BRICS-T Ülkeleri İçin Satın Alma Gücü Paritesinin Geçerliliğinin Ekonometrik Tahmini

Econometric Estimation Of The Validity Of Purchasing Power Parity For BRICS-T Countries

Fatma İdil BAKTEMUR
Osmaniye Korkut Ata Üniversitesi, İktisadi ve İdari Bilimler Fakültesi, Ekonometri Bölümü
idilbaktemur@gmail.com, https://orcid.org/0000-0003-2455-5898

Özet

Satın alma gücü paritesi (SGP) hipotezi makroekonomide önemli bir konu olduğu için birçok uygulamalı çalışmada yer almıştır. Durağanlığın belirlenmesinde kullanılan birim kök analizleri bu konuda yardımcı olmaktadır. Birim kök mevcutsa şokların kalıcı, mevcut değilse şokların geçici etkisi olduğu ifade edilmektedir. Durağan bir reel döviz kuru SGP'nin geçerli olduğunu, tersi ise geçerli olmadığı anlamına gelmektedir. Bu çalışmada BRICS-T ülkeleri, yani Brezilya, Rusya, Hindistan, Çin, Güney Afrika ve Türkiye için 2017-2024 dönemini kapsayan veriler kullanılarak SGP'nin geçerliliğinin belirlenmesi amaçlanmıştır. Doğrusal ve doğrusal olmayan birim kök testlerine çalışmada yer verilerek sonuçlar tartışılmıştır. Doğrusal ve doğrusal olmayan panel birim test sonuçlarına göre, bu ülkelerde SGP'nin geçerli olmadığı görülmektedir (ortalamaya dönüş olmadığı). Bu da şokların kalıcı bir etkiye sahip olduğu anlamına gelmektedir.
Anahtar Kelimeler: Satın Alma Gücü Paritesi, Birim Kök, Reel Döviz Kuru, Doğrusal Olmama
Jel Kodları: C22, C23, F31

Abstract

The purchasing power parity (PPP) hypothesis is an important issue in macroeconomics that has been the subject of many applied studies, and unit root analyses, used to determine stationarity, have proven to be helpful in this regard. If a unit root is present, the shocks are considered permanent, and if absent, the shocks are considered to have a temporary effect. A stationary real exchange rate implies that PPP holds, whereas the opposite does not. This study investigates the validity of PPP for which it draws upon 2017–2024 data for BRICS-T countries, namely Brazil, Russia, India, China, South Africa and Türkiye, and subjects them to both linear and nonlinear unit root tests. The subsequent discussion of the results reveals that PPP does not hold in these countries (no mean reversion), meaning that shocks have a permanent effect.
Keywords: Purchasing Power Parity, Unit Root, Real Exchange Rates, Nonlinearity
JEL Codes: C22, C23, F31

1.   INTRODUCTION

PPP, which remains one of the most contentious economic theories, defines the equality of the long-run exchange rate (EX) between two countries based on the ratio of their relative price levels. The original concept stems from the observation that foreign EX will inevitably fluctuate in a direction that will cause identical product baskets to cost roughly the same in different nations due to arbitrage activity in international markets. The PPP hypothesis states that nominal exchange rates (NEX) respond to price differences to maintain long-run market equilibrium. Consequently, mean-reverting features are expected for real exchange rates (REX) that integrate the nominal rate with relative prices. Stated otherwise, if the REX is a covariance stationary process, then the PPP can be sustained (Bahramian and Saliminezhad, 2020).

PPP has maintained its significance as one of the most resilient metrics in international economics. The assumption, based on a generalization of the law of one price, is that all items are the same and that trade obstacles and transportation expenses are negligible in both nations (Kula et al., 2011).

Officer (1978) approached PPP in two ways: Under the absolute version of the theory, when represented in terms of the same currency, the same basket of goods and services should have the same cost. Conversely, when the rate of depreciation of one currency in comparison to another equals the variation in the inflation of aggregate prices between the two countries in question, the relative PPP can be said to be true (Kula et al., 2011). The REX is the NEX adjusted for relative national price level disparities, assuming that the NEX can be simply defined as the price of one currency in terms of another (Sarno and Taylor, 2002).

Real exchange rates exhibit mean reversion, which makes them stable in the long term, thus supporting the validity of PPP. The REX will not ultimately tend to gravitate toward equilibrium value if changes in price levels don't also affect the NEX at the same rate. The PPP model, however, does not account for transportation costs and tariffs; sticky prices that prevent the application of multiple commodity baskets for index computation; and other phenomena that affect its validity. In literature, the validity of PPP is tested using panel unit root, non-linear, linear and structural break tests, in line with the structure of the classified series. Unit root tests are commonly employed in empirical PPP testing. Shocks will have a temporal effect if the REX is stationary, and will have a long-lasting impact if there is a unit root in the actual EX. From this perspective, PPP can therefore be considered erroneous (Güriş and Tıraşoğlu, 2018). As an alternative approach, cointegration can be sought between prices and the NEX, which, if long-run PPP is true, should combine to generate a stationary linear (or nonlinear) combination (Haug and Basher, 2011).

This study investigates the validity of PPP through an investigation of 2017–2024 data for BRICS-T countries, and differs from previous studies in its analysis of PPP for BRICS-T countries with linear and nonlinear unit root approaches using an updated data set.

The study is presented in four sections. Following the introduction, the second section presents a review of literature; the third section discusses the method and application; and the fourth section concludes the study with a summary of the findings.

2. LITERATURE REVIEW

A selection of the studies in literature investigating PPP with different methods is presented below.

Table 1. Summary of Literature

Study	Country	Period	Method	Result
Chang and Su (2009)	OPEC countries	1995–2008	Nonlinear panel unit root test	+ For four countries
Kula et al. (2011)	MENA	1970–1998	LM unit root test	+for the four of thirteen countries
Yılancı (2012)	eight Central and Eastern European countries	1990's–2010	KSS and rolling-KSS unit root tests	(the KSS unit root test) + for Romania, (the rolling-KSS unit root test) + Poland. + for the remaining countries.
Tica and Soric (2012)	ASEAN, MERCOSUR countries and China vis à vis Germany and the USA	1960–2007	IPS panel unit root test	+
Chang et al. (2013)	Germany and trading partners	1994–2010	TAR model	+
Kavkler et al. (2016)	EA 11	1998–2012	KSS unit root test	-
Peng et al. (2017)	BRICS	1995–2015	Quantile unit root tests	+
Omay et al. (2017)	EU	1994–2014	Unit root tests that allow for structural breaks and asymmetric nonlinear adjustment	+
Gyamfi (2017)	BRICS	1993–2015	Nonlinear cointegration	-
Munir et al. (2018)	ASEAN-5 countries	1968–2013	Panel unit root	+ for the sub-period
Güriş and Tıraşoğlu (2018)	BRICS	1993–2015	Fourier unit root	+ for Brazil and South Africa - for others
Wang et al. (2019)	China	2005–2016	bootstrap sub-sample rolling-window causality test	-
Aixala et al. (2019)	Spain	1868–1914	Linear and nonlinear unit root tests	+
She et al. (2020)	Pakistan	1983–2014	Fourier unit root test	Partially +
Bahramian and Saliminezhad, (2020)	ASEAN-5 countries	1994–2018	Fourier quantile unit root test	+ for Indonesia, the Philippines, Singapore, and Thailand.
Zeren and Kızılkaya (2020)	seven fragile economies	1990–2020	Fourier ADF and Fourier KSS unit root tests	+ for four economies
Bhatti and Al Nassar (2020)	GCC countries and the US	1989–2018	Conventional and nonlinear unit root tests	-
Omay et al. (2021)	11 OECD countries	1957–2000	KSS-FF unit root test	+
Doğanlar et al. (2021)	10 developed, 20 developing, and 15 frontier market economies	1993–2018	Conventional, nonlinear, and Fourier-type unit root tests	+ 8 developed, 11 emerging, and 7 frontier market economies
Gövdeli and Sumer (2021)	BRICS countries	1980's–2017	Fourier unit root	+
Goswami and Saha (2022)	17 countries	2010–2021	Fourier nonlinear quantile unit root test	+
Nazlioglu et al. (2022)	GIIPS	1970–2020	unit root approaches with/ without structural breaks and non-linearity	+
Lee et al. (2023)	China and European countries	2000–2020	Nonlinear nonparametric approach	+
Jie and Liu (2023)	China	1952–2019	Kim and Perron's structural break unit root test, ADF and Fourier ADF unit root test, Narayan and Popp unit root test	+
Kyei-Mensah (2023)	some major advanced and developing economies	1980–2020	Univariate unit root tests	-
Omay and Uçar (2023)	34 countries	2010–2020	Unit root test for structural breaks and symmetric nonlinear adjustment	+ for 31
Uğur and Alper (2023)	OECD countries	1994–2021	Hepsag unit root test	+ for 22
Yılancı et al. (2024)	E7	1995–2023	faestar-qks unit root test	+ (except Türkiye)

+ denotes validity of PPP; – denotes invalidity of PPP.

3. METHOD AND APPLICATION

Quarterly data for REX from 2017Q1 to 2024Q2 for the BRICS-T countries was sourced from International Monetary Fund International Financial Statistics. Figure 1 presents the time series graphs (1: Brazil, 2: Russia, 3: India, 4: China, 5: South Africa, 6: Türkiye) and Table 2 presents the statistical properties of the series.
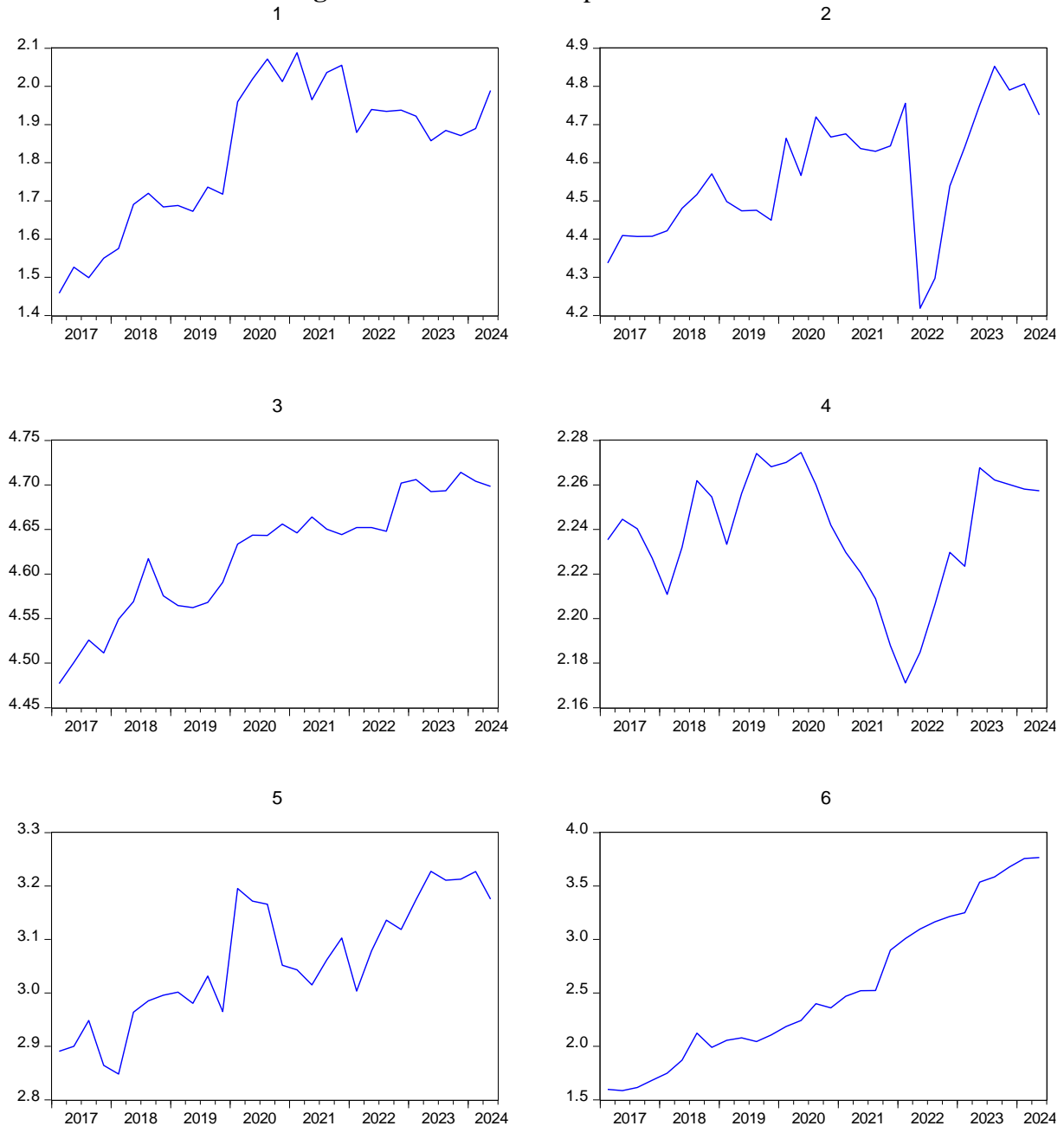
Figure 1. Time Series Graphs for Countries

Table 2. Descriptive Statistics for Panel

Mean	42.13222
Median	20.05000
Maximum	128.1000
Minimum	4.300000
Std. Dev.	41.98797
Skewness	0.710158
Kurtosis	1.704073
Jarque-Bera	27.72544
Probability	0.000001
Sum	7583.800
Sum Sq. Dev.	315575.2
Observations	180

The validity of PPP will be tested with a unit root test. If the series is found to be stationary, PPP holds. A REX that is mean reverting (stationary) and eventually converges with its equilibrium values is considered valid under the PPP. If the series is found to be nonstationary, PPP does not hold, meaning that no mean reversion exists.

Im, Pesaran and Shin (1997) and Pesaran (2003) CADF include first- and second-generation panel unit root tests for comparison purposes. The equations applied by Im, Pesaran and Shin (1997) and Pesaran (2003) for their unit root tests are presented below.

$$\Delta Y_{it} = \delta_i Y_{i,t-1} + e_{i,t} \tag{1}$$

$$\Delta Y_{it} = a_i + b_i Y_{i,t-1} + c_i \overline{Y}_{t-1} + d_i \Delta \overline{Y}_t + e_{i,t} \tag{2}$$

Table 3 shows the linear panel unit root test results.

Table 3. Linear Panel Unit Root Tests

	Variable: lnREX	
	Pesaran (2003) Test	**Im, Pesaran and Shin (1997) Test**
model	**statistics**	**W-t-bar statistics**
Constant	-1.913	-0.0947
	(0.349)	(0.4623)
Constant and trend	-1.962	-0.9519
	(0.820)	(0.1706)

Critical values for Pesaran (2003) test are stated as -2.210 (10%), -2.330 (5%) and -2.570 (1%) for the constant model; and -2.730 (10%), -2.860 (5%) and -3.100 (1%) for the constant and trend models. The values in parentheses denote probability.

The stationarity of the series will be investigated using the nonlinear unit root test developed by Kapetanios et al. (2003). The panel form of the equation is presented below.

$$\Delta y_{i,t} = \delta_i y_{i,t-1}^3 + \eta_{i,t} \tag{3}$$

Equation (3) tests the hypothesis of $H_0 : \delta_i = 0$ against the hypothesis of $H_1 : \delta_i < 0$.

Table 4 shows nonlinear unit root test results.

Table 4. Nonlinear Panel Unit Root Test

Variable: lnREX	
model	**statistics**
demeaned	-1.452767

Critical values are stated in the study of Ucar and Omay. (2009) as -2.08 (10%), -2.20 (5%) and -2.44 (1%).

As can be seen in Table 4, the null hypothesis of the unit root cannot be rejected, meaning that PPP does not hold for BRICS-T countries.

The result of the nonlinear unit root test is the same as that of the linear unit root test: the series is non-stationary, i.e. PPP does not hold.

To test the PPP of each country, individual unit roots (Table 5) are also conducted.

Table 5. Nonlinear Unit Root Test for Countries

countries	Variable: lnREX statistics	
	demeaned	**detrended**
Brazil	-2.074911	-1.953868
Russia	-2.582867	-3.252755*
India	-1.974170	-3.063432
China	-1.585998	-1.530405
South Africa	-1.819501	-3.248758
Türkiye	0.344682	-1.475223

Critical values stated in the study of Kapetanios et al. (2003) for the demeaned model: -2.66 (10%), -2.93 (5%) and -3.48 (1%); and -3.13 (10%), -3.40 (5%) and -3.93 (1%) for the detrended model. * denotes significance at a 10% level.

PPP is invalid for each country. Only for Russia, at a 10% level, can it be said that PPP is valid, although this is weak evidence.

There are previous studies in literature reporting PPP to be invalid, among which Gyamfi (2017) and Güriş and Tıraşoğlu (2018) addressing BRICS countries can be given as examples.

4. CONCLUSION

PPP remains one of the core macroeconomic principles. The present study investigating the validity of the PPP hypothesis through the application of linear and nonlinear unit root analyses for BRICS-T countries reveals that PPP does not hold, suggesting the lack of a mean reversion in REX. Deviations from the REX are permanent for BRICS-T countries.

According to Güriş and Tıraşoğlu (2018), the factors affecting the invalidity of PPP include variations in price indices, the use of various goods baskets in the index calculation, the effect of transportation costs on prices in two countries, customs taxes, administrative rules and tariffs. There is a need also to consider economic and political conditions and their effect on the invalidity of PPP.

The planned exchange rate policies of the nations in question could have long-lasting effects. Stated differently, the nations' exchange rate policies would change, which would impact their ability to compete in the international market (Uğur and Alper, 2023).

The formulation of policies targeting the minimization of exchange rate risk in these countries would increase their competitiveness with developed countries. It is believed that the removal of trade barriers in countries experiencing rapid industrial growth would reduce EX volatility and increase welfare. It should be ensured that the necessary steps are taken in the fight against inflation. Making medium- and long-term decisions will have a positive effect on PPP (Gövdeli and Sumer, 2021).

REFERENCES

Aixalá, J., Fabro, G., and 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

Bahramian, P., and Saliminezhad, A. (2020). Revisiting purchasing power parity in the ASEAN-5 countries: evidence from the Fourier quantile unit root test. *Applied Economics Letters*, *28*(13), 1104–1109. https://doi.org/10.1080/13504851.2020.1803473

Bhatti, R. H., and Al-Nassar, N. S. (2020). Price convergence and goods market integration in GCC countries. *Macroeconomics and Finance in Emerging Market Economies*, *14*(1), 86–104. https://doi.org/10.1080/17520843.2020.1784975

Chang, H. L., and Su, C. W. (2009). Revisiting purchasing power parity for major OPEC countries: evidence based on nonlinear panel unit-root tests. *Applied Economics Letters*, *17*(11), 1119–1123. https://doi.org/10.1080/00036840902817565

Chang, T., Chang, H. L., and Su, C. W. (2013). Real Exchange Rate with Nonlinear Threshold Effect. *Economic Research-Ekonomska Istraživanja*, *26*(2), 167–176. https://doi.org/10.1080/1331677X.2013.11517614

Doğanlar, M., Mike, F., and 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.

Goswami, G. G., and Saha, T. K. (2022). Fourier Nonlinear Quantile Unit Root Test of Purchasing Power Parity in cryptocurrencies. *Applied Economics Letters*, *31*(4), 312–322. https://doi.org/10.1080/13504851.2022.2132205

Gövdeli, T., and Sumer, S. (2021). Testing the Purchasing Power Parity Hypothesıs for BRICS: Evidence from the Fourier Unit Root and Cointegration Test. *Journal of Mehmet Akif Ersoy University Economics and Administrative Sciences Faculty*, 8(3), 1394-1406. https://doi.org/10.30798/makuiibf.822369

Güriş, B., and Tıraşoğlu, M. (2018). The Validity of Purchasing Power Parity in the BRICS Countries. *Prague Economic Papers*.

Gyamfi, E. N. (2017). Testing the validity of purchasing power parity in the BRICS: Further evidence. *Euro Economica*, *36*(02), 117-122.

Haug, A. A., and Basher, S. A. (2009). Linear or nonlinear cointegration in the purchasing power parity relationship? *Applied Economics*, *43*(2), 185–196. https://doi.org/10.1080/00036840802403656

Im, K.S., Pesaran, M.H. and Shin, Y. (1997). Testing for unit roots in heterogeneous panels. Cambridge University, pp. 1-30.

Jie, H., and Liu, X. (2023). Price Regulation, Exchange Rate Regulation and the Purchasing Power Parity: Empirical Evidence from China. *Emerging Markets Finance and Trade*, *60*(7), 1537–1548. https://doi.org/10.1080/1540496X.2023.2281414

Kapetanios, G., Shin, Y. and Snell, A. (2003). Testing for a Unit Root in the Nonlinear STAR Framework, *Journal of Econometrics*, 112, 359–379.

Kavkler, A., Boršič, D., and Bekő, 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

Kula, F., Aslan, A., and Feridun, M. (2011). Purchasing Power Parity In Mena Revisited: Empirical Evidence in the Presence of Endogenously Determined Break Points. *Economic Research-Ekonomska Istraživanja*, *24*(1), 1–12. https://doi.org/10.1080/1331677X.2011.11517441

Kyei-Mensah, J. (2023). The long-run validity of PPP in some major advanced and emerging countries using alternative models. *Cogent Economics and Finance*, *11*(1). https://doi.org/10.1080/23322039.2023.2220248

Lee, S. K., Lam, L., and Woo, K. Y. (2023). Tests of goods market integration between China and European countries: a nonlinear nonparametric approach. *China Economic Journal*, *17*(2), 285–299. https://doi.org/10.1080/17538963.2023.2277976

Munir, Q., Kok, S. C., Lean, H. H., and Teplova, T. (2018). Purchasing power parity in ASEAN-5 countries: revisit with cross-sectional dependence and structural breaks. *Macroeconomics and Finance in Emerging Market Economies*, *11*(3), 233–249. https://doi.org/10.1080/17520843.2018.1505760

Nazlioglu, S., Altuntas, M., Kilic, E. and Kucukkkaplan, I. (2022). Purchasing power parity in GIIPS countries: evidence from unit root tests with breaks and non-linearity, *Applied Economic Analysis*, Vol. 30 No. 90, pp. 176-195. https://doi.org/10.1108/AEA-10-2020-0146

Officer, L. H. (1978). The relationship between absolute and relative purchasing power parity. *The Review of Economics and Statistics*, 562-568.

Omay, T., Emirmahmutoglu, F., and Hasanov, M. (2017). Structural break, nonlinearity and asymmetry: a re-examination of PPP proposition. *Applied Economics*, *50*(12), 1289–1308. https://doi.org/10.1080/00036846.2017.1361005

Omay, T., Corakci, A., and Hasdemir, E. (2021). High persistence and nonlinear behavior in financial variables: A more powerful unit root testing in the estar framework. *Mathematics*, *9*(20), 2534.

Omay, T., and Ucar, N. (2023). Testing for Unit Roots in Nonlinear Dynamic Heterogeneous Panels with Logistic Smooth Breaks. *Symmetry*, *15*(3), 747.

Peng, H., Liu, Z., and Chang, T. (2017). 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

Pesaran, M. H. (2003). *A Simple Panel Unit Root Test in the Presence of Cross Section Dependence*, Cambridge Working Papers in Economics 0346, Faculty of Economics, University of Cambridge.

Sarno, L. and Taylor, M.P. (2002). Purchasing power parity and the real exchange rate, IMFStaff Papers, 49, 65–105.

She, F., Zakaria, M., Khan, M., and Wen, J. (2020). Purchasing Power Parity in Pakistan: Evidence from Fourier Unit Root Tests. *Emerging Markets Finance and Trade*, *57*(13), 3835–3854. https://doi.org/10.1080/1540496X.2019.1709820

Tica, J., and Sorić, P. (2012). Economic Integrations and Purchasing Power Parity Assumption . *Economic Research-Ekonomska Istraživanja*, *25*(1), 4–17. https://doi.org/10.1080/1331677X.2012.11517490

Ucar, N. and Omay, T. (2009). Testing for unit root in nonlinear heterogeneous panels, *Economics Letters*, 104, 5–8. doi:10.1016/j.econlet.2009.03.018

Uğur, M. S., and Alper, A. E. (2023). Revisiting Purchasing Power Parity in OECD Countries: New Evidence from Nonlinear Unit Root Test with Structural Breaks. *Sosyoekonomi*, 31(57), 25-45. https://doi.org/10.17233/sosyoekonomi.2023.03.02

Wang, K. H., Su, C. W., Tao, R., and Xiong, D. P. (2019). Does the purchasing power parity fit for China? *Economic Research-Ekonomska Istraživanja*, *32*(1), 2028–2043. https://doi.org/10.1080/1331677X.2019.1637763

Yilanci, V. (2012). The Validity of Purchasing Power Parity in Central and Eastern European Countries: A Rolling Nonlinear Unit Root Test. *Economic Research-Ekonomska Istraživanja*, *25*(4), 973–986. https://doi.org/10.1080/1331677X.2012.11517542

Yilanci, V., Ursavaş, U., and Mike, F. (2024). Revisiting Purchasing Power parity in Emerging-7 Countries. *Investigación Económica*, *83*(328), 31-54.

Zeren, F., and Kızılkaya, F. (2020). A new combination of Fourier unit root tests: a PPP application for fragile economies. *Applied Economics Letters*, *28*(19), 1707–1711. https://doi.org/10.1080/13504851.2020.1851647