# Testing Purchasing Power Parity in Romania using standard unit root tests, with one structural break and cointegration analysis

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*In this paper we aim to analyze the long-run validity of the Purchasing Power Parity (PPP) hypothesis for the Romanian exchange rate. Our goal is achieved using Zivot-Andrews test with one structural break in order to identify changes in real exchange rate compared with traditional tests like Augmented Dickey-Fuller and Phillips-Perron and cointegration analysis in order to identify the long-run relationship between exchange rate and domestic and foreign prices. Real exchange rate stationarity implies that a shock it is absorbed in time and PPP holds in long-run. If nominal exchange rate and prince indices are non-stationary we verify if the variables are cointegrated as PPP weak form and symmetry and proportionality conditions as PPP strong form. We identify evidence of cointegration for all three models, but we don't find any evidence to support symmetry and proportionality condition for PPP strong form case. Also, we use three different price indices: consumer price index, consumer price index without regulated prices and industrial producer price index in order to identify which indices is more relevant for our*

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*analysis. The monthly data cover the 2001M01-2011M09 period. The empirical analysis provided mixed results depending on the used price index and methodology.*
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## 1.Introduction

Purchasing Power Parity remains a fundamental model in the theory of exchange rate determination. The PPP states that national price indices should be equal when expressed in a common currency.

It is a consensus that in the short-run the PPP theory does not hold due to the price rigidity for short periods of time. However, many authors argue that in the long-run the PPP remains the most appropriate model for the exchange rate assessment.

Nowadays, the appropriate analyze of the exchange rate sustainability is an important issue especially in view of the acceding process into the euro zone. In order to avoid future disequilibrium, it is important for policy makers to assess the level of the national price convergence with respect to the euro market and to understand the relationship between exchange rate and prices level.

Considering the above-mentioned issues, the purpose of our study is to test the long-run validity of the Purchasing Power Parity for Romania. To increase the relevance of our study and for a better understanding, we use as a proxy for prices a range of different indices, and we explore popular econometrical procedures such as classical unit root tests and with one structural break and cointegration.

We structure our paper as follows: in section 2 we study the existing literature for Central and Eastern European (CEE) countries. In section 3, we present the methodology and in section 4 we highlight the empirical results of our study. Finally, we point the main conclusions of our empirical analysis.

## 2. Literature review

The roots of the concept of the Purchasing Power Parity can be traced back to the 16th century, School of Salamanca, but the modern form of this theory was developed by the Gustav Cassel, in 1918.

The concept of the PPP is based on the Law of One Price, which states, that once prices are converted to a common currency, the same good should sell for the same price in different countries (Rogoff, 1996).

Based on the different econometric techniques, which have been applied over the time, the empirical studies on Purchasing Power Parity are structured as follows: "early studies", before 1970, unit root test studies, panel data studies and cointegration-based studies.

The most representative for the early stage of the Purchasing Power Parity are works of Frenkel (1978) and Frenkel (1981). At this stage they applied mainly the OLS technique and found a support for the PPP theory only for countries with high inflation rates. The main drawbacks of the mentioned studies were the fact that they neglected that exchange rate and prices are non-stationary.

In order to examine the long-run validity of the PPP, other studies tested real exchange rate stationarity. If real exchange rate follows a random walk, then PPP does not hold.

The most recent analysis performed for CEE countries, which employed the unit root tests are Kasman et al. (2010), Telatar and Hasanov (2009), Ozturk and Ali (2010).

For example Kasman (2010) applied Lagrange multiplier (LM) test and found little evidence for validity of PPP for CEE countries. The results of Telatar and Hasanov (2009) research suggest PPP validity, when structural changes and nonlinearities are considered. After applying a series of unit root tests, Ozturk and Ali (2010), concluded that PPP holds only for a few countries, finding weak evidence for PPP for other countries.

Also, support for PPP theory for CEE countries was provided by Sideris (2006) and Koukouritakis (2009) by employing Johansen cointegration. Sideris (2006) found evidence for cointegration among the nominal exchange rate and foreign and domestic prices for twelve countries. But the signs and magnitudes of the estimated coefficients of the cointegrating vectors indicated weak support for PPP strong form. Koukouritakis (2009) found evidence for PPP for four countries: Bulgaria, Cyprus, Romania and Slovenia.

In two recent studies, using Engle-Granger cointegration we highlight PPP rejection in Romania (Ghiba, 2012) and mixed results for four CEE countries (Sadoveanu and Ghiba, 2012).

## 3. Methodology description

### 3.1. Purchasing Power Parity theoretical framework

A major part of the empirical literature investigates the two forms of PPP theory: the weak and the strong forms. First, we apply stationarity tests on real exchange rates ($rer_t$). PPP holds in the long-run if the real exchange rate is a stationary series. The weak form is mainly investigated by applying cointegration methods and the strong form is verified by testing the proportionality and symmetry restrictions.

The purchasing power parity in a simplified form denotes that the modification degree of a currency is approximately equal to the difference between domestic and foreign price indices:

$$ner_t = p_t - p_t^* + d_t \qquad (1)$$

where $\mathrm{ner_t}$ is the exchange rate in a logarithmic form and $\mathrm{p_t}$, respectively $\mathrm{p_t^*}$ are the logarithms of the national and foreign price index. $\mathrm{d_t}$ denotes the deviations from purchasing power parity and it is associated with real exchange rate movements ($\mathrm{rer_t}$):

$$rer_t \equiv ner_t + p_t^* - p_t \qquad (2)$$

Under these conditions, we admit that purchasing power parity holds in the long-run if the real exchange rate is a stationary series. A variable is stationary if it has a tendency in returning to a constant value. In other words, its trajectory must be around a mean value or around a linear trend. Economically, this means that any shock on series is temporary and it is absorbed in time. In practice, almost every variable is stationary and must be differenced. Hence, the exchange rate is nonstationary for the most cases and the series is first order integrated (requires just one differentiation).

Relaxing the condition of the perfect arbitrage on the international market, we can rewrite the Eq. (1) as follows:

$$e_t = \propto + \beta_1 p_t + \beta_2 p_t^* + u_t \quad (3)$$

where: $e_t$ - nominal exchange rate, $p_t, p_t^*$- foreign and domestic prices, $u_t$ – error term for deviations from PPP.

The most empirical studies on PPP theory use this equation in order to identify the long-run relationship among exchange rate and domestic and foreign prices. In order to assess the PPP validity are imposed two conditions: „a symmetry condition" for equal coefficients with opposite signs and a "proportionality condition" for coefficients that are equal with the unit and also, with opposite signs (Frenkel, 1978, 1981). Therefore, proportionality and symmetry restrictions are: β1=1, β2=-1, and β1= - β2, respectively.

## 3.2. Econometric issues

### *3.2.1. Unit root tests*

The econometric theory refers to a null hypothesis that claims a unit root in series. In our case, the real exchange rate is nonstationary. The most popular stationarity test were developed by Dickey and Fuller (ADF stationarity test), respectively by Phillips and Perron (1988). The difference between them is given by the less stringent restrictions on error process for Phillips-Perron test. These tests are important because it is necessarily for us to know the order of integration of our variables. If the obtained t-statistics and associated probability reflect null hypothesis acceptance, than we conclude that purchasing power parity doesn't holds. Recently, PPP studies based on stationarity are considering the presence of structural breaks.

Testing real exchange rate stationarity through Dickey-Fuller (ADF) entails three assumptions: the intercept presence, the presence of an intercept and a time trend, and finally, the absence of any deterministic element. For each supposition, we have built three different relationships:

- Includes both a drift and a linear time trend:

$$\Delta y_t = a_0 + \gamma y_{t-1} + a_2 t + \varepsilon_t \quad (4)$$

- Random walk with a drift:

$$\Delta y_t = a_0 + \gamma y_{t-1} + \varepsilon_t \quad (5)$$

- Pure random walk:

$$\Delta y_t = \gamma y_{t-1} + \varepsilon_t \quad (6)$$

If $\gamma = 0$, than the real exchange rate sequence contains a unit root (the series is non-stationary). The test estimates a regression equation using ordinary least squares, in order to determine an estimated value for $\gamma$ and associated standard error.

Augmented Dickey-Fuller is developed for *p*th-order autoregressive process and the estimated equation is the following:

$$\Delta y_t = a_0 + \gamma y_{t-1} + \sum_{i=2}^{p} \beta_i \Delta y_{t-i+1} + \varepsilon_t \quad (7)$$

where $\gamma = -(1 - \sum_{i=1}^{p} a_i$ $\gamma = -(1 - \sum_{i=1}^{p} a_i)$ and $\beta_i = \sum_{j=1}^{p} a_j$ .

We consider the equation being in first difference and having a unit root if $\gamma = 0$.

Phillips and Perron (1988) developed ADF procedure and allowed a weaker set of assumptions regarding the error process. Also, Phillips-Perron test (PP) is powerful in rejecting the null hypothesis.

Considering the following regression equations:

$$y_t = a_0^* + a_1^* y_{t-1} + \mu_t \quad (8)$$

$$y_t = \tilde{a}_0 + \tilde{a}_1 y_{t-1} + \tilde{a}_2 \frac{t-T}{2} + \mu_t \quad (9)$$

where T is the number of observation and $\mu_t$ is the disturbance term

The PP has the followings test statistics:

- $Z(ta_1^*)$ for testing the hypothesis $a_1^* = 1$.
- $Z(t\tilde{a}_1)$ for testing the hypothesis $\tilde{a}_1 = 1$.
- $Z(t\tilde{a}_2)$for testing the hypothesis $\tilde{a}_2 = 0$.
- $Z(\Phi_3)$for testing the hypothesis $\tilde{a}_1 = 1$ and $\tilde{a}_2 = 0$.

The PP critical values are the same as in ADF stationarity test. In our analysis, we choose to use both unit root tests due to the difficulties in knowing the true data-generating process.

Lately, many studies on PPP based on stationarity procedures are considering the **structural change** in order to avoid non-rejection of a unit root in that series with structural breaks, when using ADF or PP. The structural changes appear as a result of economic or financial crisis, policy changes and regime shifts.

Zivot and Andrews (ZA) (1992) find a solution and identified a break point where the unit root t-statistic is the smallest. The authors tested a procedure with an estimated time of the break assuming it as an exogenous phenomenon. Therefore, they test for a unit root using three models:

- A': one-time change in the level is allowed:

$$\Delta y_t = c + \alpha y_{t-1} + \beta t + \gamma DU_t + \sum_{j=1}^{k} d_j \Delta y_{t-j} + \varepsilon_t \quad (10)$$

- B': allows one-time change in the slope of the trend:

$$\Delta y_t = c + \alpha y_{t-1} + \beta t + \theta DT_t + \sum_{j=1}^{k} d_j \Delta y_{t-j} + \varepsilon_t \quad (11)$$

- C': combines one-time change in the level and the slope of the trend function:

$$\Delta y_t = c + \alpha y_{t-1} + \beta t + \theta DU_t + \gamma DT_t + \sum_{j=1}^{k} d_j \Delta y_{t-j} + \varepsilon_t \quad (12)$$

where $DU_t$ is a dummy variable for a mean shift occurring at a possible break-date (TB) and $DT_t$is a corresponding trend shift variable.

Also, we mention the following restrictions:

$$DU_t = \begin{cases} 1, if\ t > TB \\ 0, \text{otherwise} \end{cases} \quad (13)$$

$$DT_t = \begin{cases} t - TB, \text{if } t > TB \\ 0, \text{otherwise} \end{cases} \quad (14)$$

The null hypothesis in all above models is $\alpha=0$, which implies that $y_t$ contains a unit root (it is non-stationary) with a drift and without any structural break. The alternative hypothesis implies $\alpha<0$ and the series is considered a trend-stationary process with a one-time break at an unknown date in time. ZA test runs a regression for every possible break-date sequence and considers every point as being a potential break-date. The C' model is considered as being superior to others.

The main ZA unit root test advantage is that we don't need to know the exactly date of a structural break.

### *3.2.2. Cointegration analysis*

In order to identify the long-run relationship among the non-stationary variables, we considered that the most appropriate methodology is the Johansen cointegration.

The econometric methodology for this model can be described as follows.

Let us consider the p-dimensional VAR(k) model:

$$x_t = \prod_1 x_{t-1} + \cdots + \prod_k x_{t-k} + \phi D_t + \varepsilon_t \quad (15)$$

where: $x_t$ is a vector of the p endogenous variables at time t, $\Pi_i$ – pxp matrices of parameters and $D_t$ – a vector of deterministic components (constant and seasonal dummies).

To account for non-stationarity of the data, the error-correction form of the VAR (k) model can be written as:

$$\Delta x_t = \prod x_{t-1} + \sum_{i=1}^{k-1} \Gamma_i \Delta x_{t-1} + \phi D_t + \varepsilon_t \quad (16)$$

where: $\Pi = \sum_{i=1}^{k} \Pi_i - I_p$ and $\Gamma_i = -\sum_{j=i+1}^{k} \Pi_j$

If we assume, the VAR(k) model contains processes with unit roots, when $\Pi$ has a reduced rank r, $r<p$ and $\Pi$ can be expressed as:

$$\Pi = \alpha\beta' \quad (17)$$

where β is the cointegrating vectors and α is the adjustments coefficients.

The cointegrated form of the VAR model becomes:

$$\Delta x_t = \alpha\beta' x_{t-1} \sum_{i=1}^{k-1} \Gamma_i \, \Delta x_{t-1} + \phi D_t + \varepsilon_t \quad (18)$$

To determine the cointegration rank mainly are applied two tests: Trace and Maximum Eigen Value tests:

$$\lambda_{trace}(r) = -T \sum_{i=r+1}^{g} \ln(1 - \hat{\lambda}_i) \quad (19)$$

$$\lambda_{max}(r, r+1) = -T\ln(1 - \hat{\lambda}_{r+1}) \quad (20)$$

where: T – sample size, r- number of cointegrating vectors, $\hat{\lambda}$ – squared canonical correlation between the linear combination of the levels and a linear combination of the differences.

The difference between these two tests is that the Trace Test tests the null hypothesis, $r < r_0$ versus $r > r_0$ and the Maximum Eigen Value: $r = r_0$ against the alternative hypothesis $r_0 = r_0 + 1$.

## 4. Empirical results

### 4.1. Data

In this study were used data with monthly frequency covering the period from 2001M1 to 2011M9. Variables used can be described as follows:

- *Nominal exchange rate* – we use nominal exchange rates of the national currency against the euro. Source: Eurostat
- *Real exchange rate* – we compute real exchange rate against the euro using three different price indices: consumer price index, consumer price index adjusted with the administered prices and industrial producer price index. Source: Eurostat
- *Price indices* – we consider consumer price index (CPI), consumer price index adjusted for regulated prices (CPI_RP) and industrial producer price index for national economy and Euro Area. All series are 2005 year based. Source: Eurostat

- *Dummy variables* – to account for seasonal variation of the data were used centered seasonal dummies and for extreme observations we introduced a series of impulse dummies: for consumer price: dumm2010M07; for industrial producer price: dumm2003M09.

Our analysis is built around three models: A, B and C. All three models analyze the long-run relationship between nominal exchange rate and domestic and foreign prices. For the first model we apply the traditional approach and as a proxy for prices, the consumer price index is chosen. Due to the fact that important variation of the prices can be attributed to increases in regulated prices, in the second model (B) we use the consumer price index adjusted for regulated prices. Also, many studies consider that PPP theory seems to be valid just for the tradable sector of economy, and in order to test this hypothesis we develop a model (C), where we used the industrial producer price index as a proxy for domestic and foreign prices.

**4.2. Unit root tests results**

Purchasing Power Parity holds in a long-run horizon if the real exchange rate deflated with different price indices is a stationary series. Null hypothesis of one unit root presence is accepted if the probability is bigger than assumed threshold of 5%. The coefficients relevance indicates the type of process: pure random walk, random walk with drift or a process with both a drift and trend time. Using ADF unit root test we obtain the following results, reflected in table 1:

**Table 1**

**Results of ADF unit root tests without structural breaks**

| Model | Augmented Dickey-Fuller | | |
|---|---|---|---|
| | **t-statistic (Prob.)** | **Process type** | **Conclusion ADF test** |
| **A** | -0.837202 (0.3514) | Pure random walk | Non-stationary in level |
| | -7.545337 (0.0000) | | Stationary in first difference |
| **B** | -0.521213 (0.4891) | Pure random walk | Non-stationary in level |
| | -7.600107 (0.0000) | | Stationary in first difference |
| **C** | -1.891606 (0.0561) | Pure random | Non-stationary in level |

| | | | |
|---|---|---|---|
| | -7.733878 (0.0000) | walk | Stationary in first difference |

*Source: Author's calculations*

From the ADF test result we can conclude that the Romanian real exchange rate is a pure random walk and PPP doesn't hold for the considered models.

For additional proof for this conclusion we proceed with tests on the real exchange rate of the Romanian leu using Phillips-Perron technique.

**Table 2**

**Phillips-Perron unit root test results**

| **Model** | **Phillips-Perron test results** | |
|---|---|---|
| | **t-statistic (Prob.)** | **Conclusion** |
| **A** | -1.104596 (0.2434) | Non-stationary in level |
| | -7.469581 (0.0000) | Stationary in first difference |
| **B** | -0.774614 (0.3788) | Non-stationary in level |
| | -7.497258 (0.0000) | Stationary in first difference |
| **C** | -2.448778 (0.0144) | *Stationary in level* |

*Source: Author's calculations*

Using the Phillips-Perron unit root test we obtain similar results. Some differences results for the C model. PP test showed that PPP holds just for industrial producer price index.

In order to identify if the result of the ADF and PP tests are not misspecified by the presence of the structural break we also, applied the Zivot-Andrews test.

The null hypothesis of this test is that the series has a unit root with structural breaks against its alternative that the series is stationary with structural breaks. ZA test is important because it offers information on that series that are non-stationary as a whole, but stationary around a break-point.

**Table 3**

**Zivot-Andrews unit root with a structural break test results**

| Model | t-statistic (Prob.) | | | | | |
|---|---|---|---|---|---|---|
| | **Break in intercept** | **Break point** | **Break in trend** | **Break-point** | **Break in both** | **Break point** |
| **A** | *-4.342412 (0.000001)* | *2004M11* | *2.475955 (0.001648)* | *2007M12* | *--4.455401 (0.001320)* | *2004M11* |
| **B** | *-4.215684 (0.000002)* | *2007M05* | *-2.519374 (0.003798)* | *2004M11* | *-4.512478 (0.001066)* | *2004M11* |
| **C** | *-3.436562 (0.001402)* | *2004M11* | *-2.561628 (0.000003)* | *2007M01* | *-3.327786 (0.046707)* | *2004M11* |

*Note: Probability values are calculated from a standard t-distribution and do not take into account the breakpoint selection process;*
*Source: Author's calculations*

The ZA unit root test results showed that in Romania, PPP holds for all of the used price indices and for all of the assumption about the location of the structural break. From this we can conclude, that the PPP hypothesis is valid in long-run. The different results of ADF and PP other two tests can be caused by the fact that both did not account for the possible structural breaks in the series. We identify structural changes in exchange rate behavior due to its important appreciation started in 2004. Also, we identify a structural break in 2007 due exchange rate reverted evolution, when in a difficult macroeconomic situation, it is have started to depreciate.

**4.3. Johansen cointegration results**

Due to the fact that we identified non-stationary processes, we decided to apply the Johansen cointegration method.

As a first step in our analysis we estimate a VAR model, then we choose the appropriate lag length by examining the Akaike Information Criterion (AIC) and Schwartz Bayesian Criterion (SBC), and finally we check the diagnostic pass of the considered model.

**Table 4**

**Diagnostic tests results**

| Model | lags | LM test | White test | Normality test Jarque-Bera |
|---|---|---|---|---|
| **A** | 3 | 10.20557 (0.3341) | 233.6803 (0.0101) | 12.55372 (0.0507) |
| **B** | 2 | 5.984514 (0.7415) | 192.7729 (0.0106) | 16.06600 (0.0134) |
| **C** | 4 | 10.72191 (0.2953) | 292.1582 (0.0011) | 5.596629 (0.4699) |

*Note: figures in (.) indicate probability*
*Source: Author's calculations*

All VAR models satisfy the stability condition: no root lies outside the unit circle. Also, all models passed the autocorrelation test. As we can see, there are some problems with heteroskedasticity for all models and normality for model B, the last miss specification test results are caused by an excess kurtosis. Considering that many similar studies did not account for the last two tests diagnostic pass, all statistic tests were accepted and we consider that all VAR models describe well the data. Next we proceed with tests for cointegration rank.
The cointegration rank was determined by applying two tests: Trace test and Maximum Eigen Value test. The results for these two tests can be seen from the table below:

**Table 5**

**Cointegration test results: Testing for cointegration rank**

| Model | Trace Statistic | | | Maximum Eigenvalue | | |
|---|---|---|---|---|---|---|
| | r=0 | r≤1 | r≤2 | r=0 | r=1 | r=2 |
| **A** | 46.58966 * | 7.292802 | 2.055524 | 39.29685 | 5.237278 | 2.055524 |
| **B** | 37.87279 * | 11.10765 | 2.433076 | 26.76514* | 8.674579 | 2.433076 |
| **C** | 38.67035 * | 8.763678 | 2.625628 | 29.90667* | 6.138049 | 2.625628 |

*Note: * indicate rejection of the null hypothesis al the 5% level of significance*
*Source: Author's calculations*

Based on the results of the both tests we found evidence of cointegration for all three models.

Examining the normalized cointegrating vectors from the table below, we can see that the coefficients of the β vector have the expected signs. Regarding the theoretically expected magnitudes of these coefficients, the results are closer only for model C. Therefore we proceed with further tests of the hypothesis of symmetry and proportionality.

The test results for these two restrictions indicated that none of the hypothesis was accepted at the 5% significance level, from which we can conclude that none of the hypothesis of the PPP theory are valid for Romania.

**Table 6**

**Normalized Cointegrating Equations and Long-Run Coefficients**

| Model | Estimated cointegrating vectors β | | | $H_1(-\beta_1=\beta_2)$ | $H_2(\beta_1=-1, \beta_2=1)$ |
|---|---|---|---|---|---|
| | $ner_t$ | P | p* | $\chi^2$ *(1 degree of freedom)* | $\chi^2$ *(2 degrees of freedom)* |
| **A** | 1.0000 | -5.958426 (0.91839) | 16.62697 (3.40038) | 12.85547* | 30.37468* |
| **B** | 1.0000 | -5.354456 (0.94018) | 14.73390 (3.37266) | 7.366868* | 20.39262* |
| **C** | 1.0000 | -1.990704 (0.23363) | 5.404290 (0.95581) | 5.083870* | 17.44057* |

*Note: figures in (.) indicate standard error, * indicate rejection of the null hypothesis al the 5% level of significance*
*Source: Author's calculations*

## 5. Conclusion

The main goal of our paper was to assess the validity of the Purchasing Power Parity theory for Romanian leu.

The empirical results of our study show a strong evidence for the PPP in long-run, supported by the Zivot-Andrews test for all three models. We identify 2 structural breaks: one is for 2004 when the Romanian exchange rate appreciated and another in 2007 when it depreciated in a difficult international context.

Regarding the strong form of the PPP theory, we did not find any evidence to support it. The cointegration test results indicated that exist a long-run relationship among exchange rate of the leu against the euro and domestic and euro area prices. From that we can conclude that the long-run behavior of the exchange rate in Romania is influenced by domestic and foreign prices, but cannot be entirely explained by these. There are some other fundamental factors which also affect the exchange rate in the long-run and a good example in this case is the Harrod-Balassa-Samuelson effect.

Also, comparing the results for all price models used: A, B and C we can see that closer results, in order to accept the validity of the PPP theory we obtained for model C for all applied methods, from which we can conclude that the PPP theory is more like to be valid for tradable goods sector. In Romania, industrial prices show a significant level of convergence with the similar prices from Eurozone.

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**References**

Acaravci, A, Ilhan, O. (2010), "Testing Purchasing Power Parity in Transition Countries: Evidence from Structural Breaks", Amfiteatru Economic Journal, 12(27): 190-198.

Banerjee, A., Carrion-i-Silvestre, J.L. (2006), „Cointegration in Panel data with Breaks and Cross-section Dependence", European Central Bank Working Paper, 591

Frenkel, J. (1978), „Purchasing Power Parity: Doctrinal Perspective and Evidence from the 1920s", Journal of International Economics, 8: 169-91

Frenkel, J., Mussa, M. (1980), „The Efficiency of Foreign Exchange Markets and Measures of Turbulence", American Economic Review, 70: 374-81

Ghiba, N. (2012), "Purchasing Power Parity influence on real exchange rate behavior in Romania", CES Working Papers Series, 3(4): 524-536

Hasanov, M., Erdinc, T. (2009), „Purchasing power Parity in Central and East European Countries", Eastern European Economics, 47(5): 25-41

Kasman, S., Adnan, K., Duygu, A. (2010), „Testing the Purchasing Power Parity Hypoothesis for the New Member and Candidate countries of the European Union: Evidence from Lagrange Multiplier Unit Root Tests with Structural Breaks", Emerging Markets Finance and Trade, 46(2): 53-65

Kavkler, A., Jani, B., Darja, B. (2009), „Investigating Purchasing Power Parity in Central and Eastern European Countries: a Panel Data Approach", http://oliver.efri.hr/~euconf/2009/session2.html, [Accessed 14.01.2012]

Koukouritakis, M. (2009), „Testing the Purchasing Power Parity: Evidence from the New EU Countries", Applied Economics Letters, 16(1): 39-44

Rault, C., Imed, D. (2008), „Purchasing Power Parity for Developing and Developed Countries. What can we Learn from Non-Stationary Panel Data Models?", CESIFO Working Paper 2255, Monetary Policy and International Finance

Rogoff, K. (1996), „The Purchasing Power Parity Puzzle", Journal of Economic Literature, 34(2): 647-668

Sadoveanu, D., Ghiba, N. (2012), "Purchasing Power Parity: Evidence from four CEE Countries", Journal of Academic Research in Economics, 4(1): 80-89

Sideris, D. (2006), „Purchasing Power Parity in Economies in Transition: Evidence from Central and East European Countries", Applied Financial Economics, 16(1-2):135-143