The Validity of Purchasing Power Parity: TAR Panel Unit Root Approach

Selçuk KOÇ[♠] Tezcan ABASIZ[♣] Durmuş Çağrı YILDIRIM[♣]

– Preliminary Conference Draft –

Abstract

In today's competitive world the structure and the direction of external trade are determined by the exchange rate conducts. In other words nominal exchange rate affects competitive power in external trade. Policy makers can use PPP theory as a guide for the external competitive power of a country. Furthermore numerous empirical workings have been presented that misalignment exchange rate causes currency crises and macroeconomic disequilibrium. PPP provides an indicator for the misalignment.

In the short run numerous studies has been rejected purchasing power parity for countries which have floating exchange rate system. Even though numerous studies have been presented strong evidences about real exchange rate tends to towards purchasing power parity. PPP theory has two versions: absolute and relative. Absolute purchasing power parity has a lot of weakness. So that relative version is commonly used instead of absolute version.

The aim of this paper analyses validity of PPP in the long run in some of EU countries including Turkey. In this context, we use a panel unit root test in a TAR framework which based on Caner-Hansen (2001) methodology and bootstrap method to compute critical values for the null and alternative hypothesis. According to the findings relative PPP is valid some of EU countries which are Turkey, Holland and Spain. As Denmark has 0.0936 p-value, we exclude it.

JEL Codes: C23, F31, F41.
Keywords: Exchange Rate, PPP, Nonlinear Unit Root, TAR model.

[♠] Dr., Kocaeli University, Department of Economics, 41380 Umuttepe/ Izmit/Turkey, selcukkoc@kocael.edu.tr
[♣] Phd Candidate, Research Asistant, Kocaeli University, Department of Economics, 41380 Umuttepe/ Izmit/Turkey, tezcan.abasiz@kocaeli.edu.tr ; cagri.yildirim@kocaeli.edu.tr

Introduction

In today's competitive world the structure and the direction of external trade are determined by the exchange rate conducts. In other words nominal exchange rate affects competitive power in external trade. When relative price level decreases (increases) in domestic country, export volume of domestic country will increase (decrease) and import volume will decrease (increase). Consequently external trade volume is affected positively thereby GDP increases (decreases). In this context nominal exchange rate affects firstly competitive power and then external trade volume and GDP so that determination of exchange rate is an important issue for countries.

Policy makers can use PPP theory as a guide for the external competitive power of a country. Furthermore numerous empirical workings have been presented that misalignment exchange rate causes currency crises and macroeconomic disequilibrium (Civcir, 2003: 2).

It's not to easy to find trend paths of nominal and real exchange rate. The calculating of long run real exchange rate value is a empirical issue. In the literature there is at least three model for implementing real exchange rate. Firstly, Price Based Criteria, namely PPP and its variants. Secondly, Model Based Criteria is based on a nominal exchange rate model. Finally Solvency and Sustainability Based Criteria makes reference to trends in the current account and the external debt to GDP ratio (see, Civcir, 2003, Chinn, 1998 and). Price Based Criteria is easy for implementing real exchange rate value relative to other criterions. However, this criterion doesn't address "optimal exchange rate level" for a given country and for a given moment in time (Chinn, 1998: 1).

The starting point for understanding according to price based criteria how exchange rate determined is the law of one price that's famous hypothesis in economics. Purchasing power parity is based on the law of one price. According to the law of one price, if two countries produce same goods, the domestic price of goods should be the same. The law of one price presents that same goods in different places cannot sell for different prices (Mankiw, 2003: 138 and Mishkin, 1992: 472). Because international goods trade links prices of goods which are produced and consumed in different countries (Frenkel and Mussa, 1981: 253). The law of one price applied to international markets is called purchasing power parity (Mankiw, 2003: 138). In other words purchasing power parity is an application the law of one price to countries' price level rather than a goods (Mishkin, 1992: 472-473).

As a implementing method for real exchange rate value price based criteria namely purchasing power parity[1] can be formulated:

$$E = K\frac{P}{P*}$$

Whereby, E denotes equilibrium exchange rate, K is a scalar, P denotes domestic price level lastly, P* denotes foreign price level. Purchasing power parity is that shows the ratio of domestic price level to foreign price level ratio. Purchasing power parity asserts that exchange rate between two countries is determined by the domestic relative price level of two countries.

Furthermore, purchasing power parity shows that domestic price volatility is equal to exchange rate volatility (Daniel, 1986: 484). This theory based on the idea that price level changes are important determinant in determination of exchange rate (Civcir, 2003: 3).

In the short run numerous studies has been rejected purchasing power parity for countries which have floating exchange rate system. Even though numerous studies have been presented strong evidences about real exchange rate tends to towards purchasing power parity, in the longer run purchasing power parity still remains a controversial issue (Kim, 1990: 491; Rogoff, 1996: 647; Rush and Husted, 1985: 139). On the other hands, when free movement of merchandise and a somewhat comprehensive trade occur, real (actual) exchange rate cannot deviate from purchasing power parity so much. However, as long as countries strike trade equally, trade restrictions will not cause that exchange rate deviates from purchasing power parity (Cassel, 1918: 413).

According to purchasing power parity, if goods are measured with same currency, arbitrage forces equalize prices of goods. For this reason if arbitrage potentiality is restricted, there can be deviations from purchasing power parity. There are many reasons of deviations from purchasing power parity in the short run. Transport costs, transfer pricing in a country which will distort the relationship between home and foreign prices, trade barriers, speculative attacks, government interventions, different weighting schemes for price indices and changes in relative prices of nontraded goods cause deviation from purchasing power parity (Frenkel and Mussa, 1981: 253; Bunting, 1939: 283-284).

The theory has two versions: absolute and relative. Absolute purchasing power parity which is calculated as a ratio of consumer goods prices for two countries would tend to equilibrium rates of exchange. In other words, absolute versions assert that the cost of a given

[1] PPP first articulated by scholars of the ISalamanca school in sixteenth century in Spain (see Rogoff, 1996). However, In the literature, there is a conflict about who does the theory advance? The theory restated by Gustav Cassel with his "*Money and Foreign Exchange After 1914*" (see Bunting, 1939). Furthermore some studies state that the theory is advanced by Cassel (1918).

goods basket would be same in domestic and foreign countries if goods prices are converted to same currency unit. As a result this versions of purchasing power parity states that the purchasing of money in different countries is equal. On the other hand according to relative purchasing power parity when equilibrium rates prevailed changes in relative prices would indicate the necessary adjustment in exchange rates. This version which focuses on changes in purchasing power of money state that inflation differential between two countries balances nominal exchange rate and power purchasing parity will constant between the countries (Balassa, 1964: 584-585; Deuctsche Bundesbank, 2004). In the long run absolute version of the doctrine is formulated as,

$$P_d = \frac{P_f}{W}$$

whereby P_d: domestic prices of a goods basket, P_f: foreign prices of same goods basket, finally, *W*: nominal exchange rate between two countries.

Relative interpretations of the theory is formulated as,

$$\frac{W_1 - W_0}{W_0} = P_f - P_d$$

whereby $(W_1 - W_0) \backslash W_0 = \hat{W}$: the change rate in nominal exchange rate, $P_f - P_d$: the inflation differential between two countries. That's, according to relative version of purchasing power parity, change of nominal exchange rate is equal to the inflation differential (Deuctsche Bundesbank, 2004).

Absolute purchasing power parity has a lot of weakness. For example, One of these weakness is that absolute version is difficult to determine without using precisely same goods basket (Taylor and Taylor, 2004: 137-138). In other words, on account of the goods basket can include different goods in each country, absolute version cannot be a good indicator. So that relative version is commonly used instead of absolute version.

The aim of this paper analyses validity of PPP in the long run in some of EU countries including Turkey. In this context, we use a panel unit root test in a TAR framework which based on Caner-Hansen (2001) methodology and bootstrap method to compute critical values for the null and alternative hypothesis.

Methodology and Data

A most of absolute empirical testing of PPP takes into account the possibility of non-linear mean reversion in real exchange rates. Owing to non-linear mean reversion in Exchange rates, we execute Beyaert and Camacho's paper for the validity of PPP in EU countries including Turkey.

A model have been considered TAR model based on ADF test with n cross section in t period and specified as fallows:

$$\Delta RER_{n,t} = \delta_n' + \rho_n' RER_{n,t-1} + \sum_{i=1}^{p} \varphi_{n,i}' \Delta RER_{n,t-i} I_{\{z_{t-1}\langle\lambda\}} + \delta_n'' + \rho_n'' RER_{n,t-1} + \sum_{i=1}^{p} \varphi_{n,i}'' \Delta RER_{n,t-i} I_{\{z_{t-1}\geq\lambda\}} + \varepsilon_{n,t} \quad \text{(Model 1)}$$

n=1,…..,N and t=1,…..,T where $I_{\{\cdot\}}$ is the indicator function, $z_t = RER_{m,t} - RER_{t-d}$ transition variable which can be determined exogenous or endogenous via estimating from $RER_{n,t}$, $\varepsilon_{n,t}$ is an iid error with component cross section. The threshold parameter is represent like λ. As should be seen, Model 1 is reverted to a linear form in the absence of threshold, that the form being the ADF regression which would be estimated in testing for unit root of the equilibrium error or deviations from PPP. When all $\rho_n' = \rho_n'' = 0$, the larger the PPP deviation the stronger the movement towards inequilibrium and also no evidence for PPP all countries.. Therefore, small deviations of RER from the equilibrium may mean a random walk process that is, we can have $\rho_n' \rangle 0$. However, for large deviations from RER, there is an equilibrium reverting process, so we must have $\rho_n'' \langle 0$ and $(\rho_n' + \rho_n'') \langle 0$ so that the process is full stationary. For achieving cross-country contemporaneous correlation, we must find out a diagonal variance-covariance matrix like $V = \Omega \otimes I_T$ where $\Omega = \left[\sigma_{nm}\right] n, m = 1,..., N$ with $\sigma_{nm} = \text{cov}(\varepsilon_{n,t}, \varepsilon_{m,t})$ for all period t. As the threshold parameter λ is unknown, we must impose restriction that $0 \langle \pi_1 \leq P(z_{t-1} \leq \lambda) \leq \pi_2 \langle 1$ and also $\pi_2 = 1 - \pi_1$. For this reason, threshold parameter is beetween π_1 and π_2.

Literature have shown that in this restriction process, π_1 and π_2 fractional values must be 0.10 or 0.15 and 0.85 or 0.90 respectively so that we might decide the linear-symetrics or nonlinear-asymetrics process for given value. If π_2 increases above itsef values, linear-symetrics process is used. The linear model which in the absence of threshold parameter

(Model 1), is including time period and also cross sections is estimated by Feasible Generalized Least Squares (FGLS) by reason of unknown threshold value of z_t. Estimated value of λ, m, d obtained by minimizing weighted sum of squared residuals as shown $wssr(\lambda, m, d) = (TV)^{-1} \sum_{t=1}^{T} \hat{\varepsilon}_{t,(\lambda,m,d)}$. It is called Grid-FGLS in the estimating process. For testing null hypothesis, we can not use conventional test such as Wald or LM tests statistics owing to non-standard distribution. Test statistics values obtain by boostrap replication based on Caner and Hansen (2001) methodology.

If we want to test $H_{0,1} : \delta_n' = \delta'', \rho_n' = \rho_n', \varphi_{i,n}' = \varphi_{i,n}''$ or against alternative we might use maximum likehood function to obtain value for both Model 1 and absence threshold in Model 1. For each model, value of the likehood function is computed as $L_{1,2} = -2In(\frac{L_1}{L_2})$ where L_1 is the value of one-regime linear model, the other L_2 is the two regime TAR model. If null hypothesis is be rejected, Caner Hansen (2001)'s bootstrap methodology may be used to identify value of maximum likehood by restricted and unrestricted bootstrap. The next step that testing the other null hypothesis which is restricted as shown $H_{0,2} : \rho_n' = \rho_n'' = 0$. If the joint hypothesis holds insignificantly different from zero, $RER_{n,t}$ has unit roots in both regimes. The other unit root test process consist of partial unit root test and alternative unit root test. If $H_{1A} : \rho_n' \langle 0$ and $\rho_n'' \langle 0$ hypothesis holds significantly, $RER_{n,t}$ will be a stationary state in both regimes. See Caner and Hansen (2001:1567). Partial unit root process is tested as shown below.

$$H_{A,2} : \left\{ \begin{array}{c} \rho_n' \langle 0 \text{ and } \rho_n'' = 0 \\ \text{or} \\ \rho_n' = 0 \text{ and } \rho_n'' \langle 0 \end{array} \right\}$$

$H_{A,2}$ holds, $RER_{n,t}$ is a stationary process in one regime, but a unit root process in the other regime. We can determine regimes how they have stationary process or not. We use Evans and Karras's (1996) test statistic, quasi Caner-Hansen one sided or two sided Wald test statistic (See Caner and Hansen (2001:1568)) to discriminate rejimes which have stationary process or not. The statistic is $R_2 = t_I^2 + t_{II}^2$ where t_I and t_{II} are t-statistics associated with the estimation of ρ_n' and ρ_n''.The last step of the PPP analysis consists of discriminating between

absolute and Relative PPP based on $\sum_{i=1}^{c} \Phi_i$ statistics (See Beyaert and Camacho; 2008:673).

Empirical Application

All the data of this study were obtained by the Economic and Financial Affairs on EURO-STAT. The sample is comprised of yearly data of varying time spans determined by data availability. The sample period is 1970 to 2008 for the Austria, Belgium, Denmark, France, Germany, Netherlands, Spain, Sweeden; and 1980 to 2008 for the Turkey. For 1970-1980 period in Turkey, RER series were created by using nominal Exchange rate (units of YTL per USA $), domestic CPI and foreign CPI for the EU-12 countries.

The statistical results are denoted in Table 1, whether PPP holds for the some of EU countries and Turkey.

Linear Model

PPP invalid vs PPP valid=Null of PPP is invalid				Transition Variable: Country	Absolute vs Condition
0.4005				sweden	
TAR Model					
	Linearity Tests vs TAR model			d	Threshold Parameter
Unrestricted	Restricted	L12	2		-0.7044
0.0400	0.0200	47.9650 (Prob: 0.0379)			
Whether PPP is valid or not tests					
PPP instable vs PPP stable=null of PPP is instable				Absolute vs Relative PPP=Null of	
Regime I	Regime II	Both		Regime I	Regime II
-	Bootstrap Pval: 0.0000	Bootstrap Pval: 0.3000		Bootstrap Pval: 0.5000	Bootstrap Pval: 0.000
t1	t2	R2		Fia	Fib
0.0313 (prob: 0.5125)	3.1654 (Prob: 0.0008)	10.0210 (t12+t22)		8.2766 (Prob: 0.0000)	4.4092 (Prob: 0.0001

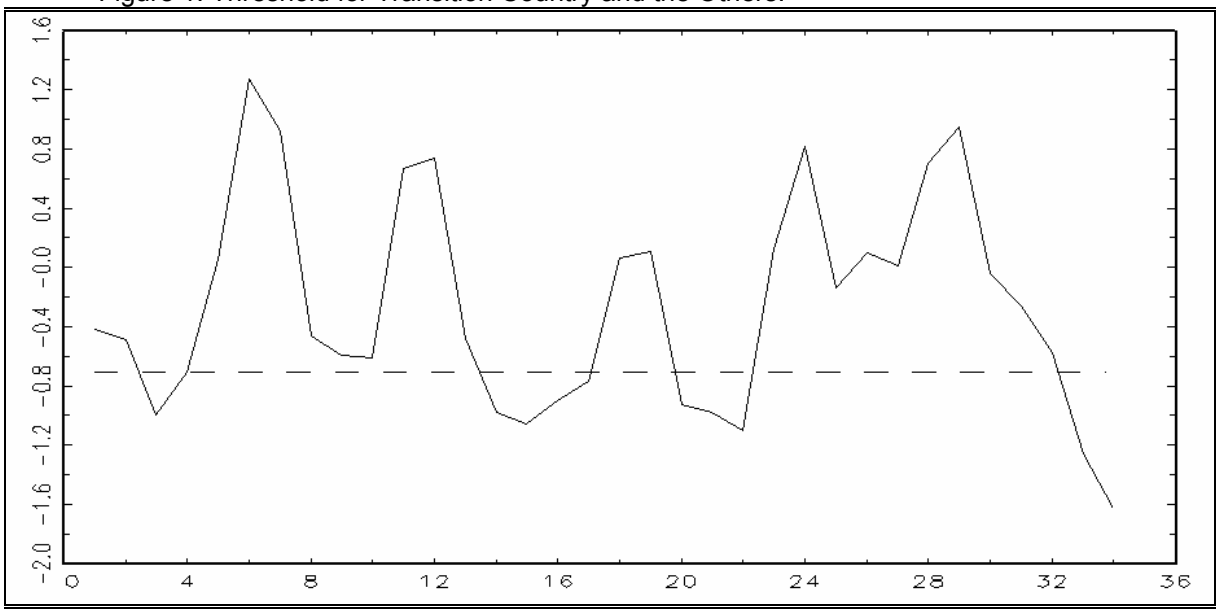
Note: The selected lag length is estimated by FGLS (on the basis of the Ljung-Box statistic) for each country. Estimated lag lengths are 1 for Austria, Belgium, Denmark, France, Turkey, Netherlands, Spain, Sweeden and 6 for Germany.

According the results (in Table 1), PPP is not valid in the linear form with 0.4005 p-value, which implies that it can be rejected and also we can say in the linear form RER series of each country has a unit root process. In fact, it is not necessary the test on absolute PPP against relative PPP[2]. In the TAR framework, we can reject linearity with restricted and unrestricted bootstrap p value for 0.0200 and 0.0400 respectively. The transition variable or country is Sweeden which determines the switching from first regime to the second regime

[2] But we want to see whether PPP is stationary in the linear form or in the FGLS, absolute PPP is valid in each country with 0.50 bootstrap p-value for the null of absolute PPP.

with d=2 value of delay parameter ($z_t = RER_{Sweden,t} - RER_{Sweden,t-2}$) and estimated value of threshold parameter is -0.7044. It meas that growth rate of RER which belongs to Sweden is below the other country group by more than 0.7044 percentage point and around %29.41 of observations belong to the Regime I, and roughly %70.59 of observations belong to the Regime II. So we can say that; the threshold paramater value reflects each RER series have fallen by more than -0.7044 points when $z_{t-1} \langle -0.7044$ occurs in the Regime I and they have fallen by less than -0.7044 points when $z_{t-1} \rangle -0.7044$ occurs in the Regime II. After the reject linear model we can test whetter PPP stable or not. As far as p value is significant in the Regime II, the null of PPP is instable is rejected with a 0.0008 p value. At this point we can test the other partial unit root process to determine absolute PPP and relative PPP is valid in each regime. In this stage we accepted relative PPP is valid in Regime II with 0.0000 bootstrap p value. Relative PPP is valid Turkey, Denmark, Netherland and Spain which are stated in Regime II with 0.0800, 0.0936, 0.0791 and 0.0839 p value respectively. According the other finding, transition country's threshold value which is determined with d=2 delay parameter is drawn in Figure 1. Regime II which occurs each RER series have fallen by less than -0.7044 points when $z_{t-1} \rangle -0.7044$ dominate between the 4-13(1974-1983), 17-19 (1987-1989), 23-32 (1993-2002) observations.

Figure 1: Threshold for Transition Country and the Others.



CONCLUDING REMARKS

PPP has been one of the major topic discussed in econometric studies in today competitive world. Reel exchange rate which can be affected by policy makers is one of indicators of country competitive power. Other words a country competitive power is closely

link exchange rate level. Also misalignment of exchange rate level can cause financial crises. Owing to exchange rate has a substantial impact on economy, determination of exchange rate is an important issue.

The aim of this paper analyses validity of PPP in the long run in some of EU countries including Turkey. A most of absolute empirical testing of PPP takes into account the possibility of non-linear mean reversion in real exchange rates. Owing to non-linear mean reversion in Exchange rates, we execute Beyaert and Camacho's paper for the validity of PPP in EU countries including Turkey. In this context, we employs a panel unit root test in a TAR framework which based on Caner-Hansen (2001) methodology and bootstrap method to compute critical values for the null and alternative hypothesis. Panel unit root test procedure extends the pre-existing methods by pooling TAR model and bootstrap method. It takes into account that some of EU countries could be in equilibrium under one regime or PPP is valid and inequilibrium under the other regime or PPP is invalid, and also in the partial unit root process we can appraise Absolute PPP or relative PPP is valid or not.

This application is provided to a panel of bilateral real exchange rate series with the US dollar from the 8 EU countries including Turkey. In contrast to the evidence obtained by linear tests, we find evidence of nonlinear mean-reversion in the real exchange rates for the whole EU counnties panel that gives support to the long run PPP hypothesis. According the other finding to partial unit root process; it is found evidence of relative PPP hypothesis or null of Absolute PPP valid can rejected with 0.0000 bootstrap p value for the whole Regime II countries which contains Turkey, Denmark, Netherland and Spain. Accepted relative PPP, it focuses on changes in purchasing power of money state that inflation differential between Regime II countries nominal exchange rate and power purchasing parity are constant.

References

Balassa, Bela (1964), "The Purchasing-Power Parity Doctrine: A Reappraisal", ***The Journal of Political Economy***, Vol. 72, No. 6, pp. 584-596.

Bunting, Frederick H. (1939), "The Purchasing Power Parity Theory Reexamined", ***Southern Economic Journal***, Vol. 5, No. 3, pp. 282-301.

Cassel, G. (1918), "Abnormal Deviations in International Exchanges", ***The Economic Journal***, Vol. 28, No. 112, pp. 413-415.

Civcir, İrfan (2003), "Before the fall was the Turkish Lira overvalued?", ***Forthcoming in Eastern European Economics,*** March-April 2003, pp. 1-23.

Chinn, Menzie D. (1998), ""Measuring Misalignment: PPP and East Asian Currencies in the 1990's", **UCSC Department of Economics Working Paper** No. 398, pp.1-29.

Daniel, Betty C. (1986), "*Optimal Purchaasing Power Parity Deviations*", ***International Economic Review***, Cilt: XXVII, N.2, pp. 483-511.

Deutsche Bundesbank (2004), "Purchasing power parity theory as a concept for evaluating price competitiveness", Montly Report, June 2004.

Dornbusch, Rudriger and Stanley Fischer (1994), **Macroeconomics**, 6th. Ed.,USA: McGraw-Hill,inc..

Edison, Hali J. (1987), "Purchasing Power Parity in the Long Run: A Test of the Dollar/Pound Exchange Rate (1890- 1978)", ***Journal of Money, Credit and Banking***, Vol. 19, No. 3, pp. 376-387.

Frenkel, Jacob A. and Michael L. Musa (1981), "Monetary and Fiscal Policies in an Open Economy", The **American Economic Review**, Vol.71, No.2, Papers and Proceedings of the Ninety-Third Annual Meeting of the American Economic Association, 253-258.

Mankiw, N. Gregory (2003), **Macroeconomics**, 5th ed., New York: Worth Publishers.

Mishkin, Frederic S. (1992), **The Economics of Money, Banking and Financial Markets**, 3rd. Ed., New York: Harper Collins.

Kalyoncu, Hüseyin and Kahraman Kalyoncu (2008), "Purchasing power parity in OECD countries: Evidence from panel unit root", ***Economic Modelling*** 25, pp. 440–445.

Kim, Yoonbai (1990), "Purchasing Power Parity in the Long Run: A Cointegration Approach", ***Journal of Money, Credit and Banking***, Vol. 22, No. 4, pp. 491-503.

Rush, Mark and Steven Husted (1985), "Purchasing Power Parity in the Long Run", ***The Canadian Journal of Economics / Revue canadienne d'Economique***, Vol. 18, No. 1, Econometrics Special, pp. 137-145.

Rogoff, Kenneth (1996), "The Purchasing Power Parity Puzzle", ***Journal of Economic Literature***, Vol. 34, No. 2, pp. 647-668.

Taylor, Alan M. and Mark P. Taylor (2004), "The Purchasing Power Parity Debate", ***Journal of Economic Perspectives,*** Volume 18, Number 4-Fall 2004, pp. 135-158.

Hansen, Bruce E. and Byeongseon Seo (2002); "Testing For Two-Regime Threshold Cointegration in Vector Error-Correction Models" *Journal of Econometrics*, Vol.110, pp: 293-318.

Caner, Mehmet and Bruce Hansen (2001); "Threshold Autoregression with a Unit Root"

Econometrica, Vol.69, No.6, pp:1555-1596.
Beyaert, Arielle and Maximo Camacho (2008); "TAR Panel Unit Root and Real Convergence" *Review of Development Economics*, Vol.12, No:3, pp: 668-681.