TESTING PURCHASING POWER PARITY IN TRANSITION COUNTRIES: EVIDENCE FROM STRUCTURAL BREAKS

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Abstract
This study examines the validity of the purchasing power parity (PPP) in 8 transition countries for monthly data from 1992:1 to 2009:1. While results from both the ADF unit root and the KPSS unit root test indicate that PPP does not hold for Bulgaria, Croatia, Czech Republic, Hungary, Macedonia (FYR), Poland, Romania and Slovak Republic. In the presence of structural breaks, PPP holds only for Bulgaria and Romania it does not hold for the other 6 transition countries. Testing the stationarity of real exchange rate series by using four types of unit roots tests, the evidence suggests that real effective exchange rate is nonstationary and thus PPP doesn't hold for all 6 transition countries in the long run. All results emphasized that there is weak evidence about the long-run PPP hypothesis in transition countries and the validity of PPP remains a controversial and unsettled issue.

Keywords: real exchange rate, unit root tests, structural breaks, transition countries

JEL Classification: C22, E31, F31

Introduction

Purchasing power parity (PPP) is an important theory of exchange rate determination in international finance and the stationarity of real exchange rates is crucial for PPP. It states that exchange rates between currencies are in equilibrium when their purchasing power is the same in each of the two countries. While economists generally doubt the validity of PPP in the short run, they may be more willing to believe PPP's validity in the long run (Acaravci and Acaravci, 2007b). Because PPP theory emphasize that price differentials between countries are not sustainable in the long run as market forces that has forced tried to adjust exchange rates between countries in order to denote the purchasing power of each currency.

The validity of the PPP has been extensively tested, especially for developed countries (see for example, Taylor, 1988; Froot and Rogoff, 1995; Frankel and Rose, 1996; Lothian and

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Taylor, 2000; Acaravci and Acaravci, 2007a; Narayan, 2008; Kalyoncu and Kalyoncu, 2008). In general, most of these studies concluded that the PPP holds in the long-run. However, the empirical validity of PPP remains a controversial and unsettled issue in transition countries.

Choudhry (1999) investigated PPP between USA and Poland, Romania, Russia and Slovenia, and provided evidence of relative PPP only in Slovenia and Russia. Christev and Noorbakhsh (2000) test for PPP for six Central and East European (CEE) countries (Bulgaria, the Czech Republic, Hungary, Poland, Romania and Slovakia). Even though they find evidence for long-run equilibrium, the cointegrating vectors reject the symmetry and proportionality restrictions implied by the PPP hypothesis. Kim and Korhonen (2002) present panel unit-root tests for real exchange rates in Czech Republic, Hungary, Poland, Slovakia and Slovenia, and reject the null stationarity. Barlow (2003) employed cointegration methodology in order to test for PPP in Poland, Czech Rep. and Romania, without evidence of PPP vis-a-vis developed economies.

Maican and Sweeney (2006) investigate whether long run PPP holds for ten CEE transition countries, by testing the unit-root hypothesis for their real exchange rates. In both single-equation tests and panel tests with SUR techniques, the data reject the unit-root null for the CEE countries. Solakoglu (2006) uses a panel approach and concludes that the PPP holds for the transition economies. Sideris (2006) performed long-run PPP test for each of seventeen transition economies together with panel cointegration test. The analysis provided support for long-run equilibrium, but the cointegrating vectors violated the symmetry and proportionality hypotheses suggested by PPP. Koukouritakis (2009) examines the validity of the purchasing power parity (PPP) between each of the 12 new EU countries. Using the Johansen cointegration methodology and allowing for a structural break for the countries that joined the EU on May 2004, it is found that there is a long-run equilibrium relationship among the nominal exchange rate, the domestic prices and the foreign prices for all the new EU countries. The evidence also suggests that the PPP holds only for Bulgaria, Cyprus, Romania and Slovenia.

In this article we use the most recent monthly data available from 1992:1 to 2009:1 and four types of unit roots in the presence of structural breaks, to test the PPP hypothesis for the 8 transition countries. Because of changes in exchange-rate regimes, financial or political crises, and the large structural changes they have had to make, some transition-country time series appear to show such shifts. In other words, turbulent histories in transition countries appear as structural shifts in real exchange rates. Thus, the validity of PPP hypothesis is tested with structural changes in this study.

The rest of the article is organized as follows. Section II describes the model and data. Section III presents the empirical results. The last section concludes paper.

1. Model and Data

The most common definition for the log of real exchange rate (q_t) for country at time t follows as:

$$q_t = e_t + p_t^* - p_t . \quad (1)$$

where e_t is the exchange rate defined in units of home currency per unit of foreign, p_t^* is the consumer price index (CPI) for a wider group of partner or competitor- countries and p_t is the CPI for home country (all in logs).

If purchasing power parity (PPP) holds the price for any combination or basket of goods should be equalized, then *q* is always constant. The PPP theory, therefore, predicts that real exchange rates converge in the long run. Thus, this proposition is equivalent to testing for the stationarity of the real exchange rate.

The stationarity of the real exchange rate can be established two ways: (1) The strong form of the PPP hypothesis is to examine if the real exchange rate has a unit root in the q_t series. (2) Testing for a cointegrating relationship between the nominal exchange rate (e_t) and relative prices ($p_t^* - p_t$). This, however, is a much weaker form of evidence.

In order to test PPP for these transition countries, we use the series of monthly real effective exchange rates (REER) based on CPI from the IMF International Financial Statistics (IFS) online database for the selected eight transition countries. The IMF computed REER as the rate of exchange against a basket of currencies of the main trade partners. The time period is from 1992:1 to 2009:1. The countries included in this study are: Bulgaria, Croatia, Czech Republic, Hungary, Macedonia (FYR), Poland, Romania and Slovak Republic.

As suggested by most of the empirical studies (see Papell, 1997), a time trend in real exchange rates would not be consistent with the PPP hypothesis. Therefore, the condition of mean stationarity is required for the strong form of the PPP hypothesis; otherwise agents will be making systematic errors.

Following the existing literature, we apply to set four different unit root tests for the empirical validity of PPP in Transition countries. The first two unit root tests may depend on the assumptions of model with intercept and level stationarity for the PPP hypothesis, respectively. On the other hand, latter two unit root tests that assume unit root with one and two changes in level, respectively. We, however, provide a brief description of these unit root tests.

1.1 Unit Root Tests without Structural Breaks

The augmented Dickey-Fuller (hereafter ADF, 1981) regression can be expressed for the strong form of the PPP hypothesis:

$$\Delta q_t = \mu + \alpha q_{t-1} + \sum_{j=1}^{k} c_j \Delta q_{t-j} + \varepsilon_t \qquad (2)$$

where Δq_t is the first-difference of the log of real exchange rate and *k* is the number of lagged first differences. The null hypothesis is unit root and the alternative hypothesis is

level stationarity. If the coefficient of the lag of q_{t-1} (α) is significantly different from zero, then the null hypothesis is rejected.

Kwiatkowski *et al.* (hereafter KPSS, 1992) provide an alternative test for testing the null of stationarity against the alternative of a unit root:

$$q_t = r_t + \varepsilon_t \tag{3}$$

where $r_t = r_{t-1} + u_t$ is a random walk, the u_t is *iid*($0, \sigma_u^t$). Under the null hypothesis ($H_0 : \sigma_u^t = 0$) q_t is stationary around a level (r_0) against the alternative of a unit root ($H_1 : \sigma_u^t > 0$).

1.2 Unit Root Test with One Structural Break

Lee and Strazicich (2004) consider two models of structural break: Model A is known as the "crash" model, and allows for a one-time change in intercept under the alternative hypothesis. Model C allows for a shift in intercept and change in trend slope under the alternative hypothesis. Lee and Strazicich claimed that the one-break minimum Lagrange multiplier (LM) unit root test tends to estimate the break point correctly and is free of size distortions and spurious rejections in the presence of a unit root with break. Lee and Strazicich argued that augmented Dickey-Fuller (ADF) type endogenous break unit root tests (like Zivot and Andrews test, 1992) (1) will exhibit size distortions such that the unit root null hypothesis is rejected too often, and (2) incorrectly estimate the break point. When utilizing such tests, researchers may incorrectly conclude that a time series is stationary with break when in fact the series is nonstationary with break. As such, "spurious rejections" might occur and more so as the magnitude of the break increases (see, Nunes, *et al.*, 1997; Vogelsang and Perron, 1998; and Lee and Strazicich, 2001).

Lee and Strazicich (2004) consider the data generating process (DGP) based on the observed components models:

$$y_t = \delta' Z_t + X_t, \qquad \mathrm{X}_t = \beta X_{t-1} + \varepsilon_t \tag{4}$$

where Z_t contains exogenous variables. The unit root hypothesis is described by $\beta = 0$. Lee and Strazicich consider two models of structural break. "Model A" is known as the "crash" model, and allows for a one-time change in intercept under the alternative hypothesis. Model A can be described by $Z_t = [1,\ t,\ D_t]'$. The LM unit test statistic can be estimated by regression according to the LM principle as follows:

$$\Delta y_t = \delta' \Delta Z_t + \phi \tilde{S}_{t-1} + u_t, \tag{5}$$

where $\tilde{S}_t = y_t - \tilde{\psi}_x - Z_t\tilde{\delta}$, t=2,...,T; $\tilde{\delta}$ are coefficients in the regression of Δy_t on ΔZ_t; $\tilde{\psi}_x$ is the restricted maximum likelihood estimation (MLE) of $\psi_x (\equiv \psi + X_0)$ given by $y_1 - Z_1\tilde{\delta}$; and y_1 and Z_1 denote the first observations of y_t and Z_t,

respectively. The unit root null hypothesis is described by $\phi = 0$, and the LM test statistics are given by

$\tilde{\tau} = t - statistics$ testing the null hypothesis $\phi = 0$ (6)

1.3 Unit Root Tests with Two Structural Breaks

Lee and Strazicich (2003) propose an endogenous two-break LM unit root test that allows for breaks under both null and alternative hypotheses. Model A allows for two shifts in level while model C includes two changes in level and trend. Lee and Strazicich (2003) consider the DGP as follows:

$$y_t = \delta' Z_t + e_t \quad (7)$$

where Z_t is a vector of exogenous variables and $e_t = \beta e_{t-1} + \varepsilon_t$, $\varepsilon_t \sim$ iid $N(0, \sigma^2)$. Two structural breaks can be considered as follows. Model A allows for two shifts in level and is described by $Z_t = [1, t, D_{1t}, D_{2t}]'$. Where $D_{jt} = 1$ for $t \geq T_{Bj}+1$, j=1,2 and zero otherwise. T_{Bj} denotes the time period when a break occurs. The two break LM unit test statistic can be estimated by regression according the LM principle as follows:

$$\Delta y_t = \delta' \Delta Z_t + \phi \tilde{S}_{t-1} + u_t, \quad (8)$$

where $\tilde{S}_t = y_t - \tilde{\psi}_x - Z_t \tilde{\delta}$, t=2,...,T; $\tilde{\delta}$ are coefficients in the regression of Δy_t on ΔZ_t; $\tilde{\psi}_x$ is given by $y_1 - Z_1 \tilde{\delta}$; and y_1 and Z_1 denote the first observations of y_t and Z_t, respectively. The unit root null hypothesis is described by $\phi = 0$, and the LM test statistics are given by

$\tilde{\rho} = T\Phi$ (9.a)

$\tilde{\tau} = t - statistics$ testing the null hypothesis $\phi = 0$. (9.b)

2. Empirical Results

We employed four unit root tests to empirically test the validity of PPP in Transition countries. First two unit root tests, the ADF and the KPSS, may depend on the assumptions of model with intercept and level stationarity for the PPP hypothesis, respectively. On the other hand, in this study the LS1 and the LS2 unit root tests that assume unit root with one and two changes in level, respectively.

The optimal number of lag for unit root tests is to include lags sufficient to remove any serial correlation in the residuals. Because the size and power properties of the unit root tests are sensitive to the number of lagged terms (*k*) used, lag selection procedures are important to get robust outcomes. Specifically, the existing literature suggests using the general-to-specific procedure proposed by Hall (1994). As discussed by Campbell and Perron (1991) and Ng and Perron (1995), this procedure has better size and power properties than alternative methods. Besides this, the structural break in a time series is of great importance for the stationary analysis, we employed recently developed the LS1 and

LS2 unit root tests. For the ADF, LS1 and LS2 unit root tests, we set k-max as three years of lags (k=36) and determined the optimal number of lag according to the recursive t-statistics procedure with significance determined at 5% level of asymptotic normal distribution. Break points (T_B) are determined endogenously in LS1 and LS2 unit root tests. For the KPSS unit root test, a nonparametric estimator based on a Bartlett window with a lag truncation parameter ($k = \text{int}[m(T/100)^{1/4}]$) is used. Here, T is observations and m is 12 for monthly data. Here, k is calculated as 14.

Table no. 1 represents the empirical results from unit root tests. Our findings indicate that the ADF unit root test cannot reject the null hypothesis of real exchange rate nonstationarity for all eight transition countries. Besides this the KPSS unit root test rejects the null hypothesis of real exchange rate stationarity for these countries. Both these results do not support the validity of PPP hypothesis for these countries.

Note that if we take into consideration one or two structural changes, both tests have the same results that PPP holds only for Bulgaria and Romania. These tests are represented in Table 1 as the LS1 unit root and LS2 unit root tests, respectively.

Generally, the results derived from four unit root tests indicate that real effective exchange rate is nonstationary and thus PPP doesn't hold for 6 transition countries in the long run. Our results are in line with the work of Alba and Park (2003), who mentioned that the empirical validity of PPP remains a controversial and unsettled issue.

Table no. 1: Unit Roots Tests Results

	ADF	KPSS	LS1	LS2
Bulgaria	-2.32 (5)	1.41	-3.91 (29) [1997M2]	-4.43(29) [1996M1;1997M2]
Croatia	-2.22 (21)	0.81	-1.15(30) [2001M4]	-1.43(30) [1997M12;2001M4]
Czech Republic	-1.16 (10)	1.45	-2.14 (10) [2008M5]	-2.90(10) [1999M1;2002M7]
Hungary	-0.19 (32)	1.39	-1.36 (32) [2004M10]	-1.57(36) [2005M4;2006M1]
Macedonia, FYR	-2.68 (29)	0.91	-1.05(33) [1997M5]	-0.75(33) [1995M12;2006M4]
Poland	-1.77 (1)	1.27	-3.23(14) [2005M6]	-3.48(14) [1997M12;2003M5]
Romania	-1.80 (13)	1.28	-3.73(14) [1997M11]	-4.13(14) [1998M1;2000M5]
Slovak Republic	-1.36 (10)	1.40	-1.38(10) [2004M10]	-2.18(8) [2000M4;2004M10]
C.V. at 1% C.V. at 5%	-3.46 -2.88	0.74 0.46	-4.24 -3.57	-4.55 -3.84

Notes: Number of lags, k, and break point, T_B, are in ( ) and [ ], respectively. For the ADF, LS1 and LS2 unit root tests, we employed the general-to-specific procedure proposed by Hall (1994). For the KPSS unit root test, we used a nonparametric estimator and calculated k as 14. For LS1 and LS2 unit root tests, critical values are taken from Lee and Strazicich (2004, table 1) and Lee and Strazicich (2003, table 2), respectively.

Conclusion

This study examines the validity of PPP hypothesis for 8 transition countries during the period 1992:1 to 2009:1. These countries are Bulgaria, Croatia, Czech Republic, Hungary, Macedonia (FYR), Poland, Romania and Slovak Republic. For this purpose, we have tested the stationarity of real exchange rate series by using four types of unit roots tests. The first two unit root tests may depend on the assumptions of model with intercept and level stationarity for the PPP hypothesis, respectively. On the other hand, latter two unit root tests that assume unit root with one and two changes in level, respectively.

Empirical findings imply that both the ADF unit root and the KPSS unit root tests results indicate that PPP does not hold for these countries. In the presence of structural breaks, PPP holds only for Bulgaria and Romania. All results emphasized that there is weak evidence about the long-run PPP hypothesis in transition countries and the validity of PPP remains a controversial and unsettled issue.

As a conclusion, our results are consistent with the existing literature on transition countries and the empirical validity of PPP remains a controversial and unsettled issue. The real exchange rates do not converge in the long run the way PPP theory predicts. A possible explanation for the violation of the PPP is that the periods of strong real appreciation which imply often interventions in the exchange rate markets, productivity shocks, fiscal imbalance and the existence of non-tradable goods and services.

References

Acaravci, SK. & Acaravci, A., 2007a. Purchasing power parity under the current float. *International Research Journal of Finance and Economics*, 10, pp.167-174.

Acaravci, SK. & Acaravci, A., 2007b. Nonstationarity and the level shift for Turkish real exchange rates. *Empirical Economics Letters*, 6, pp.517-523.

Alba, JD. & Park, D., 2003. Purchasing power parity in developing countries: Multi-period evidence under the current float. *World Development*, 31(12), pp.2049-2060.

Barlow, D., 2003. Purchasing Power Parity in Three Transition Economies. *Economics of Planning*, 36(3), pp.201-221.

Campbell, J. & Perron. P., 1991. Pitfalls and opportunities: What macroeconomics should know about unit roots, In O. Blanchard, and S. Fisher (Eds.), *NBER Economic Manual*, Cambridge.

Choudhry, T., 1999. Purchasing power parity in high-inflation Eastern European countries: Evidence from Fractional and Harris-lnder cointegration tests. *Journal of Macroeconomics*, 21(2), pp.293-308.

Christev, A. & Noorbakhsh, A., 2000. Long-run purchasing power parity, prices and exchange rates in transition: The case of six Central and East European countries. *Global Finance Journal*, 11(1-2), pp.87-108.

Dickey, D. & Fuller, WA., 1981. Likelihood ratio statistics for autoregressive time series with a unit root. *Econometrica*, 49, pp.1057-1072.

Frankel, JA. & Rose, AK., 1996. A panel project on purchasing power parity: Mean reversion within and between countries. *Journal of International Economics*, 40, pp.209–24.

Froot, KA. & Rogoff, K., 1995. Perspectives on PPP and long-run real exchange rate. *Handbook of International Economics*, 3, pp.1647–88.

Hall, A., 1994. Testing for a unit root in time series with pretest data-based model selection. *Journal of Business and Economic Statistics*, 12, pp.461-470.

Kalyoncu, H. & Kalyoncu. K., 2008. Purchasing power parity in OECD countries: Evidence from panel unit root. *Economic Modelling*, 25, pp.440–445.

Kim, BY. & Korhonen, I., 2002. *Equilibrium exchange rates in transition countries: Evidence from dynamic heterogeneous panel models*. Technical report, Discussion Paper No. 15, Bank of Finland Institute for Economies in Transition BOFIT.

Koukouritakis, M., 2009. Testing the purchasing power parity: Evidence from the new EU countries. *Applied Economics Letters*, 16(1), pp.39–44.

Kwiatkowski, D., Phillips, PCB., Schmidt, P. & Shin, Y., 1992. Testing the null hypothesis of stationarity against the alternative of a unit root: How sure are we that economic time series have a unit root?. *Journal of Econometrics*, 54, pp.159-178.

Lee, J. & Strazicich, MC., 2001. Break point estimation and spurious rejections with endogenous unit root tests. *Oxford Bulletin of Economics and Statistics*, 63(S1), pp.535-558.

Lee, J. & Strazicich, MC., 2003. Minimum LM unit root test with two structural breaks. *Review of Economics and Statistics*, 85(4), pp.1082-1089.

Lee, J. & Strazicich, MC., 2004. Minimum LM unit root test with one structural break. Appalachain State University, Department of Economics, Working Paper No: 17.

Lothian, JR. & Taylor, MP., 2000. Purchasing power parity over two centuries: Strengthening the case for real exchange rate stability, a reply to Cuddington and Liang. *Journal of International Money and Finance*, 19, pp.759–64.

Maican, FG. & Sweeney, RJ., 2006. Real exchange rate adjustment in European Transition countries. Göteborg University, Department of Economics Working Paper, No: 202.

Narayan, PK., 2008. The purchasing power parity revisited: New evidence for 16 OECD countries from panel unit root tests with structural breaks. *International Financial Markets, Institutions and Money*, 18(2), pp.137-146.

Ng, S. & Perron, P., 1995. Unit root tests ARMA models with data dependent methods for the selection of the truncation lag. *Journal of the American Statistical Association*, 90, pp.268-281.

Nunes, LC., Newbold, P. & Kuan, CM., 1997. Testing for unit roots with breaks: Evidence on the Great Crash and the unit root hypothesis reconsidered*., Oxford Bulletin of Economics and Statistics*, 59(4), pp.435-448.

Papell, DH., 1997. Searching for stationarity, purchasing power parity under the current float. *Journal of International Economics*, 43, pp.313–332.

Sideris, D., 2006. Purchasing Power Parity in economies in transition: Evidence from Central and East European countries. *Applied Financial Economics*, 6, pp.135–143.

Solakoglu, EG., 2006. Testing purchasing power parity hypothesis for transition economies. *Applied Financial Economics*, 16, pp.561–8.

Vogelsang, T. & Perron, P., 1998. Additional tests for a unit root allowing for a break in the trend function at an unknown time. *International Economic Review*, 39(4), pp.1073-1100.

Taylor, MP., 1988. An empirical examination of long-run purchasing power parity using cointegration techniques. *Applied Economics*, 20, pp.1369–81.

Thacker, N., 1995. Does PPP hold in the transition economies? The case of Poland and Hungary. *Applied Economics*, 27, pp.477–81.

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