical values. In other words, the null hypothesis of unit root in the conventional ADF unit root test cannot be rejected. According to the results of the RALS-ADF unit root test, the null hypothesis of PPP is also not valid. However, the conventional ADF and RALS-ADF unit root tests do not consider structural breaks. Ignoring structural breaks may yield results that tend towards the acceptance of the null hypothesis of unit root. Accordingly, the Fourier ADF unit root test considering soft structural

breaks was applied to the CPI-based real exchange rate series and the test results are presented in Table 3.

Table 3

Fourier ADF Unit Root Test Results

Optimal Lag Length	1
k	1
Minimum Residual Sum of Squares	19127,54694
Fourier ADF Test Statistic	-6,52525
Critical Value (%1)	-4,86
Critical Value (%5)	-4,30
F Statistic	970,64055

Note. Critical values for F test: 6,873 (%1), 4,972 (%5)

As seen in Table 3, the calculated test statistic is smaller than the critical values. The null hypothesis of unit root is rejected and it is concluded that the series follows a trend stationary process under soft structural breaks. When soft structural breaks are taken into account, it is understood that the series becomes stationary. In this context, the PPP hypothesis is found to be valid for the Turkish economy for the period analyzed. For the stationarity result to be valid, it is important that at least one of the coefficients of the trigonometric terms in the model is statistically significant. In order to test the significance of the coefficients on the trigonometric terms, the F test was applied and the test results are included in the last row of Table 3. Critical values for the F test are provided in the footnote. As seen in the table, the calculated test statistic is greater than the critical values. The null hypothesis that neither of the trigonometric terms is statistically significant is rejected. In this context, the stationarity result is valid.

In order to verify the result obtained at this stage, flexible Fourier unit root tests were applied. First, Enders-Lee unit root test is applied and the test results are presented in Table 4.

Table 4

Enders-Lee Unit Root Test Results

Optimal Lag Length	1
K	1
Minimum Residual Sum of Squares	3913,44614
Test Statistic	-6,52541
Critical Value (%1)	-4,81
Critical Value (%5)	-4,29
F Statistic	17,84018

Note. Critical values for F test: 12,21 (%1), 9,14(%5)

In flexible Fourier unit root tests, the significance of the parameters related to the trigonometric terms should be tested first. As seen in Table 4, the statistical value obtained for the F test is greater than the critical values. In other words, the null hypothesis that both trigonometric terms are statistically insignificant is rejected. In this context, we proceeded to the unit root test and as seen in Table 4, the test statistic obtained is smaller than the critical values. Accordingly, the null hypothesis of unit root is rejected and it is concluded that the series follows a trend stationary process under soft breaks. The Enders-Lee unit root test also provides evidence that the series is stationary and the PPP hypothesis is valid. Finally, the Omay test, known as the fractional flexible Fourier unit root test, is applied and the test results are presented in Table 5.

Table 5

Omay Unit Root Test Results

Optimal Lag Length	1
K	0,2
Minimum Residual Sum of Squares	3955,16722
Test Statistic	-5,17253
Critical Value (%1)	-4,50
Critical Value (%5)	-3,90
F Statistic	10,15683

Note. Critical values for F test: 13,42 (%1), 10,40 (%5), 8,91 (%10)

In the Omay unit root test, the statistical significance of the parameters related to the trigonometric terms should be tested first. As seen in Table 5, the F statistic is greater than the critical value at the 10% significance level. The null hypothesis that both parameters of the trigonometric terms are not statistically significant is rejected at the 10% significance level. Accordingly, we proceed to test for the existence of a unit root. As can be seen from the table, the calculated test statistic is smaller than the critical values. The null hypothesis of unit root is rejected

and it is concluded that the series follows a trend stationary process under soft breaks. In other words, according to this test, the PPP hypothesis is also valid.

When all the unit root tests are evaluated together, it is seen that the tests that take structural breaks into account give different results than the tests that do not take these breaks into account. According to the tests that do not take structural breaks into account, the PPP hypothesis is not valid, while the tests that take structural breaks into account indicate the validity of the PPP hypothesis. It is known that when structural breaks are not taken into account, unit root tests give results that tend towards the acceptance of the null hypothesis of unit root. In addition, in order to support the results of the Fourier ADF test, flexible and fractionally flexible Fourier unit root tests were also applied and these tests provided evidence that the PPP hypothesis is valid.

6. Discussion and Conclusion

This study investigates the validity of the PPP hypothesis for Türkiye using advanced econometric methods. The findings of the study reveal the necessity of applying advanced methods. According to the results of the conventional ADF and RALS-ADF unit root test, which takes into account the non-normal distribution of the residual series, the hypothesis is not valid for the Turkish economy. However, according to the results of the Fourier ADF unit root test, which takes into account soft structural breaks, the real effective exchange rate series is found to be stationary. In other words, the PPP hypothesis is valid. An important difference of this study from the studies in the literature is that flexible Fourier unit root tests are also applied. In the Enders-Lee (2012) test, which is one of the flexible Fourier unit root tests, unlike other Fourier tests, the deterministic trend can also be modeled with Fourier functions. The Omay (2015) unit root test differs from other Fourier unit root tests by allowing the frequency value to take fractional values. The results of the flexible Fourier unit root tests also provide evidence that the PPP hypothesis is valid in Türkiye. The results of the study are inconsistent with Gerek and Karabacak (2017) and consistent with Aydın (2019).

The validity of the PPP hypothesis for Türkiye can be interpreted in various ways. The real effective exchange rate series tends to revert to the average in the long run. In other words, shocks to the real effective exchange rate do not leave a permanent effect. In this context, it can be said that nominal exchange rates move in a way to eliminate price differences. In this context, it is understood that the exchange rate market is able to eliminate short-term deviations in the long run

with its own internal dynamics. Moreover, it can be stated that the real effective exchange rate is independent of the monetary policies being implemented. This is particularly important for inflation targeting. Knowing that the inflation targeting policy will not have a permanent effect on the real effective exchange rate will increase the effectiveness of the policy. This result provides an important perspective for policy makers.

In an environment where exchange rate fluctuations do not directly threaten inflation targeting, the central bank's policy effectiveness increases, and its ability to achieve price stability is strengthened. In this context, it is concluded that while temporary shocks to the exchange rate can be managed by policymakers through limited and careful interventions, the main objective should be to achieve price stability and manage expectations. Moreover, macroprudential policies should be used effectively to maintain financial stability, and the short-term effects of exchange rate shocks on the banking and financial sector should be prevented. In order to limit the adverse effects of exchange rate volatility on the real sector, emphasis should be placed on structural reforms to transform the export structure into a high-value-added and technology-oriented one. Reliable information that exchange rate movements do not cause permanent inflationary effects will bring the pricing behavior of market actors to a rational basis and limit cost pass-through. Moreover, the Central Bank's adoption of a transparent and strong communication policy will reduce uncertainties by providing accurate information to the public.

Declaration of Research and Publication Ethics

This study which does not require ethics committee approval and/or legal/specific permission complies with the research and publication ethics.

Researcher’s Contribution Rate Statement

The authors contributed equally to the article.

Declaration of Researcher’s Conflict of Interest

There are no potential conflicts of interest in this study.

References

Abuaf, N. & Jorion, P. (1990). Purchasing power parity in the long run. *The Journal of Finance*, *45*(1), 157-174.

Akçay, A.Ö. & Erataş, F. (2015). Satın alma gücü paritesi teorisinin geçerliliği: G7 örneği. *İstanbul Gelişim Üniversitesi Sosyal Bilimler Dergisi*, *2*(1), 81-100. https://doi.org/10.17336/igusbd.72757

Aslan, N. and Kanbur, A. (2007). Türkiye'de 1980 sonrası satın alma gücü paritesi yaklaşımı. *Marmara Üniversitesi İktisadi ve İdari Bilimler Dergisi*, *23*(2), 9-43.

Ay, İ. C. (2021). OECD ülkelerinde satın alma gücü paritesinin geçerliliğinin analizi. *Iğdır Üniversitesi Sosyal Bilimler Dergisi, ICOMEP Özel Sayısı,* 180-191.

Aydın, M. (2019). Satın alma gücü paritesi hipotezi geçerliliğinin Fourier birim kök testleri ile incelenmesi: Türkiye örneği. *EKOIST Journal of Econometrics and Statistics*, *0*(30), 35-48. https://doi.org/10.26650/ekoist.2018.30.0001

Becker, R., Enders, W. & Lee, J. (2006). A Stationarity test in the presence of an unknown number of smooth breaks. *Journal of Time Series Analysis*, *3*(5), 381-409.

Behera, S. R. (2019). Purchasing power parity tests in cointegrated panels: Evidence from newly industrialized countries. *Journal of Economic Development*, *44*(1), 69-99. https://doi.org/10.35866/CAUJED.2019.44.1.004

Büyükkantarcı Tolgay, S. & Kula, F. (2020). Satın alma gücü paritesinin geleneksel olmayan para politikaları altında geçerliliği: Türkiye üzerine bir uygulama. *Erciyes Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi*, (55), 1-20. https://doi.org/10.18070/erciyesiibd.556202

Carrion-i Silvestre, J.L., Kim, D. & Perron, P. (2009). GLS-Based Unit Root tests with multiple structural breaks under both the null and the alternative hypothesis. *Econometric Theory, 25*(6), 1754-1792.

Christopoulos, D. K. & León-Ledesma, M. A. (2010). Smooth breaks and Non-Linear mean reversion: Post-Bretton Woods real exchange rates. *Journal of International Money and Finance, 29*(6), 1076-1093.

Coşkun, N. (2020). Mutlak satın alma gücü paritesi hipotezi: Kırılgan Beşli örneği. *Bulletin of Economic Theory and Analysis*, *5*(1), 41-55. https://doi.org/10.25229/beta.678866

Dickey, D. A. & Fuller, W. A. (1979). Distribution of the estimators for autoregressive time series with a Unit Root. *Journal of the American Statistical Association*, *74*(366), 427-431.

Dickey, D.A. & Fuller, W.A. (1981). Likelihood ratio statistics for autoregressive time series with a Unit Root. *Econometrica*, *49*(4), 1057-1072.

Doğanlar, M. & Özmen, M. (2000). Purchasing power parity and real exchange rates in case of developing countries. *Istanbul Stock Exchange Review*, *4*(16), 91-102. Retrieved April 20, 2025, from https://ideas.repec.org/a/bor/iserev/v4y2000i16p91-102.html

Dornbusch, R. (1985). *Purchasing power parity.* National Bureau of Economic Research, Working Paper No: 1591.

Enders, W. & Lee, J. (2012). The flexible Fourier form and Dickey–Fuller type Unit Root tests. *Economics Letters*, 196-199.

Frenkel, J.A. (1978). Purchasing power parity: Doctrinal perspective and evidence from the 1920s. *Journal of International Economics*, *8*, 161-91.

Frenkel, J.A. (1981). The Collapse of purchasing power parities during the 1970s. *European Economic Review*, 16 (May), 145-165.

Ghiba, N. (2013). Purchasing power parity influence on real exchange rate behavior in Romania. *Research Papers in Economics*, *4*, 524-536. Retrieved March 5, 2025, from http://ceswp.uaic.ro/articles/CESWP2011_III4_GHI.pdf

Güney, A. & Tunalı, H. (2015). Satın alma gücü paritesi teorisinin döviz kuru belirleme modeli olabilirliği üzerine ampirik bir inceleme: Türkiye örneği. *AİBÜ Sosyal Bilimler Enstitüsü Dergisi*, *15*(4), 1-34.

Hacıimamoğlu, T. (2021). Satın alma gücü paritesi geçerliliğinin Fourier birim kök testi ile incelenmesi: N-11 ülkeleri örneği. *Business and Economics Research Journal*, *12*(4), 799-811. http://dx.doi.org/10.20409/berj.2021.353

Hepsağ, A. (2021). Critical values for FADF and FKSS Unit Root Tests (Model with a constant and a linear trend). *Researchgate*, Retrieved May 4, 2025, from https://www.researchgate.net/publication/352750116_Critical_Values_for_FADF_and_FKSS_Unit_Root_Tests_Model_with_a_constant_and_a_linear_trend

Hondroyiannis, G. & Papapetrou, E. (1997). Purchasing power parity and cointegration: The case of Greek exchange rates. 60-80. Palgrave Macmillan, London. https://doi.org/10.1007/978-1-349-25755-3_5

Im, KS. Lee, J. & Tieslau M.A. (2014). More powerful unit root tests with non-normal errors. (Eds: R. C. Sickles, W. C. Horrace), Festschrift in honor of Peter Schmidt. Springer, New York, 315–342.

İmre, S. (2021). The validity of the purchasing power parity hypothesis in OECD countries: Evidence from the Fourier test/OECD ülkelerinde satın alma gücü paritesi hipotezinin geçerliliği: Fourier testinden kanıtlar. *Uluslararası Ekonomi İşletme ve Politika Dergisi*, *5*(2), 274-289.

Kapetanios, G. (2005). Unit-Root testing against the alternative hypothesis of up to M structural breaks. *Journal of Time Series Analysis*, *26*(1), 123-133.

Karaoğlu, Ö. (2022). Satın alma gücü paritesi teorisinin geçerliliği: Seçilmiş OECD ülkeleri için bir uygulama. *International Journal of Applied Economic and Finance Studies*, *7*(1), 86-104.

Karaş Aydın, E. K. & Zeren, F. (2023). OECD ülkelerinde satın alma gücü paritesi hipotezinin analiz edilmesi: RALS Fourier KPSS Durağanlık Testi1. Ekonomi, *Sürdürülebilir Kalkınma ve İşletme Alanında Akademik Çalışmalar*, 101-110.

Kasman, S. & Ayhan D. (2008). Avrupa Birliği'nin genişleme sürecinde satın alma gücü paritesi sağlanıyor mu?. *2. Ulusal İktisat Kongresi*, 1-14.

Kaya, H. & Çelik, İ. (2018). Türkiye'de satın alma gücü paritesi hipotezinin geçerliliği: Uzun hafıza testlerinden kanıtlar. *Journal of Mehmet Akif Ersoy University Economics and Administrative Sciences Faculty*, *5*(2), 351-365. https://doi.org/10.30798/makuiibf.406276

Kim, Y. (1990). Purchasing power parity in the long-run: A Cointegration approach. *Journal of Money Credit, and Banking*, *22*, 491-503.

Lee, J. & Strazicich, M.C. (2003). Minimum lagrange multiplier unit root test with two structural breaks. *The Review of Economics and Statistics*, *85*(4), 1082-1089.

Lee, J. & Strazicich, M.C. (2004). Minimum lagrange multiplier unit root tests with one structural break. Appalachian State University Working Papers, *4*(17), 1-15.

Liew, V. K. S., Chia, R. C. J. & Ling, T. H. (2010). Long-run validity of purchasing power parity and rank tests for cointegration for Central Asian countries. *Applied Economics Letters*, *17*(11), 1073-1077.

Lumsdaine, R. L. & Papell, D. H. (1997). Multiple trend breaks and the unit root hypothesis. *The Review of Economics and Statistics*, *79*, 212-218.

Melvin, M. & Norrbin, S. C. (2017). Prices, exchange rates and purchasing power parity. 135–154. https://doi.org/10.1016/B978-0-12-804106-2.00007-1

Mike, F. (2018). Gelişen piyasa ekonomilerinde satın alma gücü paritesinin geçerliliğinin test edilmesi. *Finans Politik & Ekonomik Yorumlar*, *55*(637), 7-30.

Mishra, R.K. & Sanjay, S. (2011). Exchange rates and prices in purchasing power parity framework: Are Bilateral real exchange rates stationary?. *International Journal of Economic Policy in Emerging Economies*, *4*(3), 274-286. https://doi.org/10.1504/IJEPEE.2011.040918

Mohapatra, S. & Biswas, B. (1997). Purchasing power parity and equilibrium real exchange rate. *9*, 1. Retrieved April 10, 2025, from https://digitalcommons.usu.edu/cgi/viewcontent.cgi?article=1119&context=eri

Narayan, P.K. & Popp, S. (2010). A new unit root test with two structural breaks in level and slope at unknown time. *Journal of Applied Statistics*, *37*(9), 1425-1438.

Omay, T. (2015). Fractional frequency flexible Fourier form to approximate smooth breaks in unit root testing. *Economics Letters*, *134*, 123–126.

Perron, P. (1989). The great crash, the oil price shock, and the unit root hypothesis. *Econometrica*, *57*, 1361-1401.

Perron, P. (1997). Further evidence on breaking trend functions in macroeconomic variables. *Journal of Econometrics*, *80*(2), 355-385.

Sarno, L. & Taylor, M. P. (2002). Purchasing power parity and the real exchange rate. *IMF Staff Papers*, *49*(1), 65-105.

Şeker, A. & Şimdi, H. (2018). Yeni dönemde satın alma gücü paritesinin güçlü formda geçerliliği: Türkiye örneği. *Süleyman Demirel Üniversitesi Sosyal Bilimler Enstitüsü Dergisi*, (31), 91-104.

Taylor, A. M. & Taylor, M. P. (2004). The Purchasing power parity debate. *Journal of Economic Perspectives*, *18*(4), 135-158.

Turgut, E. & Uçan, O. (2024). Satınalma gücü paritesinin geçerliliği: E-7 ülkeleri örneği (1992-2022). *Ömer Halisdemir Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi*, *17*(2), 343-356.

TCMB, (2025), *TÜFE Bazlı Reel Efektif Döviz Kuru*, Retrieved April 10, 2025, from https://www.tcmb.gov.tr/wps/wcm/connect/TR/TCMB+TR/Main+Menu/Istatistikler/Doviz+Kurlari/Reel+Efektif+Doviz+Kuruu/Veri+%28Tablolar%29+-+Mart+2025/

Turgut, E. & Uçan, O. (2024). Satınalma gücü paritesinin geçerliliği: E-7 ülkeleri örneği. *Ömer Halisdemir Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi*, *17*(2), 343–356.

Yardımcı, M. C. (2024). Satın alma gücü paritesi hipotezinin Türkiye için geçerliliğinin araştırılması: Lineer olmayan birim kök testi. *Uluslararası Batı Karadeniz Sosyal ve Beşeri Bilimler Dergisi*, *8*(1), 22-39.

Zivot, E. & Andrews, D. (1992). Further evidence on the great crash, the oil-price shock and the unit-root hypothesis. *Journal of Business Economic Statistics*, *10*(3), 251- 270.