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THE NATURE OF SHOCKS TO TURKISH EXCHANGE RATES: WHAT PANEL APPROACH SAYS?

Abstract:

This paper investigates the behavior of Turkish exchange rates within the context of purchasing power parity (PPP) hypothesis, -employing ten Turkish real exchange rates during January 2002-May 2012-, by means of recent developments in panel unit root testing procedures. When we account for nonlinearity, smooth structural shifts, and cross-section dependency, the empirical analysis supports that PPP hypothesis is valid for Eurozone and European countries (Denmark, Norway, Sweden, Switzerland, and United Kingdom), while it does not hold for non-European trading partners (Canada, Japan, Saudi Arabia, and USA). From the empirical results, we can conclude that PPP hypothesis is hold in the countries which have the free trade agreement, while it is violated in the countries in which there are trade barriers and greater distance. The findings therefore provide important policy implications for Turkey about determining equilibrium exchange rates with Eurozone and other European Union countries.

Keywords:

Purchasing power parity, Turkey, panel unit root

JEL Classification: C23, F31

1. Introduction

Turkey as an emerging country and one of the fast growing economies during the last decade has been implementing the trade-oriented growth model. The exchange rate policy in that respect is at the center of trade and monetary policies. After the eruption of the 2001 crisis, Turkey shifted from pegged to flexible exchange rate system and hence the behavior of Turkish lira has attracted a great deal of attention in recent years. Thereby determining the behavior of exchange rates would provide important information for better understanding of the dynamics of Turkish lira against major trading partners and is also crucial for designing sound monetary policy for macroeconomic stability.

With respect to whether exchange rates exhibit trend or do not follow a mean reverting process, the prominent theory is purchasing power parity (PPP) hypothesis which implies that exchange rates adjust to their equilibrium values until purchasing power discrepancy across countries disappears. This means that exchange rates between two countries change according to relative prices so they show a mean reverting behavior. Given the importance of PPP hypothesis in open economy macroeconomics and for constructing fundamental equilibrium exchange rates, long-run PPP relationship is of great importance for academicians and policy makers (Cerrato and Sarantis, 2007). The common approach in examining PPP hypothesis is to carry out unit root analysis on real exchange series in order to determine whether or not real exchange rates are mean reverting. The stationary real exchange rates provide evidence in favor of PPP hypothesis (see Rogoff, 1996; Sarno and Taylor, 2002; Taylor, 2003).

The literature on the behavior of Turkish real exchange rates shows that there is no consensus whether PPP hypothesis holds[1]. On the one hand, some studies supports evidence on the validity of PPP hypothesis (Sarno, 2000; Yazgan, 2003; Erlat, 2003; Kalyoncu, 2009; Guloglu et al., 2011). On the other hand, some studies find out the lack of PPP hypothesis (Telatar and Kazdagli, 1998; Erlat and Ozdemir, 2003; Doganlar et al., 2009). The controversy in the literature can be attributed to two reasons. It seems that the results from the empirical studies differ based on time period and data frequency. For instance, Telatar and Kazdagli (1998) reject PPP hypothesis for the period 1980-1993 with monthly data; Kalyoncu (2009) supports the hypothesis employing quarterly data for 1980-2005. It also appears that the difference in empirical evidence is based on empirical methods which have different assumptions regarding data generating process of the exchange rates. In the panel data studies, Erlat and Ozdemir (2003) rely on the panel unit root test that takes into account dependency across series. In a recent study, Guloglu et al. (2011) utilize panel unit root approach controlling for structural shifts. The lack of consensus on the validity of PPP hypothesis provides a room to analyze the behavior of Turkish exchange rates within the context of recent developments in unit root tests which assume different generating process. By employing a different unit root testing approach, this paper tries to extend the recent discussion on whether shocks to Turkish exchange rates are permanent or transitory. This study contributes to the literature by providing new information regarding the nature of the dynamics in Turkish exchange rates.

This paper examines the behavior of Turkish exchange rates within the context of PPP hypothesis for ten Turkish real exchange rates during the period January 2002-March 2012. In the empirical analysis, we follow a systematic modelling approach within the panel data framework. First, we conduct a preliminary analysis which includes testing cross-section

[1] The literature on Turkey is summarized with respect data, method, and findings in appendix 1.

dependency and nonlinearity. Second, we focus on employing an appropriate panel unit root test which is able to take information into account provided by the preliminary analysis. Accordingly, we employ the sequential panel selection method (SPSM) along with Panel KSS unit root tests with a Fourier function. The results support on the validity of PPP hypothesis in Eurozone and five European countries (United Kingdom, Switzerland, Norway, Denmark, Sweden), although PPP hypothesis in not valid for four countries (Saudi Arabia, Canada, Japan, and USA).

In our modelling approach, nonlinearity in exchange rates is captured by the nonlinear panel unit root test proposed by Ucar and Omay (2009); structural shifts are modeled as gradual adjustment; and finally cross-section dependency is taken into account by means of bootstrap distribution. Furthermore, the unit root strategy employed here classifies whole panel into a group of stationary series and a group of non-stationary series.

The rest of the paper is organized as follows: The developments in Turkish exchange rates policy is summarized in section 2. In section 3, we concentrate on modelling issues in PPP hypothesis which provides the background of this paper. The empirical framework is outlined in section 4 and the findings are discussed in section 5. Finally, brief summary and policy discussion are provided in section 6.

2. Turkish exchange rate policy: a brief overview

With the implementation of the trade-oriented growth strategy since 1980, Turkey has assigned a crucial role to the exchange rate policy. From 1980 to early 2000s, Turkey adopted fixed exchange rate regime and shifted from pegged exchange rate regime to flexible exchange rate system after the eruption of the 2001 economic crisis. The trade dynamics and exchange rate policy developments in Turkish economy during recent years show a positive relation between floating exchange rates and an increase in exports.

It seems that the changes in Turkey's exchange rate policy are in line with the developments in the macro-economy. A fixed exchange rate regime was adopted before 1980 by adjusting the value of Turkish lira according to changes in economic condition. After implementation of the outward-oriented growth strategy in 1980, adjustable peg policy was followed in order to maintain the trade-oriented growth model. During 1980-1988, the Turkish lira was daily adjusted in form of devaluations and consequently it depreciated more than 8 percent in real terms. In 1989, the government decided to put into effect the partial official exchange rate system and allow the free capital movements along with higher interest rates and convertible Turkish lira. These structural shifts led to the appreciation of the Turkish lira[2].

The 1994 crisis which was one of the major turmoils in Turkish economy induced a structural policy change. The government put into effect the stabilization and economic rescue programs in cooperation with the International Monetary Fund (IMF). In this respect, Turkish lira was considerably devaluated by 39 percent. The 1999 stabilization program guided by the IMF to decrease inflation and real interest rates and to provide a stable macroeconomic environment was essentially designed based on exchange rate policy. It depended on announcing value of exchange rate basket for first one and a half year period (CBRT, 2002).

[2] An interested reader is referred to Asikoglu and Uctum (1992) for a broad overview of Turkish exchange rate policies during the 1980-1990 and to CBRT (2002) for an overview of the liberalization process.

In February 2001, Turkey experienced the most destructive economic crisis since 1945 and aftermath of the crisis, the Central Bank of the Republic of Turkey (CBRT) decided to implement floating exchange rate regime and the value of Turkish lira was essentially leaved to market forces. However, it is worthwhile emphasizing that the Turkish central bank intervenes in exchange rate markets when Turkish lira is dramatically depreciated against the dollar and euro. The global financial crisis in 2008 led to a considerable depreciation of the Turkish lira and thereby the CBRT launched the monetary expansion process in November 2008. After the global financial crisis, even though the CBRT continues to implement floating exchange rate regime, changes in the real effective exchange rate indices are closely monitored and policy measures are taken in order to maintain financial stability[3].

3. Background

The definition of PPP hypothesis by Cassel (1918) postulates that real exchange rates is mean reverting around a constant term. Even though this definition requires only a constant term in an estimated model, a deterministic trend term can also be introduced to take into account high levels of productivity growth shown by the countries. The so-called “trend PPP” concept described by Balassa (1964) and Samuelson (1964) therefore entails a stationary real exchange rate series that has a linear time trend in addition to the constant term. Structural breaks in constant and time trend are usually considered as evidence of why PPP hypothesis does not hold. If structural breaks are ignored in testing for PPP, a stationary real exchange rate could not necessarily imply evidence of PPP hypothesis (Erlat, 2003). The presence of one structural break in level of the real exchange rate is first considered in Dornbusch and Vogelsang (1991). While examining PPP hypothesis around structural breaks in constant term has been called “qualified PPP” by Dornbusch and Vogelsang (1991), it has been defined as “quasi PPP” by Hegwodd and Papell (1998), Papell (2002), and Papell and Prodan (2006). The case of which real exchange rate is stationary around a linear time trend with structural shifts can be denoted as “trend qualified PPP” or “trend quasi PPP” (Basher and Carrion-i-Silvestre, 2008).

The literature on PPP hypothesis shows that some important issues are still remaining. First, univariate time series unit root tests have low power and therefore more recent studies have paid attention to panel unit root tests because panel data methods increase power of tests (for example, Papell, 1997; Cerrata and Sarantis, 2002; Choi, 2001; Erlat and Ozdemir, 2003; Wu et al., 2004; Coeklay et al., 2005; Baharumshah, 2007). Second, there is a growing consensus on that; real exchange rate series exhibit nonlinearities (asymmetries) and therefore unit root tests which are not able to control for this feature may have low power. As extensively discussed in Chinn (1991), nonlinear behavior of exchange rates can be attributed to regime changes, greater trade barriers, tighter currency bands, and shocks causing high volatility in exchange rates. Third, it is important to consider impact of possible structural breaks in real exchange rate series since changes in economic structure and conditions result in structural policy shifts. Omission of structural breaks in data can result in bias towards non-stationarity conclusion (Perron, 1989). As shown in Papell (2002), structural breaks in real exchange series can play important role to appropriately analyze whether or not PPP hypothesis holds. Fourth, dependency across exchange rates has triggered great interest in empirical analysis. The dependency can arise from the fact that a shock in one country may be easily transmitted to other countries through international trade and financial integration. In recent studies Basher and Carrion-i-Silvestre (2009) and Basher

[3] See CBRT (2009) for the general framework of the monetary and exchange rate policy.

and Westerlund (2009) provide that in addition to structural breaks, accounting for cross-sectional dependence is crucial for the investigation of PPP hypothesis.

4. Data and empirical framework

Based on aforementioned discussion, we first attempt to determine whether or not Turkish exchange rate series exhibits dependency and non-linearity. In that respect, following data description, we carry out preliminary analysis to employ a suitable unit root test that accommodates the features of Turkish exchange rates.

4.1. Data

We use monthly real exchange rates between Turkey and ten trading partners[4] (Canada, Denmark, Eurozone, Japan Norway, Saudi Arabia, Sweden, Switzerland, United Kingdom, and USA) during the period January 2002-March 2012. According to discussion in Koedijk et al. (2004), as Eurozone countries gradually converge to each other; Euro area can increasingly be regarded as a single economic entity. Consistent with this view, the importance of the euro in Turkish trade contracts has increased considerably. The euro accounted for about 48 percent of Turkey's exports by currency and 30 percent of Turkish imports by currency as of 2012. Since the euro banknotes and coins were put into circulation for cash payments on 1 January 2002, our data starts from January, 2002.[5]

The nominal exchange rates and consumer price indexes (2005=100) are obtained from the International Financial Statistics on-line database of International Monetary Fund. Then the real exchange rate is described as $y_{it} = e_{it} + p^*_{it} - p_t$ where y denotes the real exchange rate, e is the log of nominal exchange rates, p* is the log of foreign CPI, and p is the log of domestic (Turkey's) CPI. Thereby, an increase (a decrease) in the real exchange rates represents real depreciation (appreciation) of Turkish lira.

4.2. Preliminary analysis

Cross-section dependency tests

Following Breusch and Pagan (1980), the following panel data regression model is estimated for testing cross-sectional dependence in the exchange rates.

$$\Delta y_{i,t} = d_i + \delta_i y_{i,t-1} + \sum_{j=1}^{p_i} \lambda_{i,j} \Delta y_{i,t-j} + u_{i,t} \quad i = 1,...,N \; ; \; t = 1,...,T \qquad (1)$$

where deterministic component d_i is considered for constant or constant and trend, and *p* is lag length (s). To test for the null hypothesis of no cross-sectional dependency ($H_0 : Cov(u_{it}, u_{jt}) = 0$, for all *t and* $i \neq j$) against the alternative hypothesis of cross-sectional

[4] In fact, we concentrated on twenty major trading partners in Turkey's trade (export and import), however we cannot collected balanced data for Turkish exchange rates series for Iraq, Iran, the UAE, China, Azerbaijan, Romania, Israel, Libya, India, South Korea, and Ukraine. This difficulty is also available in other studies for Turkey (see, appendix 1). Nevertheless, the countries in our data explain about 97 and 96 percent of Turkish exports and imports by currency, respectively, that basically dominated by euro and US dollar.

[5] The statistics were taken from Turkish Statistical Institute on-line database that are available at http://www.tuik.gov.tr/PreTablo.do?alt_id=1046 and upon request.

dependence ($H_1 : Cov(u_{it}, u_{jt}) \neq 0$, for at least one pair of $i \neq j$), Breusch and Pagan (1980) developed the following Lagrange multiplier statistic:

$$LM = T\sum_{i=1}^{N-1}\sum_{j=i+1}^{N}\hat{\rho}_{ij}^{2} \tag{2}$$

where $\hat{\rho}_{ij}$ is the pair-wise correlation between residuals from the ordinary least squares (OLS) estimation of equation (1) for each *i*. Under the null hypothesis, the *LM* statistic is asymptotically distributed as chi-square with $N(N-1)/2$ degrees of freedom. The LM test is valid for N relatively small and T sufficiently large, and this drawback is attempted to be solved by Pesaran (2004) by the following scaled version of the *LM* test:

$$CD_{lm} = \left(\frac{1}{N(N-1)}\right)^{1/2}\sum_{i=1}^{N-1}\sum_{j=i+1}^{N}(T\hat{\rho}_{ij}^{2}-1) \tag{3}$$

Under the null hypothesis with $T \to \infty$ first and then $N \to \infty$, this test statistic has a standard normal distribution. Although CD_{lm} is applicable even if N and T are large, it is likely to exhibit substantial size distortions if *N* is large and *T* is small. The shortcomings of the *LM* and CD_{lm} tests clearly show the need for a cross-sectional dependence test applicable to a large N and a small T. In that respect, Pesaran (2004) proposed the following test statistic:

$$CD = \sqrt{\left(\frac{2T}{N(N-1)}\right)}\left(\sum_{i=1}^{N-1}\sum_{j=i+1}^{N}\hat{\rho}_{ij}\right) \tag{4}$$

Under the null hypothesis with T→∞ and N→∞ in any order, the CD test has an asymptotic normal standard distribution.

Pesaran (2004) indicates that the *CD* test has a mean of exactly zero for fixed T and N and is robust for heterogeneous dynamic models, including multiple breaks in slope coefficients and/or error variances, as long as the unconditional means of y_{it} and x_{it} are time-invariant and their innovations have symmetric distributions. However, the *CD* will lack power in certain situations in which the population average pair-wise correlations are zero, although the underlying individual population pair-wise correlations are non-zero (Pesaran *et al.* 2008, p.106). Pesaran *et al.* (2008) propose a bias-adjusted test that is a modified version of the LM by using the exact mean and variance of the LM statistic. The bias-adjusted LM test is constructed as follows:

$$LM_{adj} = \sqrt{\left(\frac{2}{N(N-1)}\right)}\sum_{i=1}^{N-1}\sum_{j=i+1}^{N}\hat{\rho}_{ij}\,\frac{(T-k)\hat{\rho}_{ij}^{2}-\mu_{Tij}}{\sqrt{v_{Tij}^{2}}} \tag{5}$$

where μ_{Tij} and v_{Tij}^2 are, respectively, the exact mean and variance of $(T-k)\hat{\rho}_{ij}^2$ provided in Pesaran et al. (2008, p.108). Under the null hypothesis with first T→∞ and then N→∞, the LM_{adj} test is asymptotically distributed as standard normal.

The results from cross-section dependency tests reported in table 1 indicate that the null hypothesis of no cross-sectional dependence is rejected at one percent level of significance, indicating that Turkish real exchange rates are dependent on each other. This finding implies that a shock in one exchange rate is transmitted to exchange rate series. Since open economies are highly integrated to each other, a shock in a country easily spillovers on other countries because of high degree of international trade and financial liberalization. The existence of cross-sectional dependency entails that one need to conduct a unit root analysis which accounts for dependency in modelling the behavior of Turkish exchange rates.

Table 1: Results for cross-section dependency tests

	Constant		Constant and Trend	
Test	Statistic	p-value	Statistic	p-value
LM	848.439***	0.0000	858.602***	0.0000
CD_{LM}	84.690***	0.0000	85.761***	0.0000
CD	-7.395***	0.0000	-7.442***	0.0000
LM_{adj}	148.590***	0.0000	147.091***	0.0000

*** denotes statistical significance at 1 percent.

Nonlinearity Test

If time series data has nonlinearity, inferences drawn from a linear approach would be misleading. The BDS test proposed by Brock et al. (1996) is carried out to test for nonlinearity in the exchange rates. The BDS test provides a nonparametric statistic for testing the null hypothesis of identically and independently distributed (i.i.d) data against the alternative hypothesis of not i.i.d. data. Thereby, the alternative hypothesis implies that time series has non-linear properties. The test is based on concept of correlation integral and estimator of spatial probabilities across time. Given X_t is the m-dimensional time series of which $(X_t, X_{t+1}, \cdots, X_{t+m-1})$, the correlation integral is defined as:

$$C_m(T,e) = \sum_{t=1}^{T_m-1} \sum_{s=t+1}^{T_m} \mathrm{I}(X_t^m, X_s^m, e) \cdot \frac{2}{T_m(T_m-1)} \quad (6)$$

where T_m is sample size and $T_m = T-(m-1)$, $\mathrm{I}(X_t^m, X_s^m, e)$ denotes an indicator function which is equal to 1 if $\left\| X_t^m - X_s^m \right\| < e$ and equal to 0 otherwise. $\left\| X_t^m, X_s^m \right\|$ is the measure of Euclidian distance between X_t^m and X_s^m. Since the correlation integral measures the fraction of data pairs of (X_t^m, X_s^m) that are within a maximum-norm distance of e, the BDS test statistic can be obtained by:

$$W_m(T,e) = \frac{\sqrt{T}\left[C_m(T,e) - C_1(T,e)^m\right]}{\sigma_m(e)} \to N(0,1) \quad (7)$$

where and $\sigma_m(e)$ is standard deviation of sample given *m* dimensions. The rejection of the null of the i.i.d. assumption supports evidence of nonlinearity. The BDS statistic is the two-tailed test that large negative/positive values imply the rejection of null hypothesis.

The results for the BDS test illustrated in table 2 show that the null hypothesis of the i.i.d. assumption is rejected for all the exchange rates, supporting evidence on non-linearity.

Thereby, it would be appropriate to take into account nonlinearity when investigating the behavior of Turkish exchange rates.

Table 2: Results for nonlinearity test

Country	Statistic	p-value
Canada	34.625***	0.000
Eurozone	37.046***	0.000
Denmark	36.457***	0.000
Japan	37.750***	0.000
Norway	29.206***	0.000
Saudi Arabia	24.286***	0.000
Sweden	52.364***	0.000
Switzerland	42.136***	0.000
United Kingdom	84.566***	0.000
USA	31.621***	0.000

m (embedding dimension) is set to 2 and $\sigma_m(e)$ is set to 0.5[6]. *** denotes statistical significance at 1 percent.

The nonlinearity provided by the BDS test can also be drawn from the dynamics of exchange rates illustrated in figure 1. It seems that the movements in exchange rates from 2002 to 2008 are slightly different than those from 2008 to 2012. With the implementation of floating exchange rate regime in 2002, Turkish lira appears to be appreciated until the 2008 global financial crisis. Aftermath of the crisis, it depreciates against the major currencies and exhibits more volatile structure. Thereby, it can be drawn that the exchange rates have different regimes, resulting in nonlinear behavior or structural shifts.

To sum up, the preliminary analysis implies that Turkish real exchange rates are characterized by cross-section dependency and nonlinearity as well as structural shifts. Thereby, the proper modelling of determining trend behavior of Turkish exchange rates entails accounting for these features in unit root method. In what follows, we outline the panel unit root testing method that is able to control for nonlinearity, structural change and cross-section dependency.

4.3. Panel unit root test

In order to incorporate nonlinearity , we utilize the nonlinear panel unit root test by Ucar and Omay (2009) which combines the nonlinear framework in Kapetanios et al. (2003) (KSS hereafter) with the panel unit root testing procedure of Im et al. (2003). Ucar and Omay (2009) describe a panel exponential smooth transition autoregressive process (PESTAR). The PESTAR (1) model is given by:

[6] To investigate whether the results are sensitive to embedding dimension and to standard deviation, we set embedding dimensions and standard deviation to different values and obtained evidence on nonlinearity. To save space, the results for robustness analysis are not reported, but available upon request.

$$\Delta y_{it} = d_i + \gamma_i y_{it-1}\{1-\exp(-\theta_i y_{it-1}^2)\} + \varepsilon_{it} \quad (8)$$

where deterministic component d_i is considered for constant (α_i) or constant and trend ($\alpha_i + \beta_i t$), and $\theta_i > 0$ implies the speed of mean reversion for all *i*. By applying the first-order Taylor series approximation to PESTAR (1) model around θ_i=0 for all *i,* the auxiliary regression is obtained as

$$\Delta y_{it} = d_i + \delta_i y_{it-1}^3 + \varepsilon_{it} \quad (9)$$

where $\delta_i = \theta_i \gamma_i$. From equation (8), extending PESTAR (1) to PESTAR (k) model is very simple that a PESTAR (k) model can be written as:

$$\Delta y_{it} = d_i + \delta_i y_{it-1}^3 + \sum_{j=1}^{p_i} \lambda_{ij} \Delta y_{it-j} + \varepsilon_{it} \quad (10)$$

where *p* denotes lag langht(s)[7]. The null hypothesis of linear non-stationarity ($H_0 : \delta_i = 0$ for all *i)* is established against the alternative hypothesis of nonlinear stationary ($H_1 : \delta_i < 0$, for some *i)*. To test the null hypothesis, Ucar and Omay (2009) propose the panel KSS unit root test which is the average of individual KSS statistics developed by Kapetanios et al. (2003). The KSS statistic is the t-ratio ($t_{i,NL}$) associated with δ_i in equation (9). The panel KSS statistic thereby is written as $\bar{t}_{NL} = 1/N \sum_{i=1}^{N} t_{i,NL}$. Since the individual KSS statistics are *iid* random variables with finite means and variances, the panel statistic has standard normal distribution. It is important to note here that the panel KSS statistic assumes that individuals in panel are cross-sectionally independent to ensure the asymptotic normality. However, this assumption seems not to hold in practice as discussed earlier. In order to take into account for any kind of cross-sectional dependency, Ucar and Omay (2009) compute critical values from the bootstrap distribution[8].

Ignoring effects of structural shifts in data generating process causes unit root test to lose power (Perron, 1989). If break date is known, shifts in deterministic components can be captured by dummy variables. Breaks modelled by dummy variables are assumed to be sharp at a specified point of time. However, determining both breaks dates and number of breaks is difficult to know. Besides, effects of structural shifts can be gradual (smooth) instead of instantaneously (Enders and Lee, 2011). If characteristics of data including structural shifts are not known, it can be well captured by utilizing a Fourier approximation (Beckers et al., 2006). Enders and Lee (2011) propose a Fourier unit root test which is able to capture characteristics of data containing one or more structural breaks by using a small number of low-frequency components from a Fourier approximation. Lui (2013) and Zhang et al. (2013) extend the panel KSS unit root test by augmenting PESTAR (k) model with a Fourier function as:

$$\Delta y_{i,t} = d_i + \delta_i y^3_{i,t-1} + \sum_{j=1}^{p_i} \lambda_{i,j} \Delta y_{i,t-j} + a_{i,1} \sin(\frac{2\pi kt}{T}) + b_{i,1} \cos(\frac{2\pi kt}{T}) + \varepsilon_{i,t} \quad (11)$$

[7] Determining optimal lag(s) through information criterions in unit root analysis is the common way we use Schwarz information criterion.

[8] Any interested reader is referred to Ucar and Omay (2009) for the details of the bootstrapping procedure.

where $t = 1,2,....,T$, k is frequency selected for the approximation, and $[a_i, b_j]'$ measures the amplitude and displacement of frequency component. Enders and Lee (2009) suggest that *k* could be obtained via the minimization of the sum of squared residuals. By Monte Carlo experiment, authors indicate that no more than one or two frequencies should be used because of the loss of power associated with a larger number of frequencies. It also follows that at least one frequency component must be present if there is a structural break. Fourier approximation can often capture the behavior of an unknown function even if the function itself is not periodic.

Even though applying panel unit root methodology in examining stationarity has triggered interest in empirical economics, one of major drawbacks in a panel context is testing joint null hypothesis of non-stationarity. This drawback can lead to a misleading rejection of the null hypothesis even if only one of individuals in panel is stationary. As a result, whole panel appears to be stationary when a number of individuals are non-stationary. In such case, the conclusion can be incorrectly drawn that panel is on balance stationary or in the best case it will not be possible to distinguish which individuals are in fact stationary (Chortareas and Kapetanios, 2009). In order to overcome this difficulty in panel unit root analysis, researchers concentrate on how panel can be classified in a group of stationary series and a group of non-stationary series (see, for example, Chortareas and Kapetanios, 2009; Smeekes, 2011; Westerlund, 2013). Chortareas and Kapetanios (2009) introduce a new methodology that is referred as sequential panel selection method (SPSM) which has advantages against typical panel unit root tests. The SPSM procedure identifies stationary and non-stationary individuals in the panel and also exploits advantages of panel data in unit root testing (i.e., increase in power of tests). To determine whether or not a series is stationary, The SPSM procedure carries out a sequence of panel unit root test by reducing dataset. This reduction is conducted by dropping stationary series from panel. Lui (2013) and Zhang et al. (2013) show how this procedure can be adopted to equation (11): (i) apply the panel KSS test with a Fourier function to all series in panel. Stop procedure if the null hypothesis of unit root cannot be rejected and conclude that all series are non-stationary. If the null is rejected, proceed to Step 2; (ii) drop the series with the minimum KSS statistic since it is identified as being stationary; (iii) turn back to Step 1 for remaining series and carry out this procedure until finding evidence of stationary. Consequently, whole panel is separated into a set of stationary series and a set of non-stationary series.

5. Empirical findings

Before proceeding to unit root analysis, it would be useful to look at the time paths of the exchange rates. The actual values and Fourier approximations based on equation (11) of the series are shown in figure (1). At first glance, we observe that the actual nature of break(s) is generally unknown, and there is no specific guide regarding time and number of breaks. Using an incorrect specification about form and number of breaks could be as problematic as ignoring breaks altogether. A further examination of the figures indicates that all Fourier approximations appear reasonable and support the notion of long swings in real exchange rates. Thus, we should concentrate on estimating a regression model in which nonlinear dynamics and structural breaks are considered together, which provides room to use of Fourier approximation.

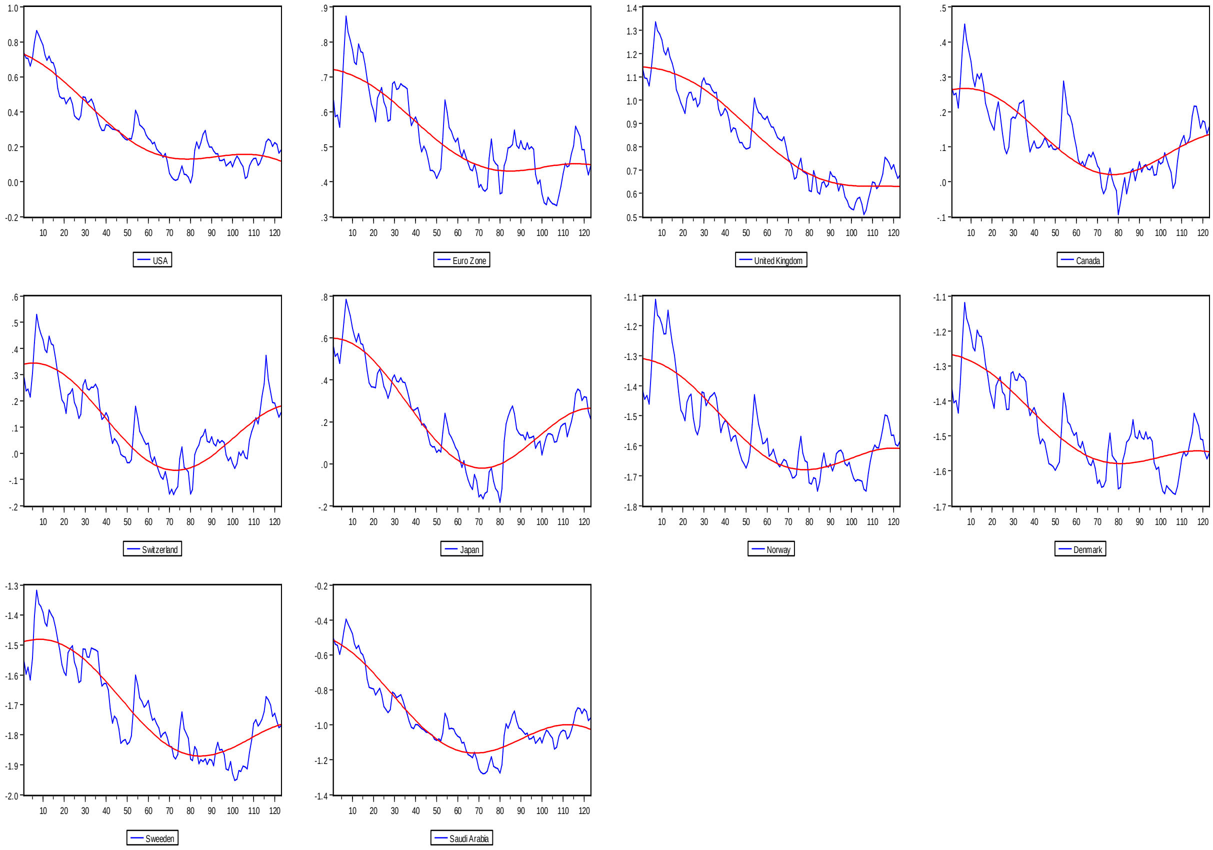

Figure 1: The real exchange rates and their Fourier approximations.

We first report the results from panel KSS unit root test without a Fourier function which ignores gradual shifts in the exchange rate series. The results in table 3 show each sequence of the panel KSS statistics with bootstrap p-values[9], the individual minimum KSS statistic, and the stationary- I(0)- and non-stationary - I(1)- series. In first sequence, the null hypothesis of unit root in the real exchange rates was rejected when the panel KSS unit root test was first applied to whole panel, producing small p-value (0.0410). After implementing the SPSM procedure, we found that the real exchange between Turkey and Norway is stationary with the minimum KSS statistic (-3.1970) among the panel. Norway is then removed from the panel and the panel KSS unit root test was re-implemented to remaining set of series. This procedure continues until the panel KSS test cannot reject the null hypothesis of unit root at the 10 percent level of significance. Accordingly, the SPSM procedure using the panel KSS approach without a Fourier function provides evidence on the long-run PPP for four countries (i.e., Norway, Denmark, Saudi Arabia, and Canada). In order to examine whether high levels of productivity growth shown by the countries (trend PPP concept) affect results, we consider model with constant and trend. The results support the evidence on PPP hypothesis in the case of Norway, Denmark, Eurozone and United Kingdom. Thus, the difference between the model with constant and trend and the model with constant is the rejection of the null hypothesis for Eurozone and United Kingdom instead of Saudi Arabia and Canada. The average labour productivity growth (in percent) during the

[9] As noted in section 4.3, to control for cross-section dependence among the real exchange rates in the SPMS procedure, we generate the bootstrap distribution of test statistics for the unit root by means of Sieve bootstrap method.

2002-2012 that about 0.63 for Canada, 0.95 for Euro-area, and 1.17 for the UK[10] supports that the productivity level may play important role in the behavior of the exchange rates.

Table 3: Panel KSS Unit root test without Fourier function

Constant

Sequence	Country	Panel KSS stat.	p-value	Minimum KSS stat.	Stationary
1	Norway	-2.3250**	0.0410	-3.1970	*Yes*
2	Denmark	-2.2281**	0.0380	-2.6778	*Yes*
3	Saudi Arabia	-2.1719**	0.0150	-2.5993	*Yes*
4	Canada	-2.1108*	0.0575	-2.5331	*Yes*
5	Eurozone	-2.0405	0.1270	-2.4783	*No*
6	Sweden	-1.9529	0.1565	-2.4344	*No*
7	United Kingdom	-1.8325	0.1155	-2.4318	*No*
8	Switzerland	-1.6328	0.3550	-2.0362	*No*
9	Japan	-1.4310	0.5580	-1.4317	*No*
10	USA	-1.4304	0.3000	-1.4304	*No*

Constant and trend

Sequence	Country	Panel KSS stat.	p-value	Minimum KSS stat.	Stationary
1	Norway	-1.9589**	0.0405	-2.9072	*Yes*
2	Denmark	-1.8535*	0.0590	-2.6607	*Yes*
3	Eurozone	-1.7527**	0.0400	-2.5339	*Yes*
4	United Kingdom	-1.6410*	0.0605	-2.3092	*Yes*
5	Sweden	-1.5297	0.1105	-2.1674	*No*
6	Switzerland	-1.4021	0.1675	-2.0875	*No*
7	Saudi Arabia	-1.2308	0.1990	-1.7119	*No*
8	Canada	-1.0704	0.3575	-1.4496	*No*
9	Japan	-0.8808	0.4955	-1.3465	*No*
10	USA	-0.4151	0.5855	-0.4151	*No*

The p-values are computed by using 5000 Sieve bootstrap replications. ***, **, and * denote statistical significance at 1, 5, and 10 percent level, respectively.

Since the estimation without a Fourier function ignores any smooth structural shifts, power of test in rejecting the null hypothesis of unit root decreases if series are stationary

[10] See OECD productivity statistics available at: http://www.oecd.org/std/productivitystats/productivitystatistics.htm

under the alternative hypothesis (Perron, 1989). Therefore, we carry out the SPSM procedure with a Fourier function in order to see whether or not the results are sensitive to the structural breaks in the real exchange rates. Table 4 illustrates the results from the panel KSS test with a Fourier function. The model with constant indicates that the SPSM procedure stopped at sequence 3, implying that the long-run PPP hypothesis is true for three cases (Saudi Arabia, Norway, and Canada). When the procedure is applied to the model with constant and trend, it stopped at sequence 6, when the real exchange rates for six countries –Norway, Denmark, Eurozone, United Kingdom, Sweden, and Switzerland- were removed from the panel. For the robustness analysis, the procedure was employed until the last sequence and the panel KSS test failed to reject the null hypothesis for the rest of the sequences. The results indicate that the null hypothesis of the unit root is rejected for Norway, Denmark, Eurozone, United Kingdom, Sweden, and Switzerland and thereby provide strong evidence on the validity of PPP hypothesis in those six countries which are all the European countries.

Table 4: Panel KSS Unit root test with Fourier function

Constant

Sequence	Country	Panel KSS stat.	p-value	Minimum KSS stat.	Stationary
1	Saudi Arabia	-2.4634**	0.0200	-3.7367	*Yes*
2	Norway	-2.3220**	0.0455	-3.2345	*Yes*
3	Canada	-2.2079*	0.0715	-2.7960	*Yes*
4	Eurozone	-2.1239	0.1085	-2.5557	*No*
5	Denmark	-2.0519	0.1255	-2.5480	*No*
6	Sweden	-1.9527	0.1635	-2.4599	*No*
7	Switzerland	-1.8259	0.2325	-2.1857	*No*
8	United Kingdom	-1.7059	0.2895	-1.8322	*No*
9	USA	-1.6428	0.3895	-1.7690	*No*
10	Japan	-1.5165	0.5595	-1.5165	*No*

Constant and trend

Sequence	Country	Panel KSS stat.	p-value	Minimum KSS stat.	Stationary
1	Norway	-2.6997***	0.0015	-2.9072	*Yes*
2	Denmark	-2.7939***	0.0020	-2.6607	*Yes*
3	Eurozone	-2.5790***	0.0050	-2.5339	*Yes*
4	United Kingdom	-2.1133**	0.0445	-2.3092	*Yes*
5	Sweden	-1.9730*	0.0740	-2.1674	*Yes*
6	Switzerland	-2.1078*	0.0740	-2.0875	*Yes*
7	Saudi Arabia	-1.7809	0.1120	-1.7119	*No*
8	Canada	-1.5230	0.2515	-1.4496	*No*
9	Japan	-1.6237	0.4020	-1.3465	*No*
10	USA	-0.4411	0.5440	-0.4151	*No*

The p-values are computed by using 5000 Sieve bootstrap replications..***, **, and * denote statistical significance at 1, 5, and 10 percent level, respectively.

Finally, in order to compare results from the SPSM approach with that from the counterparts which take into account cross-section dependency, we employ the second generation panel unit root test developed by Pesaran (2007)[11] and report the results in table 5. The individual statistics -for model with constant- indicate that the null hypothesis of unit root cannot be rejected for all countries except Norway. Similarly, the results for model with constant and trend fail to reject the unit root hypothesis for eight countries (except Norway and USA), implying that PPP hypothesis is valid in Turkish exchange rates with a few exceptions. Thereby, the results provided by Pesaran's test seem slightly different than those from the SPSM procedure. The panel results indicate that while the unit root hypothesis in model with constant can be rejected at only ten percent level of significance, this finding cannot be supported by model with constant and trend. Accordingly, the second generation panel unit root approach shows that there is no clear-cut evidence whether PPP hypothesis holds in the Turkish exchange rates.

Table 5: Panel unit root test with cross-section dependency (Pesaran, 2007)

	Constant		Constant and Trend	
Country	CADF statistic	p-value	CADF statistic	p-value
Canada	-2.759	0.135	-3.089	0.195
Denmark	-1.997	0.420	-1.784	0.760
Eurozone	-1.311	0.715	-1.541	0.835
Japan	-1.977	0.425	-1.851	0.730

[11] The rationale behind the use of this is due that Pesaran (2007) tabulates the critical values for individual test that provide us with examining the unit root properties of each cross-section in the panel. In order to save space, details of the test are not outlined here.

Norway	-3.926***	0.010	-3.561*	0.080
Saudi Arabia	-2.231	0.315	-2.930	0.245
Sweeden	-2.880	0.110	-3.256	0.140
Switzerland	-1.548	0.615	-2.612	0.380
United Kingdom	-1.252	0.735	-1.325	0.890
USA	-2.753	0.140	-3.670*	0.065
Panel (CIPS statistic)	-2.263*	0.075	-2.562	0.240

CIPS is the mean of individual cross-sectionally augmented ADF statistics (CADF). ***, **, and * denote statistical significance at 1, 5, and 10 percent level, respectively.

To sum up, the empirical analysis carried out in this paper shows the importance of how we handle data generating process that plays crucial role in examining the behavior of Turkish exchange rates. The empirical evidence thereby point outs the importance of proper modelling of structural breaks and nonlinearities in Turkish exchange rate series. We find out that the SPSM procedure result in more rejection of the unit root hypothesis, implying that shocks are temporarily and the behavior of Turkish exchange rates with European countries is consistent with PPP hypothesis.

6. Summary and discussion

This paper examines the behavior of Turkish exchange rates within the context of PPP hypothesis for the period January 2002- May 2012 by means of recent developments in panel unit root literature. The preliminary analysis provides that cross-section dependency and nonlinearity are the features of the exchange rates that need to be taken into account in a unit root testing. We also paid attention to modelling structural shifts as gradual by Fourier function. Finally, we focus on classifying the panel in a group of stationary and non-stationary series. In that respect, we employ the SPSM procedure to the panel KSSS test with Fourier function. The results support the evidence on PPP hypothesis for five European countries (Norway, Denmark, United Kingdom, Sweden, and Switzerland) and Eurozone.

The empirical results here raise an important question that while PPP hypothesis is valid for the European countries, why it does not hold for other countries. To clarify this question, we can turn back to the assumptions behind PPP hypothesis. The basis for PPP is the "law of one price" which means that in the absence of transportation costs and transaction costs, in the competitive markets the price of an identical good in two countries will be same when the prices are expressed in the same currency. However, one of the caveats with the law of one price is that transportation costs, barriers to trades, and other transaction costs can play a significant role.

Turkish trade with the European countries is subject to obligations of the customs union agreement. Accordingly, Turkey shall align its commercial policy with the EU's common commercial policy and thereby the preferential trade agreement has the important role in Turkish trade policy towards third countries. In this respect, the initiatives have been launched to start negotiations with USA, Canada, and Japan as well as some other countries[12]. Thereby it is possible to conclude from the empirical results that PPP hypothesis holds in the

[12] Thailand, India, Indonesia, Vietnam, Peru, Central American Countries, Algeria, Mexico, and South Africa.

countries which have free trade agreement with Turkey, while it is violated in the countries in which there are trade barriers. This result is in line with that of Alba and Papell (2007) who indicate that PPP hypothesis may hold better if countries are more open to trade and geographically closer because trade barriers and high transportation costs associated with greater distance could hinder trade and arbitrage.

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Appendix 1: Summary of the PPP literature on Turkey

Study	Data	Methodology	Countries	PPP hypothesis
Telatar and Kazdaglı (1998)	1980:M10 1993:M10	ADF, PP and cointegration tests	France, Germany, the UK, the USA.	Rejected
Sarno (2000)	1980:M01 1997:M12	DF and ESTAR	The US, the UK, Germany,France	Accepted
Yazgan (2003)	1982:Q1 2001:Q4	ADF and Johansen cointegration	Germany, the USA	Accepted
Erlat (2003)	1984:M01 2000:M09	Unit root with Structural shift and ARFIMA	Germany, the USA	Accepted
Erlat and Ozdemir (2003)	1984:M01 2001:M06	Panel unit root (SURADF)	Austria, Belgium, Denmark, Finland, France, Germany, Greece, Italy, Japan, the Netherlands, Norway, Saudi Arabia, Spain, Sweden, Switzerland, the UK, the USA.	Rejected
Doganlar et al. (2009)	1995:M01 2005:M12	ADF, PP, KPSS, DF-GLS unit root tests and Johansen cointegration tests	Turkey, Brazil, India, Indonesia, Pakistan, Philippines, South Africa, South Korea Mexico and Peru	Rejected (Turkey).
Kalyoncu (2009)	1980:Q01 2005:Q04	ADF, PP and KPSS unit root test	The USA, Germany, Japan, France, Netherlands, the UK	Accepted
Guloglu et al. (2011)	1991:M01 2008:M03	panel unit root KPSS test	Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Italy, Japan, the Netherlands, Norway, Saudi Arabia, Spain, Sweden, Switzerland, the UK, the USA	Accepted

DF: Dickey Fuller; ADF: Augmented Dickey Fuller ; PP: Phillips Perron ;KPSS: Kwiatkowski, Phillips, Schmidth and Shin; DF-GLS: Dickey-Fuller Test using a generalized least squares (GLS).