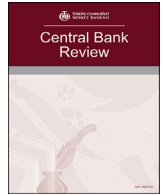


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## Empirical investigation of purchasing power parity for Turkey: Evidence from recent nonlinear unit root tests

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### ABSTRACT

This study explores the empirical validity of the purchasing power parity (PPP) hypothesis between Turkey and its four major trading partners, the European Union, Russia, China and the US. Accounting for the nonlinear nature of real exchange rates, we employ a battery of recently developed nonlinear unit root tests. Our empirical results reveal that nonlinear unit root tests deliver stronger evidence in favour of the PPP hypothesis when compared to the conventional unit root tests only if nonlinearities in real exchange rates are correctly specified. Furthermore, it emerges from our findings that the real exchange rates of the countries having a free trade agreement are more likely to behave as linear stationary processes.

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### 1. Introduction

The Purchasing power parity (PPP) hypothesis is one of the most explored issues in international macroeconomics. The PPP hypothesis postulates that the nominal exchange rate between two national currencies should adjust to changes in the price levels of the two countries, keeping the real exchange rate unchanged. The basis of the PPP theory is the law of one price (LOOP), which states that, the price of a commodity or a bundle of commodities should be equal across countries when expressed in terms of a common currency. Due to factors like transaction costs, imperfect competition, taxation, subsidies and trade barriers, PPP might not hold in the short-run. However, given that international goods market arbitrage should be traded away over time, PPP is expected to hold in the long run. This implies that the real exchange rate is expected to return to a constant equilibrium value in the long run. The validity of PPP is critical to empirical researchers and policy makers for

several reasons. As stated in [Holmes \(2001\)](#) and [Sarno \(2005\)](#), PPP is employed to predict the exchange rate and specify whether a currency is over or undervalued. This is particularly important for less developed countries and countries experiencing large differences between domestic and foreign inflation rates. PPP is also an indispensable building block of many important theoretical open economy models and its violation might cast doubts on the validity of these models ([Rogoff, 1996](#); [Taylor, 1995](#)). Finally, it is used to set exchange rate parities, compare national income levels and establish the degree of misalignment of the nominal exchange rate.

There are voluminous studies available on the empirical validity of the long-run PPP. A major strand of this literature examines its validity by testing for stationarity of real exchange rates, as stationarity implies mean reversion and, hence, PPP. In this sense, earlier studies test PPP in a linear context employing conventional unit root tests. Most of these studies, however, fail to provide empirical evidence in favour of real exchange rate stationarity (e.g. [Meese and Rogoff, 1988](#); [Edison and Fisher, 1991](#)). [Glen \(1992\)](#), [Lothian and Taylor \(1996\)](#), [Oh \(1996\)](#) and [Wu \(1996\)](#), amongst others, ascribe this failure to the low power displayed by conventional unit root tests and attempt to address the power problem

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through the use of long span data sets and panel unit root tests. Although more supportive results are reported from long span and panel data studies, they fall under the criticisms of Frankel and Rose (1996), Hegwood and Papell (1998), Taylor and Sarno (1998) and Taylor (2003). Frankel and Rose (1996) and Hegwood and Papell (1998) argue that very long time series could be exposed to structural breaks, which might produce spurious results. On the other hand, Taylor and Sarno (1998) and Taylor (2003) argue that testing PPP using panel unit root tests may entail some problems due to the heterogeneity issue. Ignoring country specific differences and expecting real exchange rates to have same dynamics for all countries in the sample, might lead to unreliable inferences on the validity of PPP. Moreover, rejecting the null hypothesis of unit root in a panel data implies that at least one of the series is mean reverting, but not that all the series under consideration are stationary. Hence, no consensus has emerged regarding stationarity of the real exchange rate and whether real exchange rate is stationary or not remains contentious in the linear framework.<sup>1</sup>

The idea that real exchange rate series may follow a nonlinear pattern has been put forward by the theoretical models of Dumas (1992) and Sercu et al. (1995). In these models, it is demonstrated that transaction costs might create a no trade band, within which the real exchange rate may follow a (near) random walk process, as the arbitrage is not large enough to cover transaction costs. However, once the real exchange rate hits the band, which is the case of an overvalued or undervalued exchange rate, arbitrage becomes profitable, international trade takes place, and hence the real exchange rate turns to a stationary process. This suggests that the real exchange rate might follow a globally stationary nonlinear process with a (near) unit root behaviour around PPP equilibrium replaced by a stationary behaviour when deviations from PPP become large. Recognizing the low power of conventional unit root tests in detecting stationarity of real exchange rates with such nonlinear dynamics due to Pippenger and Goering (1993) and Taylor (2001), a growing literature has emerged, which accommodates no-arbitrage and profitable arbitrage dynamics of real exchange rates in an exponential smooth transition autoregressive (ESTAR) model.

In this context, Kapetanios et al. (2003) propose an ESTAR type unit root test, which is designed specifically on the basis of the no arbitrage versus profitable arbitrage argument of Dumas (1992) and Sercu et al. (1995). Recently, the test of Kapetanios et al. (2003) has gained momentum in testing real exchange rate stationarity, with several applications, including Liew et al. (2004), Hasan (2004), Chortareas and Kapetanios (2004), Ceratto and Sarantis (2006), Francis and Iyare (2006), Wallace (2008), Cuestas and Gil-Alana (2009) and Telatar and Hasanov (2009). Compared to the previous studies using conventional unit root tests, these studies provide stronger evidence of stationarity of real exchange rates for a broad range of developing and developed countries. They almost uniformly indicate that the empirical evidence in favour of stationarity increases when nonlinearities in real exchange rates are explicitly accommodated. Most recently, Kılıç (2011) and Kruse (2011) propose modified versions of the nonlinear unit root test of Kapetanios et al. (2003) to examine stationarity of real exchange rates for OECD countries and the European Union, respectively. Both studies observe that their modified tests reveal more evidence in favour of PPP compared to the unit root test of Kapetanios et al. (2003).

Our study aims to investigate the empirical validity of the PPP hypothesis between Turkey and its four major trading partners, the European Union, Russia, China and the US. Existing studies on the

validity of PPP for Turkey deliver rather mixed results. Within a linear context, Telatar and Kazdagli (1998) finds no evidence in favour of stationarity of Turkish real exchange rates through the standard cointegration tests over the period 1980(10)-1993(10). Similarly, using the conventional unit root tests for a sample period of 1980Q1-2005Q4, Kalyoncu (2009) reports nonstationarity of Turkish real exchange rates with respect to the currencies of its all major trading partners except the UK. Guloglu et al. (2011) and Gozgor (2011), however, observes that PPP holds for Turkey when applying linear panel unit root tests to the samples of period 1991(1)-2008(3) and 2003(1)-2010(12), respectively. In a nonlinear framework, on the other hand, Alba and Park (2005) deliver rather mixed empirical evidences through a threshold autoregressive (TAR) type unit root test over the period 1973(1)-2004(9). They observe that the real exchange rate follows a stationary process in one-regime and a nonstationary process in the other regime, with most of the observations falling into the nonstationary regime. Using an ESTAR type nonlinear cointegration test, on the other hand, Ozdemir (2008) provides only weak empirical evidence for PPP for the period 1984(1)-2004(1), while Erlat (2004) finds stronger empirical support for stationarity of real exchange rates by adopting the ESTAR type unit root test of Kapetanios et al. (2003) for the period 1984(1)-2000(9).

The lack of consensus on the empirical validity of PPP provides a room to investigate further the behaviour of Turkish real exchange rates within the context of recent developments in unit root tests. In this sense, taking the possible nonlinear nature of real exchange rates into consideration, we utilize unit root testing procedures that account for ESTAR type nonlinearity, as in many recent studies. However, rather than being confined to a single nonlinear testing procedure, which is the case in all existing PPP studies on Turkey, we adopt a battery of newly developed nonlinear approaches. It is the aim of the study to provide a more comprehensive insight into the real exchange rate stationarity and nonlinearity. As such, we employ the recently proposed nonlinear unit root tests of Kılıç (2011) and Kruse (2011) along with the commonly applied unit root test of Kapetanios et al. (2003).

The rest of the paper is organized as follows. The next section describes the econometric methodology we utilize. The data and the empirical results are then reported in Section 3, with concluding comments in Section 4.

## 2. Methodology

This section describes, respectively, the nonlinear unit root tests of Kapetanios et al. (2003), Kruse (2011) and Kılıç (2011) within the context of the PPP hypothesis.

### 2.1. Nonlinear unit root test of Kapetanios et al. (2003)

Kapetanios et al. (2003) develop a procedure to test for non-stationarity against a globally stationary nonlinear ESTAR process defined as:

$$\Delta \tilde{q}_t = \rho \tilde{q}_{t-1} F_E(\tilde{q}_{t-1}; \gamma) + \sum_{i=1}^p \lambda_i \Delta \tilde{q}_{t-i} + \varepsilon_t \quad (1)$$

where  $\tilde{q}_t$  denotes the de-meaned real exchange rate,  $p$  is the required number of lagged changes of  $\Delta \tilde{q}_t$  that ensures an iid structure for the error term,  $\varepsilon_t$ , and  $F_E(\tilde{q}_{t-1}; \gamma)$  is the symmetrically U-shaped exponential transition function such that

<sup>1</sup> See Rogoff (1996), Sarno and Taylor (2002) and Taylor and Taylor (2004) for extensive reviews of the PPP literature.

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