



TESTING THE PURCHASE POWER PARITY HYPOTHESIS FOR BRICS: EVIDENCE  
FROM FOURIER UNIT ROOT AND COINTEGRATION TEST  
BRICS İÇİN SATIN ALMA GÜCÜ PARİTESİ HİPOTEZİNİN TEST EDİLMESİ: FOURIER  
BİRİM KÖK VE EŞBÜTÜNLEŞME TESTİNDEN KANIT

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### Abstract

This study is a review of the purchasing power parity hypothesis applied to BRICS countries (Brazil, Russia, India, China, and South Africa). For each country, time series stationarity of the series using Fourier unit root testing. The series was found to be stationary at level I(1), paving the way for the Fourier Shin cointegration test, which constituted the second stage. The analysis revealed cointegration associations with all BRICS countries. Hence, it is understood that the purchasing power parity theory applies to all five countries.

**Keywords:** *Purchasing Power Parity, Fourier Unit Root Test, Fourier Cointegration Test, BRICS Countries.*

### Öz

Bu çalışmada, BRICS (Brezilya, Rusya, Hindistan, Çin ve Güney Afrika) ülkelerinin satın alma gücü parite teorisi incelenmiştir. Her ülke için Fourier yaklaşımı içeren zaman serisi kullanılmıştır. Çalışmanın ilk aşamasında serilerin durağanlıkları Fourier KPSS testi kullanılmıştır. Seriler I(1) düzeyinde durağan oldukları tespit edilerek ikinci aşama olan Fourier Shin eşbütünlüşme testine geçilmiştir. Yapılan analiz sonucu tüm BRICS ülkelerinde eşbütünlüşme ilişkisi bulunmuştur. Böylece bu beş ülkede satın alma gücü parite teorisi geçerli olduğu sonucuna ulaşılmıştır.

**Anahtar Kelimeler:** *Satın Alma Gücü Paritesi, Fourier Birim Kök Testi, Fourier Eşbütünlüşme Testi, BRICS Ülkeleri.*

## GENİŞLETİLMİŞ ÖZET

### alışmanın Amacı

Bu alışmanın amacı BRICS (Brezilya, Rusya, Hindistan, in ve Gney Afrika) lkelerinde satın alma gc paritesinin geerliliğini test etmektir

### Araştırma Soruları

Satın alma gc paritesi belli bir mal veya hizmet sepeti seilerek her iki lkede fiyatının dviz kuru cinsinden sabitlenmesine denmektedir. Satın alma gc paritesi sadece araştırmacılar iin deęil aynı zamanda politika yapımcılar iinde ok nemli bir unsurdur. Satın alma gc paritesi ile ticaret hadlerinde lkelerin hangi sektre yoğunlaşabileceęi ngrlebilir. Bu sayede lkelerin rekabet gc artacaktır. Uluslararası arenada rekabet gcn artması lkenin geliřmiřlik ve kalkınmışlık seviyesini de arttıracaktır. Gelecekte dnya ekonomisinde nemli bir yere sahip olacağı dřnlen BRICS (Brezilya, Rusya, Hindistan, in ve Gney Afrika) lkelerinin satın alma gclerinin test edilmesi gelecek ekonomisi ile ilgili nem arz eden bir husustur. alışmanın temel sorusu; BRICS lkeleri iin satın alma gc paritesi geerli midir?

### Literatr Araştırması

Son yıllarda satın alma gc paritesi zerine yapılmış pek ok alışma vardır. Geliřmiş lkeler zerine yapılan alışmalar; Bahmani-Oskooee ve Ranjbar (2016), Jiang vd. (2015), Narayan (2005), Kalyoncu ve Kalyoncu (2008), Huang ve Yang (2015), Chen (2017), Batos vd. (2018); Yoon vd. (2019); Aixalá vd. (2019); Nagayasu (2021). Geliřmekte olan lkeler zerine yapılan alışmalar; Kim (1990), Drine ve Rault (2008), Hassan vd. (2015), Loukopoulos ve Antonopoulos (2015). Avrupa blgesi iin yapılan alışmalar; Jiang vd. (2016), Kavkler vd. (2016), Bergin vd. (2017), Bek ve Kavkler (2019). Al-Gasaymeh vd. (2019). Petrol ihra eden lkeler iin yapılan alışmalar; Eslamloueyan ve Kia (2015), Lyon ve Olmo (2017). BRICS lkeleri zerine yapılan alışmalar; Chang, Lee ve Hung (2012), Peng vd. (2016), Chang, Su, Zhu ve Liu (2010), Andre vd. (2017); Seshaiyah ve Tripathy (2018); Griř ve Tirařoęlu (2018); Rani ve Kumar (2018); Prabheesh ve Garg (2020). Afrika lkeleri zerine yapılan alışmalar; Yilanci vd., (2017), Iyke ve Odhiambo (2017), Yapılan bazı alışmalarda Papell (1997), Taylor ve Sarno (1998), Fleissig ve Strauss (2000), Wu ve Wu (2001), Narayan ve Prasad (2005), Holmes vd. (2012), Li vd. (2015), satın alma gc paritesi geerlidir. te yandan, yapılan bazı alışmalarda Taylor (1988), Layton ve Stark (1990), Telatar ve Kazdagli (1998), Tiwari ve Shahbaz (2014), Wang vd. (2017), satın alma gc paritesi geerli deęildir.

### Yntem

Bu alışmada, satın alma gc paritesini test edebilmek iin Fourier Shin (FSHIN) eşbtnleşme testi kullanılmıştır. Bu testi kullanmanın nkořulu serilerin hepsinin aynı seviyeden duraęan olmasıdır. Serilerin duraęanlıęını Becker vd. (2006) tarafından geliřtirilen Fourier Kwiatkowski Phillips Schmidt Shin (FKPSS) birim kk testi ile analiz edilmiştir. Kwiatkowski vd. (1992) testini geliřtiren Becker vd. (2006), Fourier fonksiyonunu kullanmışlardır. Bununda nedeni bilinmeyen fonksiyonların hareketini

yakalayabilmesidir (Becker vd. (2006), Gallant (1981), Yilanci ve Eris (2012)). FKPSS testi hem ani değişimleri hem de yavaş değişimleri yakalayabilmektedir. Bu testin gücü yapısal değişimlerin tarihi, sayısı ve biçimlerinden etkilenmez. Çalışmada, BRICS ülkelerinin aylık verileri kullanılmıştır. Kullanılan veriler IMF'nin (International Money Fund) IFS (International Financial Statistics) veri tabanından alınmıştır. Veriler mevsimsel etkilerden arındırılarak analize dahil edilmiştir. Brezilya ve Güney Afrika verileri 1980:1 ile 2017:12 dönemini, Rusya verileri 1995:6 ile 2017:12 dönemini, Hindistan 1980:1 ile 2017:11 dönemini, Çin verileri 1986:1 ile 2017:12 dönemini kapsamaktadır.

### **Sonuç ve Değerlendirme**

Çalışmada, BRICS ülkelerinin satın alma gücü paritesinin geçerliliğini analiz edebilmek için 1980 ile 2018 dönemi arası aylık veriler kullanılmıştır. FKPSS sonuçlarında serilerin  $I(0)$  düzeyinde birim köklü olduğu,  $I(1)$  düzeyinde durağan olduğu sonucuna ulaşılmıştır. Serilerin  $I(1)$  olması ile FSHIN eşbütünleşme testi uygulanmıştır. Analiz sonucunda beş ülkede de ikili nominal döviz kuru ve nispi fiyat oranı arasında uzun dönemli ilişki tespit edilmiştir. Böylece satın alma gücü paritesi bu ülkeler için geçerlidir. Ülkelerin refah düzeylerini gösteren etkenlerden birisi de satın alma gücü paritesidir. BRICS ülkelerinde satın alma gücü paritesinin geçerli olduğundan bu ülkelerin refah düzeylerini artırabilmek için istikrarlı politikalar ortaya koyması gerekmektedir. Gelişen ekonomiler olan bu ülkeler dünya ekonomisinden ciddi pay almaktadırlar. Enflasyondan arındırılmış ve nispi yaşam maliyetini hesaba katmasından ötürü satın alma gücü paritesi BRICS ülkelerinin dünya ekonomisindeki yerini daha belirgin bir biçimde ölçeceğinden politika yapıcılar daha rasyonel olarak karar verilebilecektir. Analizler neticesinde BRICS ülkelerinde döviz kuruna gelebilecek şokların geçici olduğu sonucuna ulaşılabılır. Böylece bu ülkelerin istikrarlı döviz kuru politikaları da izlediği söylenebilir. Finansal krizlere yol açabilen döviz kuru oynaklıkları ülkeleri risk altında bırakmaktadır. Gelişen ekonomilerin ana problemlerinden birisi olan döviz kuru şokları politika yapıcıların kararlarını ciddi biçimde etkilemektedir. Çalışmanın ampirik bulguları neticesinde BRICS ülkelerinde döviz kuru riskinin minimuma indirgenecek politika üretilmesi bu ülkelerin gelişmiş ülkelerle rekabet edebilirliğini artıracaktır. BRICS ülkelerindeki ticari engellerin kaldırılması satın alma gücü paritesini destekleyecek politikalar olarak karşımıza çıkabilir. Sanayisi hızlı biçimde artan bu ülkelerde ticari engellerin kaldırılması ile birlikte döviz kuru oynaklıklarının azalacağı, refah düzeyinin artacağı düşünülmektedir. Bu nedenle politika yapıcıların alacakları kararlarda bu faktöre dikkat etmesi önerilmektedir. Ek olarak enflasyon ile mücadelede gerekli adımların atılması sağlanmalıdır. Kısa dönemli kararlar yerine orta ve uzun dönemli kararların alınması satın alma gücü paritesine olumlu yönde etki edecektir. Politika yapıcılarının enflasyonla ilgili politikalarının daha dikkatli karar verilmesi BRICS ülkelerinin gelişmesi ve kalkınmasına katkı sağlayacaktır.

## 1. INTRODUCTION

Exchange rates serve as the main pillars of international capital movements. Countries set their terms of trade based on exchange rates. The competitiveness of countries in the international arena depends on stable exchange rates, and the rates make it easier for economic players to make decisions. The wealth of nations is often assessed in terms of GDP per capita. However, real economy is too complex for nominal GDP to offer a meaningful benchmark. Hence, economists are always on the lookout for alternatives to exchange rates, which are not, on their own, adequate measures to allow for comparisons between the wealth levels of different countries. The relationship between exchange rates and prices has long been a matter of debate in the history of economics. Purchasing power parity was introduced to the literature by Cassel exactly 100 years ago (1918), and it refers to the determination of a specific basket of goods or services and fixing its price in both countries, compared in a foreign currency. The purchasing power parity figure does not vary much between two countries, which allows for free movement of all goods and leads the countries to engage in substantial trade with each other (Balassa, 1964). Purchasing power parity allows for an analysis without the disruptive effects of price differences between the countries, and it also serves as a measure of the wealth levels of individual countries.

Purchasing power parity is crucial for not only researchers but also for policy makers. It allows an analysis of the prospective sectors that individual countries may focus on with respect to terms of trade. This helps reinforce the competitive power of countries. An increase in the competitive power of a country in the international arena will soon translate to increased levels of development.

BRICS is an abbreviation composed of the first letters of the countries of Brazil, Russia, India, China, and South Africa. According to the BRICS report published by Goldman Sachs in 2003, Brazil, Russia, India, and China will be more influential in the global economy by the year 2050. Provided that the current economic trends prevail, in less than 40 years, these four countries will catch up with the G6 economies. As a result, the list of the 10 countries with the highest GDP worldwide may substantially change by 2050. By then, the total GDP of the countries with the highest per capita figure will be less than the total GDP of these newcomers (Wilson and Purushothaman, 2003). Estimates and predictions suggest that the economic positions and rankings are prone to change—and likely will. Countries that take the correct steps will get ahead in the race.

The present study aims to test the applicability of purchasing power parity for the BRICS countries. In addition, this study adds a different dimension to the current literature by testing the purchasing power parity hypothesis of BRICS countries. The empirical techniques used provide more concrete information than other studies. The first and second parts of the study provides general information on purchasing power parity along with a summary of the literature. The third part discusses

the methods employed. The fourth part then reviews the data and empirical findings. Finally, the fifth part provides a conclusion.

## 2. LITERATURE REVIEW

Recent years have seen numerous studies on purchasing power parity. Research based on developed countries include Bahmani-Oskooee and Ranjbar (2016); Jiang et al. (2015); Narayan (2005); Kalyoncu and Kalyoncu (2008); Huang and Yang (2015); Chen (2017); Batos et al. (2018); Yoon et al. (2019); Aixalá et al. (2019); and Nagayasu (2021). Studies based on developing countries include Kim (1990); Drine and Rault (2008), Al-Gasaymeh et al. (2019); Doğanlar et al. (2020). Studies based on Europe include Jiang et al. (2016); Kavkler et al. (2016); Bergin et al. (2017); and Bekő and Kavkler (2019).

Research about oil-exporting countries includes Eslamloueyan and Kia (2015) and Lyon and Olmo (2017). BRICS countries are the focus of studies by Chang, Lee, and Hung (2012); Peng et al. (2016); Chang, Su, Zhu, and Liu (2010); Andre et al. (2017); Seshaiyah and Tripathy (2018); Güriş and Tıraşoğlu (2018); Rani and Kumar (2018); and Prabheesh and Garg (2020). Yilanci et al. (2017) and Iyke and Odhiambo (2017) conducted studies based on African countries.

Some studies, including those of Papell (1997), Taylor and Sarno (1998), Fleissig and Strauss (2000), Narayan and Prasad (2005), Holmes et al. (2012), and Li et al. (2015), have found purchasing power parity to be applicable. Others, however, do not concur, as is the case with Taylor (1988), Layton and Stark (1990), Telatar and Kazdagli (1998), and Tiwari and Shahbaz (2014).

## 3. METHODOLOGY

This study employed the Fourier Shin (FSHIN) cointegration test in an attempt to examine purchasing power parity. As a precondition, the test requires all series to be stationary at the same level. The stationarity of the series was tested using the Fourier Kwiatkowski-Phillips-Schmidt-Shin (FKPSS) unit root test developed by Becker et al. (2006). Having built on the test originally developed by Kwiatkowski et al. (1992), Becker et al. (2006) used the Fourier function. The reason for doing so lies in its ability to capture the behaviour of unknown functions (Becker et al. (2006); Gallant (1981); Yilanci and Eris (2012)). The FKPSS test is able to capture both sharp changes and smooth ones occurring over time. The strength of this test is that it is not dependent on the time, frequency, and forms of structural changes. This test is based on the following process for data compilation:

$$y_t = X_t' \beta + Z_t' \gamma + r_t + \varepsilon_t \quad (1)$$

$$r_t = r_{t-1} + u_t \quad (2)$$

In the above example,  $\varepsilon_t$  refers to static errors, and  $u_t$  is a term independent of  $\sigma_u^2$ , albeit subject to the same distribution scheme. Here, in the case of  $X_t = \mathbf{1}$ , the test is one of a stationary process, while in the case of  $X_t = (\mathbf{1}, t)'$ , it is of a stationary process in a trend.  $Z_t = [\sin(2\pi kt/T), \cos(2\pi kt/T)]'$  would help to prevent any rupture of deterministic terms. Finally,  $k$  refers to the frequency,  $t$  refers to the trend, and  $T$  refers to sample size.

In order to analyze stationarity at a level:

$$y_t = \alpha_0 + \gamma_1 \sin\left(\frac{2\pi kt}{T}\right) + \gamma_2 \cos\left(\frac{2\pi kt}{T}\right) + e_t \quad (3)$$

In order to analyze stationarity in a trend:

$$y_t = \alpha_0 + \beta t + \gamma_1 \sin\left(\frac{2\pi kt}{T}\right) + \gamma_2 \cos\left(\frac{2\pi kt}{T}\right) + e_t \quad (4)$$

would apply to generate the residuals, and it is possible to come up with the following testing statistics:

$$\tau_\mu(k) \text{ or } \tau_t(k) = \frac{1}{T^2} \frac{\sum_{t=1}^T \tilde{\varepsilon}_t(k)^2}{\tilde{\sigma}^2} \quad (5)$$

The above ordinary least squares (OLS) residuals take the form  $\tilde{\varepsilon}_t k = \sum_{j=1}^t \tilde{\varepsilon}_j$ . Nonparametric estimation of long-term variance is derived from the weight set  $w_j, j = 1, \dots, l$ , using  $\tilde{\sigma}^2, l$  cut-off latency parameter:

$$\sigma^2 = \tilde{\delta}_0 + 2 \sum_{j=1}^l w_j \tilde{\delta}_j \quad (6)$$

Above,  $\tilde{\delta}_j$  reflects the  $j$ th sample autocovariance of  $e_t$  residuals from equation 3 or 4. To assess the most applicable frequency  $k$ , the minimum residual sum of squares was chosen.

Once the same level of stationarity was established for all series, the FSHIN cointegration test developed by Tsong et al. (2016) was applied. The hypotheses discussed in the FSHIN cointegration test are as follows:

$H_0$ : Cointegration prevails.

$H_1$ : No cointegration.

The FSHIN cointegration test applies the following models:

$$y_t = d_t + x_t' \beta + \eta_t; \quad t = 1, 2, 3, \dots, T \quad (7)$$

Above,  $\eta_t = \gamma_t + u_{1t}$ ,  $\gamma_t = \gamma_{t-1} + u_t$  and  $x_t = x_{t-1} + u_{1t}$ . Here,  $u_t$  refers to independent yet identical distributed processes based on zero average and variance  $\sigma_u^2$ . That is why  $\gamma_t$  is in random movement with zero average. The deterministic component of the equation 7 can be expressed as follows:

$$d_t = \sum_{i=0}^m \delta_i t^i + f_t \quad (8)$$

$m=1$  or  $m=0$ , and

$$f_t = \gamma_1 \sin\left(\frac{2\pi kt}{T}\right) + \gamma_2 \cos\left(\frac{2\pi kt}{T}\right) \quad (9)$$

Above,  $k$  refers to the frequency,  $t$  refers to the trend, and  $T$  refers to sample size. The model specified in the equation 7–9 is reduced to Shin (1994), provided that no Fourier component exists. Upon combining the equation 7, 8 and 9:

$$y_t = \sum_{i=0}^m \delta_i t^i + \gamma_1 \sin\left(\frac{2\pi kt}{T}\right) + \gamma_2 \cos\left(\frac{2\pi kt}{T}\right) + x_t' \beta + u_{1t} \quad (10)$$

The FSHIN cointegration test statistics are presented below:

$$CI_{\hat{\beta}}^m = T^{-2} \omega_1^{-2} \sum_{t=1}^T S_t^2 \quad (11)$$

Here,  $S_t = \sum_{t=1}^T u_{1t}$  refers to the partial sum of OLS derived from equation c, and  $\omega_1^2$  refers to the consistent predictor of  $u_{1t}$ 's long-term variance.

#### 4. DATA AND EMPIRICAL FINDINGS

In this empirical study, the monthly data of the BRICS countries was used. The data was obtained from the International Money Fund's (IMF) International Financial Statistics (IFS) database. The data for Brazil and South Africa cover the period January 1980 through December 2017, while that for Russia covers June 1995 through December 2017, for India it covers January 1980 through November 2017, and for China it covers January 1986 through December 2017. The reason that the data of the countries are different is that we use the oldest time series data that we can reach for each country. After adjusting seasonal effects; the data were included in the analysis.

The purchasing power parity calculations were based on the following model:

$$\text{ner}_t = \beta_1 + \beta_2 \text{rpr}_t + \mu_t \quad (12)$$

Here,  $\text{ner}_t$  refers to the bilateral nominal exchange rate, while  $\text{rpr}_t$  stands for relative price ratio. When subjected to the natural logarithm of the series, equation 1 evolves into the following form:



$$\lnner_t = \beta_1 + \beta_2 \lnrpr_t + \mu_t \quad (13)$$

Here,  $\lnner_t$  refers to the bilateral nominal exchange rate logarithm, while  $\lnrpr_t$  refers to the relative price ratio logarithm. In the literature, some purchasing power parity analyses are based on producer prices indices because they cover commodities as well. The present study, however, used consumer price indices to account for the domestic and overseas price levels. New statistical materials exhibit more accurate results for the assessment of purchasing power parity.

**Table1.** Fourier KPSS stationarity test

Country	Nominal Exchange Rate				Relative Price Ratio			
	FREQ	Min SSR	FKPSS	Ft	FREQ	Min SSR	FKPSS	Ft
<b>Brazil</b>	1	13064.5	0.968	443.277	1	13604.9	0.960	431.915
<b>Russia</b>	2	87.781	1.181	64.125	1	78.413	0.817	131.091
<b>India</b>	1	78.731	0.970	323.666	1	50.663	0.978	285.069
<b>China</b>	1	9.7226	0.828	354.623	2	11.203	1.199	114.445
<b>South Africa</b>	1	131.824	0.958	256.474	1	77.207	1.001	274.136
<b>DBrazil</b>	1	2.546	0.098	158.637	1	2.254	0.106	179.829
<b>DRussia</b>	3	0.897	0.228	4.015	1	0.132	0.182	9.494
<b>DIndia</b>	1	0.161	0.034	5.127	2	0.035	0.041	5.514
<b>DChina</b>	1	0.213	0.034	5.528	1	0.036	0.099	10.053
<b>DSouth Africa</b>	5	0.594	0.204	4.920	5	0.592	0.212	4.968

**Note:** %5 Critic values for 1, 2, 3, 4 and 5 frequencies are 0.1696, 0.4075, 0.4424, 0.4491 and 0.4571.

Table 1 presents the FKPSS stationarity test results. Nominal exchange rate and relative price ratio series have unit roots at level I(0). The margins of the series reveal stationarity at level I(1). As I(1) for both series, the precondition for the FSHIN cointegration test is met, followed by the actual application of the FSHIN cointegration test.

**Table 2.** Fourier KPSS and Shin Cointegration Tests

Country	FREQ	Min SSR	FSHIN-test $CI_f^m$	$F_{test}$
<b>Brazil</b>	2	11.096	0.127(*)	37.186(*)
<b>Russia</b>	1	2.902	0.079(*)	25.720(*)
<b>India</b>	1	2.084	0.050(*)	67.349(*)
<b>China</b>	1	2.020	0.094(*)	24.641(*)
<b>South Africa</b>	2	4.105	0.084(*)	34.636(*)

**Note:** \* 5% critical values for the FSHIN cointegration for 1 and 2 frequencies are 0.124 and 0.276.

The results of the FSHIN cointegration tests are presented in Table 2. The cointegration relationship between the bilateral nominal exchange rate ( $ner_t$ ) and the relative price ratio ( $rpr_t$ ) for the BRICS countries is evident, and the test statistics for the BRICS countries were found to be nonsignificant. Therefore, one can argue that a cointegration relationship exists for all five countries.



## **5. CONCLUSION**

This study employed monthly data for the period 1980–2018 to analyse the validity of purchasing power parity for the BRICS countries. The FKPSS results show that the series have a unit root at level  $I(0)$  and exhibit stationarity at level  $I(1)$ , and for this reason, the FSHIN cointegration test was applied. The analysis revealed long-term associations between the log of bilateral nominal exchange rate and the log of relative price ratio for all five countries. Therefore, one can strongly argue that purchasing power parity is applicable for these countries.

The purchasing power parity means that a commodity is calculated at the same value in all countries. Since the BRIC countries have a purchasing power parity, it is a good policy decision to consider the purchasing power parity in monetary policy decisions in these countries. Also, as a result of the analyzes, the shocks that may arise in exchange rates in BRICS countries are temporary.

One of the factors that show the welfare level of countries is purchasing power parity. Since purchasing power parity is valid in BRICS countries, these countries need to put forward stable policies to increase their welfare level. These countries, which are developing economies, take a serious share of the world economy. Purchasing power parity Adjusts for inflation and takes into account the relative cost of living. Therefore, policymakers will be able to make rational decisions by measuring the place of BRICS countries in the world economy more clearly.

As a result of the analysis, it can be concluded that the shocks to the exchange rate in the BRICS countries are temporary. Thus, these countries can follow a stable exchange rate policy. Exchange rate volatility, which can lead to financial crises, puts countries at risk. Exchange rate shocks, one of the main problems of developing economies, seriously affect the decisions of policymakers. The production of policies that will minimize the exchange rate risk in BRICS countries will increase the competitiveness of these countries with developed countries.

The removal of trade barriers in the BRICS countries may appear as policies to support purchasing power parity. It is thought that with the removal of trade barriers in these countries, exchange rate volatility will decrease and the level of welfare will increase. For this reason, we recommend that policymakers pay attention to this factor in their decisions. In addition, necessary steps should be taken to combat inflation. Taking medium and long-term decisions instead of short-term decisions will have a positive effect on purchasing power parity. More careful decision-making of policy makers' inflation-related policies will contribute to the development and development of BRICS countries.

## REFERENCES

- Aixalá, J., Fabro, G., & Gadea, M. D. (2019). Exchange rates and prices in Spain during the gold standard (1868-1914). A test of purchasing power parity. *Applied Economics Letters*, 27(12), 1028–1032. <https://doi.org/10.1080/13504851.2019.1659484>
- Al-Gasaymeh, A., Ahmed, G., Mehmood, T., & Alzoubi, H. M. (2019). Co-integration tests and the long-run purchasing power parity: A case study of india and Pakistan currencies. *Theoretical Economics Letters*, 09(04), 570–583. <https://doi.org/10.4236/tel.2019.94040>
- Andre, C., Balcilar, M., Chang, T., Gil-Alana, L. A., & Gupta, R. (2017). Current account sustainability in G7 and BRICS: Evidence from a long-memory model with structural breaks. *The Journal of International Trade & Economic Development*, 27(6), 638–654. <https://doi.org/10.1080/09638199.2017.1410853>
- Bahmani-Oskooee, M., & Ranjbar, O. (2016). Quantile unit root test and PPP: Evidence from 23 OECD countries. *Applied Economics*, 48(31), 2899–2911. <https://doi.org/10.1080/00036846.2015.1130794>
- Balassa, B. (1964). The purchasing-power parity doctrine: A reappraisal. *Journal of Political Economy*, 72(6), 584–596. <https://doi.org/10.1086/258965>
- Bastos, F. S., Ferreira, R. T., & Arruda, E. F. (2018). Speed of reversion of derivations of the purchasing power parity for Brazilian cities. *Revista Brasileira De Economia*, 72(1). <https://doi.org/10.5935/0034-7140.20180002>
- Becker, R., Enders, W., & Lee, J. (2006). A stationarity test in the presence of an unknown number of smooth breaks. *Journal of Time Series Analysis*, 27(3), 381–409. <https://doi.org/10.1111/j.1467-9892.2006.00478.x>
- Bekő, J., & Kavkler, A. (2019). Do real exchange rates in small central and Eastern European economies obey purchasing power parity. *International Journal of Sustainable Economy*, 11(2), 121. <https://doi.org/10.1504/ijse.2019.099038>
- Bergin, P. R., Glick, R., & Wu, J.-L. (2017). “conditional PPP” and real exchange rate convergence in the Euro Area. *Journal of International Money and Finance*, 73, 78–92. <https://doi.org/10.1016/j.jimonfin.2017.02.005>
- Cassel, G. (1918). Abnormal deviations in international exchanges. *The Economic Journal*, 28(112), 413. <https://doi.org/10.2307/2223329>
- Chang, H.-L., Su, C.-W., Zhu, M.-N., & Liu, P. (2010). Long-run purchasing power parity and asymmetric adjustment in BRICS. *Applied Economics Letters*, 17(11), 1083–1087. <https://doi.org/10.1080/00036840902817458>
- Chang, T., Lee, C.-H., & Hung, K. (2012). Can the PPP stand on the BRICS? the ADL test for Threshold Cointegration. *Applied Economics Letters*, 19(12), 1123–1127. <https://doi.org/10.1080/13504851.2011.615727>
- Chen, F. C. (2017). Purchasing Power Parity and Nonlinear Real Exchange Rate Adjustment: Evidence From High-Growth Countries. *Taiwan Economic Review*, 45(2), 195–224. <https://doi.org/10.6277%2fTER.2017.452.1>
- Doğanlar, M., Mike, F., & Kızılkaya, O. (2021). Testing the validity of purchasing power parity in alternative markets: Evidence from the Fourier quantile unit root test. *Borsa Istanbul Review*, 21(4), 375–383. <https://doi.org/10.1016/j.bir.2020.12.004>
- Drine, I., & Rault, C. (2008). Purchasing power parity for developing and developed countries. what can we learn from non-stationary panel data models? *Journal of Economic Surveys*, 22(4), 752–773. <https://doi.org/10.1111/j.1467-6419.2007.00548.x>

- Eslamloueyan, K., & Kia, A. (2015). Determinants of the real exchange rate in oil-producing countries of the Middle East and North Africa: A panel data investigation. *Emerging Markets Finance and Trade*, 51(4), 842–855. <https://doi.org/10.1080/1540496x.2015.1043213>
- Fleissig, A. R., & Strauss, J. (2000). Panel unit root tests of purchasing power parity for price indices. *Journal of International Money and Finance*, 19(4), 489–506. [https://doi.org/10.1016/s0261-5606\(00\)00017-6](https://doi.org/10.1016/s0261-5606(00)00017-6)
- Gallant, A. R. (1981). On the bias in flexible functional forms and an essentially unbiased form. *Journal of Econometrics*, 15(2), 211–245. [https://doi.org/10.1016/0304-4076\(81\)90115-9](https://doi.org/10.1016/0304-4076(81)90115-9)
- Güriş, B., & Tıraşoğlu, M. (2018). The validity of purchasing power parity in BRICS countries. *Prague Economic Papers*, 27(4), 417–426. <https://doi.org/10.18267/j.pep.654>
- Holmes, M. J., Otero, J., & Panagiotidis, T. (2011). PPP in OECD countries: An analysis of real exchange rate stationarity, cross-sectional dependency and structural breaks. *Open Economies Review*, 23(5), 767–783. <https://doi.org/10.1007/s11079-011-9234-0>
- Huang, C.-H., & Yang, C.-Y. (2015). European exchange rate regimes and purchasing power parity: An empirical study on eleven eurozone countries. *International Review of Economics & Finance*, 35, 100–109. <https://doi.org/10.1016/j.iref.2014.09.008>
- Iyke, B. N., & Odhiambo, N. M. (2017). Foreign Exchange markets and the purchasing power parity theory. *African Journal of Economic and Management Studies*, 8(1), 89–102. <https://doi.org/10.1108/ajems-03-2017-147>
- Jiang, C., Bahmani-Oskooee, M., & Chang, T. (2015). Revisiting purchasing power parity in OECD. *Applied Economics*, 47(40), 4323–4334. <https://doi.org/10.1080/00036846.2015.1026592>
- Jiang, C., Jian, N., Liu, T.-Y., & Su, C.-W. (2016). Purchasing power parity and real exchange rate in central Eastern European countries. *International Review of Economics & Finance*, 44, 349–358. <https://doi.org/10.1016/j.iref.2016.02.006>
- Kalyoncu, H., & Kalyoncu, K. (2008). Purchasing power parity in OECD countries: Evidence from panel unit root. *Economic Modelling*, 25(3), 440–445. <https://doi.org/10.1016/j.econmod.2007.07.003>
- Kavkler, A., Boršič, D., & Bekö, J. (2016). Is the PPP valid for the EA-11 countries? new evidence from Nonlinear Unit Root tests. *Economic Research-Ekonomska Istraživanja*, 29(1), 612–622. <https://doi.org/10.1080/1331677x.2016.1189842>
- Kim, Y. (1990). Purchasing power parity in the long run: A cointegration approach. *Journal of Money, Credit and Banking*, 22(4), 491. <https://doi.org/10.2307/1992433>
- Kumar Narayan, P. (2005). New evidence on purchasing power parity from 17 OECD countries. *Applied Economics*, 37(9), 1063–1071. <https://doi.org/10.1080/00036840500081713>
- Kwiatkowski, D., Phillips, P. C. B., Schmidt, P., & Shin, Y. (1992). Testing the null hypothesis of stationarity against the alternative of a unit root. *Journal of Econometrics*, 54(1-3), 159–178. [https://doi.org/10.1016/0304-4076\(92\)90104-y](https://doi.org/10.1016/0304-4076(92)90104-y)
- Layton, A. P., & Stark, J. P. (1990). Co-integration as an empirical test of purchasing power parity. *Journal of Macroeconomics*, 12(1), 125–136. [https://doi.org/10.1016/0164-0704\(90\)90060-n](https://doi.org/10.1016/0164-0704(90)90060-n)
- Li, H., Lin, Z., & Hsiao, C. (2014). Testing purchasing power parity hypothesis: A semiparametric varying coefficient approach. *Empirical Economics*, 48(1), 427–438. <https://doi.org/10.1007/s00181-014-0813-y>

- Lyon, M., & Olmo, J. (2018). Does the PPP condition hold for oil-exporting countries? A quantile cointegration regression approach. *International Journal of Finance & Economics*, 23(2), 79–93. <https://doi.org/10.1002/ijfe.1603>
- Nagayasu, J. (2021). Causal and frequency analyses of purchasing power parity. *Journal of International Financial Markets, Institutions and Money*, 71, 101287. <https://doi.org/10.1016/j.intfin.2021.101287>
- Narayan, P. K., & Prasad, B. C. (2005). The validity of purchasing power parity hypothesis for eleven Middle Eastern countries. *Review of Middle East Economics and Finance*, 3(2). <https://doi.org/10.2202/1475-3693.1038>
- Papell, D. H. (1997). Searching for stationarity: Purchasing power parity under the current float. *Journal of International Economics*, 43(3-4), 313–332. [https://doi.org/10.1016/s0022-1996\(96\)01467-5](https://doi.org/10.1016/s0022-1996(96)01467-5)
- Peng, H., Liu, Z., & Chang, T. (2016). Revisiting purchasing power parity in BRICS countries using more powerful quantile unit-root tests with stationary covariates. *Communications in Statistics - Theory and Methods*, 46(20), 10051–10057. <https://doi.org/10.1080/03610926.2016.1228968>
- Prabheesh, K. P., & Garg, B. (2020). Testing deviations from PPP and UIP: Evidence from BRICS economies. *Studies in Economics and Finance, ahead-of-print*(ahead-of-print). <https://doi.org/10.1108/sef-10-2019-0411>
- Rani, R., & Kumar, N. (2018). Is there an export- or import-led growth in BRICS countries? an empirical investigation. *Jindal Journal of Business Research*, 7(1), 13–23. <https://doi.org/10.1177/2278682118761748>
- Shin, Y. (1994). A residual-based test of the null of cointegration against the alternative of No Cointegration. *Econometric Theory*, 10(1), 91–115. <https://doi.org/10.1017/s0266466600008240>
- Taylor, M. P. (1988). An empirical examination of long-run purchasing power parity using cointegration techniques. *Applied Economics*, 20(10), 1369–1381. <https://doi.org/10.1080/00036848800000107>
- Taylor, M. P., & Sarno, L. (1998). The behavior of real exchange rates during the post-Bretton Woods period. *Journal of International Economics*, 46(2), 281–312. [https://doi.org/10.1016/s0022-1996\(97\)00054-8](https://doi.org/10.1016/s0022-1996(97)00054-8)
- Telatar, E., & Kazdagli, H. (1998). Re-examine the long-run purchasing power parity hypothesis for a high inflation country: The case of Turkey 1980–93. *Applied Economics Letters*, 5(1), 51–53. <https://doi.org/10.1080/758540127>
- Tsong, C.-C., Lee, C.-F., Tsai, L.-J., & Hu, T.-C. (2015). The fourier approximation and testing for the null of cointegration. *Empirical Economics*, 51(3), 1085–1113. <https://doi.org/10.1007/s00181-015-1028-6>
- Venkata Seshaiyah, S., & Tripathy, T. (2018). GDP purchasing power parity per capita and its determinants: A Panel Data Analysis for BRICS. *Theoretical Economics Letters*, 08(03), 575–571. <https://doi.org/10.4236/tel.2018.83040>
- Wilson, D., & Purushothaman, R. (2003). Goldman Sachs global economics paper no. 99. In *Dreaming with BRICS: The path to 2050*. essay, Goldman, Sachs & Co.
- Yilanci, V., & Eris, Z. A. (2012). Are tourism markets of Turkey converging or not? A Fourier stationary analysis. *Anatolia*, 23(2), 207–216. <https://doi.org/10.1080/13032917.2012.665010>

- Yılandı, V., Aslan, M., & Özgür, Ö. (2017). Testing the validity of PPP theory for African countries. *Applied Economics Letters*, 25(18), 1273–1277. <https://doi.org/10.1080/13504851.2017.1418066>
- Yoon, J. C., Min, D. H., & Jei, S. Y. (2019). Empirical test of purchasing power parity using a time-varying cointegration model for China and the UK. *Physica A: Statistical Mechanics and Its Applications*, 521, 41–47. <https://doi.org/10.1016/j.physa.2019.01.072>