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EXCHANGE RATES AND PURCHASING POWER PARITY: THE CASE OF CENTRAL EUROPEAN

Introduction. *The question of how exchange rates adjust is central to exchange rate policy, since countries with fixed exchange rates need to know what the equilibrium exchange rate is likely to be and countries with variable exchange rates would like to know what level and variation in real and nominal exchange rates they should expect. In broader terms, the question of whether exchange rates adjust toward a level established by purchasing power parity helps to determine the extent to which the international macroeconomic system is self-equilibrating*

Analysis of recent researches and publications *has shown that the published up to date papers aren't systematic and can't claim to be a complete analysis in the chosen field.*

The aim *is to test the validity of PPP hypothesis in the long run in former and current European transitional economies.*

Methods. *General scientific methods such as the systematic approach, theoretical generalization and comparison, analysis, synthesis and the Levin–Lin–Chu (LLC) panel unit root test have been used in the research.*

Research results. *This paper tests the validity of purchasing power parity (PPP) hypothesis in the long run in selected European transitional economies.*

ВАЛЮТНІ КУРСИ ТА ПАРИТЕТ КУПІВЕЛЬНОЇ СПРОМОЖНОСТІ: ДОСВІД КРАЇН ЄВРОПИ

Вступ. *Питання про те, як коригуються обмінні курси, є центральним у політиці обмінного курсу, оскільки країни з фіксованими обмінними курсами повинні знати, яким може бути рівноважний обмінний курс. Для країн зі змінними обмінними курсами актуальним є визначення рівня та коливань реального й номінального курсів, на які вони мають очікувати. Ідентифікація відповідності обмінних курсів до рівня, встановленого за паритетом купівельної спроможності, допомагає визначити, наскільки міжнародна макроекономічна система спроможна самоврівноважуватися.*

Проблема. *Сучасні статті не є систематичними й не можуть претендувати на повний аналіз щодо обраної галузі.*

Метою *статті є перевірка обґрунтованості гіпотези ПКС у довгостроковій перспективі в європейських країнах з перехідною економікою.*

Методи. *У дослідженні використано: системний підхід, теоретичне узагальнення та порівняння, аналіз, синтез та панельний тест одиничних коренів Левіна–Лін–Чу (LLC).*

Результати дослідження. *Перевірено обґрунтованість гіпотези паритету купівельної спроможності (ПКС) у довгостроковій перспективі в окремих європейських країнах з перехідною економікою. База даних, що використовується в цій статті,*

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The database used in this paper contains monthly data on real effective exchange rate (REER) observed over 23 years, from March 1995 till November 2017. To test the hypothesis, the Levin–Lin–Chu (LLC) panel unit root test was employed. The results confirm that PPP holds both for Central European and Western Balkan states in the long run.

Conclusions. *The equilibrium exchange rate question is central question to exchange rate policy. Purchasing power parity hypothesis was tested on the sample of 14 European countries form the Central and Eastern Europe and Western Balkan region. The database used in this paper contains monthly data on real effective exchange rate – REER observed over 23 years, from March 1995 till November 2017. As PPP holds if the real exchange rate reverts to its equilibrium value over time, the unit root test was applied on panel REER dataset. The results of applied Levin–Lin–Chu (LLC) panel unit root tests confirmed that the PPP hypothesis holds for selected countries during the observed period. Additionaly, results confirmed that PPP hypothesis holds both for CEE and Western Balkan countries separately.*

Keywords: purchasing power parity, real exchange rate, transition, Western Balkan states, panel unit root.

містить щомісячні дані щодо реального ефективного обмінного курсу (REER), що спостерігався з березня 1995 р. по листопад 2017 р. Для перевірки гіпотези використано панельний тест одиничних коренів Левіна–Ліна–Чу (LLC). Результати підтверджують, що ПКС діє як для країн Центральної Європи, так і для країн Західних Балкан у довгостроковій перспективі.

Висновки. *Питання рівноважного обмінного курсу є центральним питанням політики визначення валютних курсів. Гіпотезу паритету купівельної спроможності перевірено на вибірці 14 європейських країн із Центрально-Східної Європи та Західних Балкан. База даних, використана в дослідженні, має щомісячні дані про реальний ефективний обмінний курс (REER) протягом 23 р. (1995–2017). Результати застосовуваних тестів на одиницю панелі Левіна–Лін–Чу (LLC) підтвердили, що гіпотеза ПКС справедлива для окремих країн під час спостережуваного періоду. Дослідження підтвердило, що гіпотеза ПКС справедлива як для країн Центральної та Східної Європи, так і для країн Західних Балкан окремо.*

Ключові слова: паритет купівельної спроможності, реальний валютний курс, перехідний період, західнобалканські держави, панельний тест одиничних коренів.

JEL Classification: E40, F31

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Introduction. The purchasing power parity (PPP) exchange rate is the exchange rate between two currencies that would equate the two relevant national price levels if expressed in a common currency at that rate, so that the purchasing power of a unit of one currency would be the same in both economies. This concept of PPP is often termed absolute PPP.

Relative PPP is said to hold when the rate of depreciation of one currency relative to another matches the difference in aggregate price inflation between the two countries concerned. If the nominal exchange rate is defined simply as the price of one currency in terms of another, then the real exchange rate is the nominal exchange rate adjusted for relative national price level differences. When PPP holds, the real exchange rate is a constant, so that movements in the real exchange rate represent deviations from PPP [1, 65–66].

Purchasing power parity (PPP) is a simple theory that holds that the nominal exchange rate between two currencies should be equal to the ratio of aggregate price levels between the two countries, so that a unit of currency of one country will have the same purchasing power in a foreign country.

The PPP concept is an important element of international macro-economics. Studies within this field are critical not only for empirical researchers but also for policy-makers. Testing the validity of PPP theory is very important because first, it forms the foundation of exchange rate economics, and second, as a measure of long-run equilibrium exchange rate, its validity has important policy implications [2, 3].

The PPP theory has a long history in economics, dating back several centuries, but the specific terminology of purchasing power parity was introduced in the years after World War I during the international policy debate concerning the appropriate level for nominal exchange rates among the major industrialized countries after the large-scale inflations during and after the war (Cassel, 1918). Since then, the idea of PPP has become embedded in how many international economists think about the world. For example, Dornbusch and Krugman (1976) noted: «Under the skin of any international economist lies a deep-seated belief in some variant of the PPP theory of the exchange rate.» Rogoff (1996) expressed much the same sentiment: «While few empirically literate economists take PPP seriously as a short-term proposition, most instinctively believe in some variant of purchasing power parity as an anchor for long-run real exchange rates.» [4].

The question of how exchange rates adjust is central to exchange rate policy, since countries with fixed exchange rates need to know what the equilibrium exchange rate is likely to be and countries with variable exchange rates would like to know what level and variation in real and nominal exchange rates they should expect. In broader terms, the question of whether exchange rates adjust toward a level established by purchasing power parity helps to determine the extent to which the international macroeconomic system is self-equilibrating [5, 135–136].

Analysis of recent research and publications. Many researchers have conducted empirical tests to study the validity of PPP. Early literature on the validity of PPP is voluminous but there is no agreement on the validity of the PPP yet. While a great deal of literature has emerged to testing PPP hypothesis, the empirical results have been mixed. There have been a large number of studies on PPP in the literature, both for developed and to a lesser extent on developing countries. Empirical results seem to have been in favour of supporting PPP in developed countries. Therefore, recent articles have focused on developed countries such as selected OECD countries (e.g. Chortareas and Kapetanios, 2009) or EU15 countries (e.g. Christidou and Panagiotidis, 2010). Generally most of these studies suggest that the PPP holds in the long-run but the empirical validity of PPP in transition economies remains an unsolved [6, 190–198]. The other view of these empirical findings, researchers believe that in short run the validity of PPP has uncertainty but they may be more willing to believe PPP's validity in the long run, since the price differentials between two countries is unsustainable in the long-run. Also the PPP hypothesis existing empirical literature results inconsistencies can be explained with that past studies

indirectly accept that exchange rate behaviour is naturally linear [7, 973]. However, the findings have been mixed for the developing and transition countries, depending on the set of countries, time period, price indices and applied econometric techniques. The different types of empirical studies on PPP can be categorised in firstly correlation studies, secondly unit root tests studies and thirdly cointegration studies [3, 517–523]. Some studies have even rejected the PPP hypothesis using univariate unit root tests and more recently panel unit root tests. While the former are exposed to criticism due to low power, the latter have solved some problems but simultaneously created new ones (see (e.g. Bahmani-Oskooee et al., 2008). Some authors cast doubts on the PPP theory, and its empirical testing, as PPP is a long run concept of exchange rate determination (in the horizon of decades for instance), which may span different exchange rate regimes and monetary policy environments. A relevant question is why there has not been enough attention devoted to the transition countries in Europe. This might be for a number of reasons. For example, the availability of data has been limited and the radical and deep structural changes during the 1990s make any analysis difficult. Additionally, some countries did not exist before 1993, which puts limits on available time series. Several studies have tried to overcome this problem by using data for the black market. However, given characteristics of the former regime in most of the new EU Member States (hereinafter referred to as NMS), it is not certain how valid these data and their results are. There have also been studies covering selected NMS countries, which focused on issues related to the process of joining the EU (Rahn, 2003) or discussed selected problems associated with the adoption of the euro [8, 109].

For example, the purpose of Ocal's research was to investigate the PPP in Romania because the results of the previous empirical studies inconsistent. Also PPP has been a great important factor that to understand the behaviour of exchange rates for policy makers. In this study, they applyed the Zivot-Andrews unit root test to re-examines the validity of PPP for Romania. In Romania, the early literature on the validity of PPP has mostly motivated on the use of unit root tests which disregard structural break. This study was different from the previous literature by using Zivot–Andrews test with applying exchange rates in Romania for the period of 1991–2012. Their results showed that PPP doesn’t hold in Romania at least for the period of 1991–2012 [7, 975].

The Zdarek’s paper focused on testing the relative version of the PPP in the NMS countries over the time span of 15 years. He tried to shed some light on the ‘old PPP puzzle’ for a set of transition countries. As there has been a large number of studies with rather ambiguous results, various econometrics methods were employed. He made use of standard unit root tests, and additionally, more robust versions of unit root tests. While standard univariate unit root tests do not provide a crystal-clear answer to his question, the robust versions do for the Euro exchange rate pairs in

particular. The results for the non-linear KSS test (ESTAR model), which gives support to PPP in eight out of 12 NMS countries and the results for another nonlinear test (non-linear in trends, the Bierens (1997) test), also tends to favour the existence of PPP, once the source of non-linearities has been controlled for. In the case of other currency pairs – the US Dollar and REER, the results are less significant and thus, they seem to give more emphasis on the importance of the Euro currency for the NMS countries [2, 31].

In their study, Ozturk and Acaravci examine the validity of PPP hypothesis for 8 transition countries during the period 1992:1 to 2009:1. These countries were Bulgaria, Croatia, Czech Republic, Hungary, Macedonia (FYR), Poland, Romania and Slovak Republic. For this purpose, they 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. 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 [6, 196].

In Asnan's and Kula's paper, the issue of PPP is revisited for Eastern European countries such as Bulgaria, Czech Republic, Hungary, Poland, Romania and Russia (due to the lack of consistent data on the CPI index for Eastern European countries before 1969 M1 and unavailability of data beyond 1998 M12 for black market, the data spans from 1969M1-1998 M12). Although there is a growing literature that tests evidence for PPP for Eastern European countries, there is an absence of (a) PPP test for black market (the black market exchange rates data are taken from the study of Reinhart and Rogoff) in these group countries, and (b) an application of the recently developed panel LM unit root tests with structural breaks. The use of LM unit root tests ensured a comprehensive treatment of PPP in Eastern European countries with black market exchange rates which represents market forces in emerging economies. Both univariate and panel tests with structural breaks strongly suggest that PPP is valid hypothesis for Bulgaria, Czech Republic, Hungary, Poland, Romania and Russia [9, 293].

Sonora and Tica use real exchange rates of eight transition countries in order to test for PPP hypothesis during 16 years of transition. Im, Lee and Tieslau panel LM unit root test is employed in order to circumvent

problems associated with power problem, initial undervaluation of absolute price levels, strong appreciation trends and volatility of former Yugoslav countries prior to dissemination of the common country. Results imply that real exchange rates between the former Yugoslav states and Germany are stationary when breaks are accounted for. Furthermore, stationarity of real exchange rates of former Yugoslav countries is implied even in the test with one break. Such a strong evidence of stationarity in the 10 years long sample of four countries is obviously a proof of rather fast post-war convergence of real exchange rates to the long run equilibrium [5, 11–12].

Sideris tested whether there exists the Purchasing Power Parity (PPP) hypothesis between each country under consideration and the Euro zone. Validity of PPP would imply high degree of trade and goods markets' integration between each of the five SEE countries (Albania, Croatia, the Former Yugoslavian Republic of Macedonia (FYROM), Moldova and Serbia) and the EU (in the study, he used monthly data starting at the beginning of the transition phase of the five economies at the early 1990s and ending in March 2009). He tested this hypothesis by applying the approach of the Generalized Purchasing Power Parity (GPPP). GPPP proposes testing whether the real exchange rates of a group of economies with respect to a base currency form a cointegrating vector or not. The theory is based on the following idea: it could be that the real exchange rates of a number of economies are not themselves stationary, as a result of the non stationarity of the fundamental economic variables; nevertheless, if the fundamentals are sufficiently integrated as in a currency area, the real exchange rates will share common trends and therefore, will form a cointegrating relationship. In the empirical work, cointegration analysis is employed to test the GPPP hypothesis –whether the real exchange rates converge in the long run– after an initial assessment of the stationarity of each real exchange rate series. The cointegration analysis examines the joint behavior of the rates, in two different periods: the full period and the period after the endorsement of the SAP agreement (Stabilisation and Association Process). The results provide evidence in favor of an OCA with the euro area only for the period following the SAP agreement. The results indicate that the group of the five economies has enjoyed a reduction in their real exchange rate instability in the recent period. This could be due to increased trade integration of the five economies with the EU caused by the introduction of the euro and the swift of the economic policies of most of the five SEE countries towards integration with the EU. They also indicate that a significant increase in policy convergence has been achieved [10, 2–9].

The main object of this paper is to test the validity of PPP hypothesis in the long run in former and current European transitional economies. The research hypothesis is, thus, that the PPP hypothesis holds for European transitional economies. Additionally, PPP hypothesis is tested on the sample of selected Western Balkan countries in order to determine if

the development pattern of their REERs is different or not compared to the Central and Eastern European countries.

Material and methods. The database used in this paper contains monthly data on real effective exchange rate - REER (CPI based) observed over 23 years, from March 1995 (1995M3) till November 2017 (2017M11). Country sample includes 14 countries: Bulgaria, Croatia, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovak Republic and Slovenia (Central and Eastern European Economies, CEEC) and Albania, North Macedonia and Serbia (Western Balkan Economies, WBS).

Database includes updated real effective exchange rates from the papers [11; 12]. They used data on exchange rates and consumer price indices and the weighting matrix derived by Bayoumi, Lee and Jaewoo (2006) to calculate consumer price index-based REER. The REER is calculated from the nominal effective exchange rate (NEER) and a measure of the relative price or cost between the country under study and its trading partners. The most popular price and costs measures are consumer prices (CPI), producer prices (PPI), GDP deflator, unit labour costs (ULC). But, as we said, in this paper we focus on CPI-based REERs. An increase in the index indicates appreciation of the home currency against the basket of currencies of trading partners. In this paper we used REER Monthly 138 (138 = the number of trading partners considered).

The REER is calculated as [7, 1–2]:

$$REER_t = (NEER_t * CPI_t)/(CPI_t^{(foreign)})$$

- where $REER_t$ is the real effective exchange rate of the country under study against a basket of currencies of trading partners,
- CPI_t is the consumer price index of the country under study,
- $NEERt = \prod_{i=1}^{N} S(i)tw(i)$ is the nominal effective exchange rate of the country under study, which is in turn the geometrically weighted average of $S(i)_t$, the nominal bilateral exchange rate between the country under study and its trading partner i (measured as the foreign currency price of one unit of domestic currency),
- $CPI_t^{(foreign)} = \prod_{i=1}^{N} CPI(i)tw(i)$
- $\prod_{i=1}^{N} CPI(i)tw(i)$ is the geometrically weighted average of CPI indices of trading partners,
- $CPI(i)_t$ is the consumer price index of trading partner i,
- $w^{(i)}$ is the weight of trading partner i and
- N is the number of trading partners considered.
- *The weights sum to one, ie* $\prod_{i=1}^{N} w(i) = 1$.

He used geometrically weighted averages, because this is the most frequently used method in the literature.

The PPP hypothesis is based on the Law of One Price, which stipulates that the price of a tradeable good will be the same everywhere. Absolute PPP stipulates that the nominal exchange rate, E, is

$$E = P/P^* \quad (1),$$

where P is the price of a basket of goods in the home country and P^* is the price of the same basket in the foreign country. The exchange rate, E, indicates the price of a foreign currency in terms of our "home" currency or, equivalently, how many units of the home currency are needed to buy one unit of the foreign currency.

Now consider the real exchange rate, e, which tells us the prices of goods and services/things we actually consume in a foreign country relative to their prices at home. We have

$$e = EP^*/P \quad (2)$$

Taking logs of both sides of (2), we have

$$y = ln\ e = lnE + lnP^* - lnP \quad (3),$$

PPP holds only if the real exchange rate reverts to its equilibrium value over time. Thus, to test for PPP, we test whether y contains a unit root. If y does contain a unit root, we reject *PPP*.

The panel unit-root tests are conducted on logarithm of real effective exchange rates for selected countries over observed period. Panel dataset is fully balanced, with 14 countries and 273 monthly data for each of them.

A dummy variable WB is included in the dataset as well. This variable flags the 3 countries belonging to Western Balkan region. The rest of countries are from CEEC group.

The Levin–Lin–Chu (LLC) test is used to determine whether the series of log of REERs contains a unit root. The number of lags for each panel is chosen by minimizing the AIC, subject to a maximum of 10 lags.

The null hypothesis is that the series contains a unit root, and the alternative is that the series is stationary. As the output indicates, the Levin–Lin–Chu test assumes a common autoregressive parameter for all panels, so this test does not allow for the possibility that some countries' real exchange rates contain unit roots while other countries' real exchange rates do not.

Results. *Table 1* presents the results of LLC panel unit root test on the sample of all 14 observed economies in the period from March 1995 till November 2017. The test allowed for panel-specific means. On average, 3.86 lags of the dependent variable lnREER were included as regressors in the ADF regressions. By default, LLC test estimated the long-run variance of dependent variable by using a Bartlett kernel with an average of 20 lags.

Table 1

LLC test results

	Statistic	p-value
Unadjusted t	-8.6767	
Adjusted t*	-7.9665	0.0000

Source: calculated by the authors.

The LLC bias-adjusted test statistic t*= -7.9665 is significantly less than zero ($p < 0.0000$), so we reject the null hypothesis of a unit-root, in favor of the alternative that lnREERs are stationary. This result supports the PPP hypothesis.

Because all observed economies have many similarities regarding transitional and reform processes, previous results could be affected by cross-sectional correlation in real exchange rates. The LLC test exhibits severe size distortions in the presence of cross-sectional correlation. Therefore, Levin, Lin and Chu (2002) suggested removing cross-sectional averages from the data to help control for this correlation. The results are shown in *Table 2.*

Table 2

LLC test results with removed cross-sectional averages

	Statistic	p-value
Unadjusted t	-9.4464	
Adjusted t*	-6.8156	0.0000

Source: calculated by the authors.

Once we control for cross-sectional correlation by removing cross-sectional means, we can still reject the null hypothesis of a unit root at the 0.1% significance level, in favor of the alternative that lnREER is stationary. This result confirms that the PPP hypothesis holds for selected countries during the observed period.

Additionaly, the LLC test was applied to only Western Balkan countries, to see if PPP hypothesis holds for this group of countries. Results are presented in *Table 3.*

Tabel 3

LLC test results for Western Balkan states (removed cross-sectional averages)

	Statistic	p-value
Unadjusted t	-6.2339	
Adjusted t*	-4.6663	0.0000

Source: calculated by the authors.

Results confirms that PPP hypothesis holds for Western Balkan countries as well.

Conclusions. The equilibrium exchange rate question is central question to exchange rate policy. The main object of this paper was to determine whether the exchange rates of European transitional economies adjust toward a level established by purchasing power parity in the long run. By providing new evidence, this paper contributes to growing, but still rare literature dealing with this subject in the European transitional countries, which is especially case for Western Balkan states. Purchasing power parity hypothesis was tested on the sample of 14 European countries form the Central and Eastern Europe and Western Balkan region. The database used in this paper contains monthly data on real effective exchange rate – REER observed over 23 years, from March 1995 till November 2017.

As PPP holds if the real exchange rate reverts to its equilibrium value over time, the unit root test was applied on panel REER dataset. The results of applied Levin–Lin–Chu (LLC) panel unit root tests confirmed that the PPP hypothesis holds for selected countries during the observed period. Additionaly, results confirmed that PPP hypothesis holds both for CEE and Western Balkan countries separately.

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