E C O N O M I C S B U L L E T I N

Purchasing power parity in Central and Eastern European countries

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Abstract

This paper investigates the validity of the purchasing power parity (PPP) hypothesis for 13 Central and Eastern European countries (CEEC) in transition. The results based on the seemingly unrelated regression ADF (SURADF) method reveal that the PPP relationship holds in 7(6) out of the 13 countries when the real exchange rate is based on US dollar (euro). Our empirical findings appear to support a long-run PPP in some of the transition countries that appears insensitive to the base country.

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1. Introduction

The purchasing power parity (PPP) hypothesis asserts that the change in exchange rates between two currencies is determined by the relative prices of the two countries. The most common approach to test for the validity of PPP investigates unit roots in real exchange rates (RERs) since the hypothesis postulates that a nominal exchange rate corrected for an inflation differential reverts to a constant mean. If the unit root hypothesis can be rejected in favor of level stationary, the deviations from PPP are temporary and the parity condition is said to hold. While there is a multitude of research focusing on PPP in developing countries (Bahmani-Oskooee, 1995; Mahdavi and Zhou, 1994; Breuer *et al.*, 2001, just to name a few), the literature dealing specifically with the CEEC and other European transition countries is rather spare.

This paper attempts to close the gap and shed some light on the hypothesis by considering recent literature. Some scholars argue that the failure to reject the unit root hypothesis as a product of the low power of the tests and tests using very long spans of historical data that cut across regimes changes. The limited empirical evidence includes Brada (1998), Kutan and Dibooglu (1998), Christev and Noorbakhsh (2000), and more recently Payne et al. (2005) and Beko and Boršič (2007). Overall, these authors find that PPP fails to hold in the transition economies. The article by Beko and Boršič (2007), for instance, find that the evidence of cointegration among prices and exchange rates but do not confirm the validity of PPP for the advance transition economies like Czech Republic, Hungary and Slovenia.

The CEEC started their liberalization programs in the late-1980s and early 1990s. In some of these countries, this period was characterized by dramatic improvements in budget deficits, debts and inflation. As these countries became increasingly open to trade (and inflation and growth rates converge to that of developed countries), we expect to find more favorable evidence of the parity condition using data in recent years. A survey by the Organization of Economic Cooperation and Development (OECD) points out that even early in the transition process international firms have been impressed at how well the CEEC have adjusted after the transition and to their commitment to a newly adopted market system (OECD, 1994). In fact, many of these countries adopted trade policies that mimic those of the European Union (EU), with a view to alignment in readiness for membership. As the reform process (price liberalization and trade opening) becomes intensified, we may expect a reduction in persistent shocks to international parity.[1] From a methodological perspective, transition economies offer more cross-sectional variations (hyperinflation rates are absent in advanced economies) and show more time series noise for conducting the panel unit root tests.

The primary objective of this study is to test for the PPP relationship in 13 European transition countries (Bulgaria, Croatia, Czech Republic, Estonia, Hungary Latvia, Lithuania, Poland, Romania, Macedonia, Russia, Slovakia and Slovenia). The paper offers two distinct features. First, the countries selected for this study have not received much attention in the literature. They include the advanced transition countries of Poland, Hungary, the Czech

[1] Some authors cast doubt about whether PPP holds for transition economies. They argued that during the catch-up phase of transition, equilibrium exchange rates should exhibit an upward trend as they experience growth in productivity and real wages (Halpern and Wyplosz, 1997). Additionally, large capital inflows due to liberalization of capital accounts might appreciate real exchange rates and hence PPP may not hold in this case (Brada, 1998).

Republic, Slovenia and Slovakia, with GDP per capita figures roughly as high as the emerging countries.[2] Second, it uses a powerful panel data method advocated by Breuer *et al.* (2002) to test for unit root in the RERs, using both the US dollar and the euro as numeraire currency.[3] Given the exceptionally large German investment in some of these countries (e.g. Latvia, Lithuania and Estonia), we also consider the euro as the base currency. Also, the euro is also the second most active traded currency in foreign exchange markets worldwide.[4]

Our paper is organized as follows: Section II provides a brief account of econometric methods. The empirical results are presented and discussed in Section III, and the final section provides some concluding remarks.

2. Panel Unit Root Test: SURADF

In this paper, the seemingly unrelated regressions augmented Dickey-Fuller (SURADF) is used to test for the unit root. Briefly, the test is based on the system of the ADF equation which can be represented as:

$$\Delta y_{1,t} = \alpha_1 + \beta_1 y_{1,t-1} + \sum_{j=1} \varphi_j \Delta y_{1,t-j} + u_{1,t}$$
$$\Delta y_{2,t} = \alpha_2 + \beta_2 y_{2,t-1} + \sum_{j=1} \varphi_j \Delta y_{2,t-j} + u_{2,t}$$
$$\vdots$$
$$\Delta y_{N,t} = \alpha_N + \beta_N y_{N,t-1} + \sum_{j=1} \varphi_j \Delta y_{N,t-j} + u_{N,t} \qquad (1)$$

where $\beta_j = (\rho_j - 1)$ and ρ_j is the autoregressive coefficient for series *j*. This system is estimated by SUR procedure and the null and the alternative hypotheses are tested individually as

$$H_0^1 : \beta_1 = 0; \qquad H_A^1 : \beta_1 < 0$$
$$H_0^2 : \beta_2 = 0; \qquad H_A^2 : \beta_2 < 0$$
$$\vdots$$
$$H_0^N : \beta_N = 0; \qquad H_A^N : \beta_N < 0$$

[2] The average GDP per capita in these five transition economies was about $4,300 US dollars in 1999.

[3] The problem of testing PPP in the post-Bretton Woods period is that the lack of power of unit root tests with 30 years of data makes the results obtained unreliable. Since extending the span of the data is not an option, we used panel methods to exploit cross-sectional information. SURADF has been employed by Chu *et al.* (2007) and Chang *et al.* (2005), to name two.

[4] It is often argued that the empirical results are sensitive to the choice of base country. Nominal exchange rates measured against the Deutschmark tend to provide more support of PPP than those measured against the US dollar, because of the long swings in the US real exchange rates; see for example Narayan (2005). To highlight the robustness of our results, we consider both the euro and the US dollar rates.

with the test statistics computed from SUR estimates of system (1) while the critical values are generated by Monte Carlo simulations. The procedure poses several advantages. First, by exploiting the information from the error covariances and allowing for an autoregressive process, it produces more efficient estimators than the single equation methods. Second, the testing procedure allows for heterogeneity lag structure across the panel members. Third, the SURADF panel integration test allows us to identify which members of the panel contain a unit root. Put differently, the advantage of the test is that it is based on an individual rather than a joint null hypothesis as in earlier versions of the panel unit root tests (Breuer *et al*., 2001, 2002). In our view this is very important in the present context as the transition economies under investigation have varying degrees of integration with global capital markets.

As this test has non-standard distributions, the critical values of the SURADF test must be obtained through Monte Carlo simulations. In the simulations, the intercepts, the coefficients on the lagged values for each series were set to equal zero. In what follows, we obtain the lagged differences and the covariances matrix from the SUR estimation on the actual exchange rate data. The SURADF test statistic for each of the 13 series was computed as the *t*-statistic calculated individually for the coefficient on the lagged level. To obtain the critical values, the experiments were replicated 10,000 times and the critical values (CVs) of 1%, 5% and 10% are tailored to each of the 13 panel members.

3. Empirical Results

We use monthly data that covers the period from January 1994 to December 2005 for 13 CEEC countries. The main source of data (nominal exchange rates and consumer price index) is extracted from the Vienna Institute for International Studies. Since this database does not cover all the countries under investigation, we added data from other sources like International Financial Statistics (IMF), Eurostat and Statistic Lithuania. The RER (q_t) is defined as nominal exchange rate (S_t) deflated by the domestic price level (P_t) to the foreign price level (P_t^*). In log form: $q_t = S_t - P_t + P_t^* = \ln(SP^*/P)_t$. We take the US dollar and the euro, alternatively, as reference currency to construct the RERs.

A major pitfall in conventional panel unit root tests is that a rejection of the joint unit root hypothesis can be driven by a few stationary series and the whole panel may erroneously be concluded as stationary (Taylor and Sarno, 1998). In other words, with a sufficiently large *T*, it could be rejected if one of the *N* real exchange rates was stationary. One way of resolving the ambiguity is to rely on the SURADF test, a test shown by Breuer *et al.* (2001, 2002) to perform well with panels of mixed integration order. The computed statistics along with the CVs for each of the 13 panel members are as tabulated in Tables 1 and 2. [Insert Tables 1 and 2]

When RERs are based on the US dollar, 7 out of the 13 transition countries are stationary and hence consistent with the PPP hypothesis at the 5% significance level or better. Specifically, PPP holds in Bulgaria, Croatia, Latvia, Lithuania, Macedonia, Russia and Slovenia. This is no surprise as most of these countries have experienced a sizable appreciation since the early 1990s, and these adjustments have resulted in the market exchange rate approaching the rate given by PPP. Furthermore, we have extended the time period to include recent data that ended in December 2005.

Does the choice of numeraire currency make a considerable difference? To address this issue, we explore the hypothesis using the euro as the base currency to the same set of data, given its importance in the region. According to the results on the euro-based real exchange rates display in Table 2, with the sole exception of Macedonia, the unit root null is rejected in all the currencies of the other six transition countries. The empirical evidence supports long-run PPP between EU and Bulgaria, Croatia, Latvia, Lithuania, Russia and Slovenia. For Croatia, we note that Payne *et al.* (2005) find no evidence supporting the validity of PPP using an univariate unit root test that allows for structural breaks in the real effective exchange rates over the period January 1992 to October 1999. Similarly, Christev and Noorbakhsh (2000) rejected the hypothesis for Bulgaria, Czech Republic, Hungary, Poland, Romania and Slovakia for the period that ended in 1998. It worth noting that the empirical evidence presented in Tables 1 and 2 appears to be insensitive to incorporating a time trend in the model. The reason for including a time trend in the analysis is to accept the existence of systematic factors with a systematic influence of the real exchange rate due to the Balassa-Samuelson effect and a demand-sided bias in favor of non-trades goods (Kalyoncu and Kalyoncu, 2008).

4. Conclusions

This study empirically examines the validity of the PPP hypothesis for 13 CEEC over the period 1994: M1 to 2005: M12 using the SURADF unit root test. We find that the long-run PPP relationship holds for Bulgaria, Croatia, Latvia, Lithuania, Russia and Slovania. In the case of Macedonia, the PPP proposition holds only for the US dollar-based rates. Our results appear to support the view that PPP holds better for countries more open to trade because trade barriers hinder international arbitrage. For transition countries with higher inflation rates and volatile exchange rates regimes, we observed that PPP fails to hold.

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Table 1
Summary of SURADF Estimations and the Critical Values (US dollar rates)

Country	Test Statistics	Critical Values			Test Statistics	Critical Values		
	SURADF (Constant)	0.01	0.05	0.10	**SURADF (Constant and trend)**	0.01	0.05	0.10
Bulgaria	-3.873 (6)**	-4.040	-3.395	-3.048	-3.856(6)**	-4.061	-3.426	-3.077
Croatia	-4.722 (4)***	-4.486	-3.855	-3.513	-4.724 (4)***	-4.386	-3.810	-3.476
Czech Rep	-1.823 (12)	-4.531	-3.812	-3.392	-1.748 (12)	-4.605	-3.844	-3.458
Estonia	-3.152 (6)	-4.723	-4.017	-3.680	-3.117 (6)	-4.667	-4.030	-3.675
Hungary	-1.594 (11)	-4.763	-4.192	-3.851	-1.756 (11)	-4.818	-4.171	-3.837
Latvia	-4.272 (5)**	-4.421	-3.737	-3.377	-4.148 (5)**	-4.386	-3.728	-3.407
Lithuania	-3.764 (7)**	-3.991	-3.298	-2.984	-4.404 (7)***	-4.013	-3.376	-3.019
Macedonia	-3.688 (6)**	-4.208	-3.594	-3.265	-3.731 (6)**	-4.305	-3.627	-3.274
Poland	-2.047 (11)	-4.571	-3.964	-3.625	-2.173 (11)	-4.561	-3.906	-3.578
Romania	-1.728 (11)	-4.164	-3.544	-3.198	-1.630 (11)	-4.191	-3.532	-3.175
Russia	-5.848 (2)***	-3.942	-3.358	-3.030	-5.909 (2)***	-4.023	-3.342	-2.996
Slovakia	-2.649 (11)	-3.030	-4.078	-3.725	-2.618 (11)	-4.627	-4.042	-3.699
Slovenia	-4.696 (3)**	-5.028	-4.431	-4.090	-4.964 (3)**	-5.099	-4.422	-4.082

Notes: The column of SURADF refers to the estimated Augmented Dickey-Fuller statistics obtained through the SUR estimation of the ADF regression. The estimated critical values are tailored by the simulation experiments based on 157 observations for each series and 10,000 replications, following the work by Breuer et al. (2002). The error series were generated in such a manner to be normally distributed with the variance-covariance matrix given from the SUR estimation of the 13 countries' panel structures. Each of the simulated RER-US was then generated from the error series using the SUR estimated coefficients on the lagged differences. (***), (**) and (*) denotes statistically significance at the 0.01, 0.05 and 0.10 level. Figures in parentheses indicate the lag length. The estimations and the calculation of the SURADF were carried out in RATS 5.02 using the algorithm kindly provided by Myles Wallace.

Table 2
Summary of SURADF Estimations and the Critical Values (Euro rates)

Country	Test Statistics	Critical Values			Test Statistics	Critical Values		
	SURADF (Constant)	0.01	0.05	0.10	**SURADF (Constant and trend)**	0.01	0.05	0.10
Bulgaria	-3.597 (7)**	-3.918	-3.248	-2.886	-3.588 (7)**	-3.880	-3.169	-2.859
Croatia	-5.641 (4)***	-4.162	-3.479	-3.116	-5.752 (4)***	-4.138	-3.474	-3.140
Czech Rep	-0.825 (8)	-4.125	-3.441	-3.091	-1.608 (8)	-4.187	-3.440	-3.071
Estonia	-2.601 (7)	-4.012	-3.362	-3.053	-2.887 (7)	-4.012	-3.408	-3.060
Hungary	-2.202 (11)	-4.224	-3.584	-3.245	-2.323 (11)	-4.225	-3.562	-3.219
Latvia	-4.307 (9)**	-4.353	-3.560	-3.208	-4.370 (9)***	-4.247	-3.580	-3.240
Lithuania	-5.130 (6)***	-4.287	-3.609	-3.246	-5.090 (6)***	-4.317	-3.609	-3.244
Macedonia	-3.094 (11)	-4.357	-3.598	-3.364	-2.993 (11)	-4.224	-3.660	-3.336
Poland	-2.673 (10)	-4.259	-3.614	-3.245	-2.649 (10)	-4.283	-3.605	-3.235
Romania	-3.068 (6)	-4.101	-3.488	-3.238	-3.000 (6)	-3.977	-3.326	-3.005
Russia	-4.803 (3)***	-4.080	-3.456	-3.125	-4.799 (3)***	-4.070	-3.467	-3.136
Slovakia	-3.234 (7)	-4.193	-3.610	-3.273	-3.186 (7)	-4.144	-3.537	-3.274
Slovenia	-4.178 (3)***	-4.014	-3.413	-3.090	-4.132 (3)***	-4.081	-3.425	-3.089

Notes: The column of SURADF refers to the estimated Augmented Dickey-Fuller statistics obtained through the SUR estimation of the ADF regression. The estimated critical values are tailored by the simulation experiments based on 149 observations for each series and 10,000 replications, following the work by Breuer et al. (2002). The error series were generated in such a manner to be normally distributed with the variance-covariance matrix given from the SUR estimation of the 13 countries' panel structures. Each of the simulated RER-EURO was then generated from the error series using the SUR estimated coefficients on the lagged differences. (***), (**) and (*) denotes statistically significance at the 0.01, 0.05 and 0.10 level. Figures in parentheses indicate the lag length. The estimations and the calculation of the SURADF were carried out in RATS 5.02 using the algorithm kindly provided by Myles Wallace.