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ASYMMETRIC COINTEGRATION TESTS IN TESTING FOR PURCHASING POWER PARITY IN NIGERIA

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ABSTRACT

This paper examined if the purchasing power parity (PPP) theory exists with asymmetric adjustment in Nigeria by using asymmetric cointegration approach of Enders and Siklos (TAR and MTAR). Results of the threshold cointegration tests revealed evidence of long run PPP with asymmetric adjustment in Nigeria. The asymmetric error correction model reveals that negative deviations from PPP are eliminated more quickly than positive deviations. Based on the results of that TAR model, breakdate threshold regression, DOLS and FMOLS, this study concludes that, PPP theory may not hold at all time, exchange rate may adjust asymmetrically, where negative deviations from PPP are eliminated more quickly than positive deviations and foreign prices affect the exchange rate more in Nigeria. It is evident that the foreign price causes appreciation of exchange rate while domestic price leads to depreciation of exchange rate.

Keywords: Purchasing Power Parity; Threshold Autoregressive (TAR) model; Momentum Threshold Autoregressive (MTAR) model; Asymmetric adjustment**.**

INTRODUCTION

The PPP theory, a very important theory in the field of international finance tells us that the exchange rate between countries should be equal to the ratio of the aggregate price levels between the countries so that the unit of currency of one country will have the same power to purchase goods and services in a foreign country. The concept of PPP is based on the law of one price which states that identical goods in different countries should have the same price whenever denominated in the same currency. This can only happen when there is no transaction costs and official trade barriers that identical goods would sell for the same price in separate markets when the prices are expressed in the same currency.

There have been substantial empirical studies on the theory of PPP, however, research on purchasing power parity is still being carried out because of its importance in policy implications in international trade and finance. The importance of PPP is not limited to the fact that it can be used to predict exchange rate to determine whether a currency is over-valued or under-valued. PPP is also used in measuring and comparing national income levels among countries. It is a tool used for forecasting general economic circumstances of countries (Beirne 2010).

Numerous researchers have utilized conventional linear unit root tests in real exchange rates, and cointegration between various measures of domestic and foreign prices and nominal exchange rates in the study of the long-run purchasing power parity (Su et al. 2010). The conclusions drawn from these studies are based on linear tests of unit roots and/ or cointegration. Since a lot of evidence supporting asymmetric reactions in key economic variables have been acknowledged, there is no reason to continue assuming that the long run PPP adjustment process towards equilibrium is symmetric (Lu et al. 2011). As shown by Bahmani-Oskooee

et al. (2015), economic variables such as the exchange rate may follow an asymmetric adjustment process. The power of linear cointegration test is low in an asymmetric adjustment process. Enders and Granger (1998) showed that the standard tests of stationarity and cointegration have low power in the presence of misspecified dynamics. Lu et al. (2011).

To this end, the purpose of this paper is to investigate if there exist a long run validity of purchasing power parity and asymmetric adjustment in Nigeria using the threshold cointegration test of Enders and Siklos (2001). This paper significantly contributes to this area of research to the best of our knowledge in the sense that it is the first to utilize the threshold cointegration test of Enders and Siklos (2001) in testing for purchasing power parity from the period of January 2003 to August 2016 in Nigeria. Based on the results of the threshold cointegration tests, results showed evidence of long run PPP with asymmetric adjustment in Nigeria.

The remaining paper is organized as follows: Section 2 presents the PPP theory, section 3 presents the literature review, section 4 presents the data used and econometric methodology, in section 5, we present our results and then conclude in section 6.

The Theory of PPP

The PPP theory says that the exchange rate between two currencies should be equal (be the same) as the ratio of aggregate price level between the two currencies, so that the unit of currency of one country will have the same power to purchase goods and services in a foreign country. To understand the concept of PPP, we need to look at the law of one price because PPP theory is based on the variation and expansion of the law of one price applied to the aggregate economy.

The law of one price states that identical goods in different countries should have the same price whenever denominated in the same currency. That is when there is no transportation cost or no differential taxes applied in the two different markets, identical goods should sell for the same price in two separate markets. If a price difference exists between two markets, then we experience arbitrage. The success of the law of one price depends on arbitrage between countries. The process of having the same prices in different countries is time consuming that is why PPP is favoured more as a long run relationship instead of a short run relationship. A mathematical representation of the law of one price is given in the equation below:

$$e = \frac{p}{p^*} \tag{1}$$

where e is the nominal spot exchange rate, p and p^* are the prices for identical commodity in the domestic and foreign country respectively.

There are basically two types of PPP; the absolute PPP and the relative PPP. The absolute PPP holds when the purchasing power of a unit of currency is exactly equal in the domestic economy and in a foreign economy, once it is converted into foreign currency at the market exchange rate. This idea suggests that the exchange rate between two countries is identical to the ratio of the price levels for those two countries. Absolute PPP could be represented by the equation $e = \frac{p}{p^*}$. Applying log we have

$$e = p - p^* \tag{2}$$

where e is the exchange rate (domestic currency per unit of foreign currency), p is the domestic price level and p^* is the foreign price level. It is generally acknowledged that

this version of PPP is not likely to hold across countries because of hindrances such as transportation costs and trade tariffs.

On the other hand, relative PPP holds that the exchange rate adjusts to the amount of the inflation differential between countries. That is, changes in the exchange rate are equal to changes in the relative national prices.

The difference between absolute PPP and relative PPP is that the former indicates that the exchange rate has to reflect the ratio of the two countries' price levels, which is not easy. In reality, there are market imperfections such as non-transferable inputs, transportation costs, tariffs, quotas, and so forth. Consequently, relative PPP takes these imperfections into account and relaxes the relationship between the exchange rate and the price levels of two countries. It does that by considering the relationship between the changes in the exchange rate and the changes in the ratio of the price levels. All that the relative PPP requires is the changes in the exchange rate and the changes in the ratio of price levels. Relative PPP could be represented by the equation below

$$\%\Delta e = \%\Delta p - \%\Delta p^* \quad (3)$$

where $\%\Delta e$ is the percentage change in the exchange rate (defined as the amount of domestic currency per one unit of foreign currency), $\%\Delta p$ is the percentage change in the domestic rate of inflation and $\%\Delta p^*$ is the percentage change in foreign rate of inflation (Beirne 2010).

Literature Review

Due to the importance of the purchasing power parity, many empirical analyses were conducted using different methods in determining the validity of PPP theory for different countries. Below are some of the works done previously on the PPP.

In a paper titled "A Threshold Cointegration Analysis of Asymmetric Price Transmission from Crude Oil to Gasoline Prices", Chen et al. (2005) found evidence in support of asymmetric adjustment in U.S. retail gasoline prices using the Enders and Siklos (2001) cointegration of weekly data for the period of January, 1991 to March, 2003. They found that the asymmetric transmission occurs not only by the spot markets of crude oil and refinery gasoline but also through their future markets. However, Baum et al. (2001) modelled the dynamics of adjustments to long run PPP over the post- Bretton Wood era in a nonlinear framework for a set of U.S. trading partners form the period of August 1973 to December, 1995 using the exponential smooth transition autoregressive (ESTAR) model. They found evidence to support a nonlinear dynamic structure with a very slow convergence to long run purchasing power parity in the post-Bretton Woods era. To test for asymmetric adjustment in the long run relationship between stock price and economic activity in the U.K, Cook (2007) found asymmetric cointegration by the use of the MTAR which was not found by the TAR model when he used quarterly data over the period of 1975Q1 to 2005Q2. He also used the threshold cointegration method of Enders and Siklos (2001).

Furthermore, Chen et al. (2013) found out that cointegration adjustment between exchange rate and oil prices in Philippines from the period of 1970Q1-2011Q4 appear to be asymmetric with the use of the momentum threshold autoregressive (MTAR) model. But they got a contrary result when they applied the threshold autoregressive (TAR) model. Moreover, Haughton and Iglesias (2012) analysed asymmetric interest rates and the monetary transmission mechanism in the volatility on interest rates and the monetary transmission mechanism in the countries of Caribbean single market and economy

(CSME) using monthly data from the period 1995 to 2010. The results of TAR and MTAR models showed asymmetric cointegration for Guyana, Jamaica and St. Lucia (but not for Barbados, Haiti, Trinidad and Tobago) for both lending and deposit rates. Additionally, Arouri and Fouquau (2009) investigated the effect of oil prices and stock market returns in GCC (Golf Cooperation Council Countries) using monthly data from January, 1996-December, 2007. Their results found evidence for asymmetric cointegration between oil prices and stock market returns when the combined the Schorderet (2003) with the Lardic and Mignon (2008) methods of asymmetric cointegration. Further, Aliyu and Tijjani (2015) found asymmetric cointegration between exchange rate and trade balance in Nigeria with monthly data from 1999-2012 when they applied the threshold cointegration of Enders and Siklos (2001). Tiwari and Shahbaz (2014), examined the PPP hypothesis for India with her five major trading partners over the period of 1991M1-2009M2 using the DF-GLS unit root test and the threshold autoregressive (TAR) model as well as the momentum-TAR (M-TAR) models for the empirical analysis. Their analysis revealed that PPP hypothesis does not hold for all the major trading partners of India, indicating that intermediate goods face high barriers to trade in these sampled countries.

Recently, Ang et al (2021) found some support for the PPP theory when they used data from 1980 to 2016 on some groups of developed, developing and low trade openness economies using panel unit root test. Finally, Olaniran and Ismail (2021) in a paper titled " Purchasing Power Parity: The West African Experience" found support for the PPP when they utilised data from 1970 to 2019 on sixteen Economic Community of West African States (ECOWAS) using unit root and cointegration tests.

This paper contributes to literature by applying the threshold cointegration of Enders and Siklos (2001) to determine if there exist a long run purchasing power parity in Nigeria from 2003 to 2016. Furthermore, it utilizes the threshold cointegration for long run purchasing power parity in Nigeria. To the best of our knowledge, it is the first of its kind to apply the threshold cointegration method on data from 2003 to 2016 in Nigeria to test for asymmetric long run purchasing power parity.

DATA AND ECONOMETRIC METHODOLOGY

Data

In this paper, we use data collected from *Datastream*, Thomson Reuters. It is a set of monthly data for Nigeria starting from January 2003 to August 2016. The data consist of the nominal exchange rate (local currency per 1USD), consumer price index (CPI) for Nigeria and CPI for the US since US is used as the base currency.

Threshold Cointegration Tests (TAR and MTAR)

Following Su et al. (2010), we apply threshold cointegration technique advanced by Enders and Siklos (2001) to test for the long run PPP with asymmetric adjustment in Nigeria. The test is based on a two-stage process. First, we estimate a long run equilibrium relationship of the form:

$$e_t = \alpha_0 + \beta_1 p_t^* + \beta_2 p_t + \mu_t \quad (5)$$

where e_t is the logarithm of nominal exchange rate, p_t^* and p_t represent the logarithm of foreign and domestic price levels respectively and μ_t is the stochastic disturbance term. The second stage focuses on the OLS estimates of ρ_1 and ρ_2 in the following regression:

$$\Delta\mu_t = I_t\rho_1\mu_{t-1} + (1-I_t)\rho_2\mu_{t-1} + \sum_{i=1}^{t}\gamma_i\Delta\mu_{t-1} + \varepsilon_t \qquad (6)$$

where ε_t is a white-noise disturbance and the residuals, μ_t , in equation (5) are extracted to equation (6) to be further estimated. I_t is the Heaviside indicator function such that:

$$I_t = \begin{cases} 1 & \text{if} \quad \mu_{t-1} \geq \tau \\ 0 & \text{if} \quad \mu_{t-1} < \tau \end{cases}$$

where τ is the threshold value. A necessary condition for $\{\mu_t\}$ to be stationary is: $-2 < (\rho_1, \rho_2) < 0$ If the variance of ε_t is sufficiently large, it is also possible for one value of ρ_j to be between

–2 and 0 and for the other value to equal zero. Although there is no convergence in the regime with the unit-root (i.e., the regime in which $\rho_j = 0$), large realization of ε_t will switch the system into the convergent regime. Enders and Granger (1998) and, Enders and Siklos (2001) both pointed out in either case, under the null hypothesis of no convergence, the F-statistic for the null hypothesis $\rho_1 = \rho_2 = 0$ has a nonstandard distribution. The critical values for this non-standard F-statistic are tabulated in their paper. Enders and Granger (1998) also showed that if the sequence is stationary, the least squares estimates of ρ_1 and ρ_2 have an asymptotic multivariate normal distribution.

Model using equation (6) is known as the threshold autoregression model (TAR), where the test for threshold behavior of the equilibrium error is termed threshold cointegration test. Assuming the system is converged, $\mu_t = 0$ can be considered as the long-run equilibrium value of the sequence. If μ_t is above its long-run equilibrium, the adjustment is $\rho_1\mu_{t-1}$ and if μ_t is below its long-run equilibrium, the adjustment is $\rho_2\mu_{t-1}$. The equilibrium error therefore behaves like a threshold autoregression. The null hypothesis of $\rho_1 = \rho_2 = 0$ tests for the cointegration relationship and the rejection of this null implies that existence of cointegration between variables. In revealing of $\rho_1 = \rho_2 = 0$ hypothesis, it is valuable to further test for symmetric adjustment (i.e., $\rho_1 = \rho_2$) by using a standard F-test. When adjustment is symmetric as $\rho_1 = \rho_2$, equation (6) converges the prevalent augmented DF test Said and Dickey (1984). Rejecting both the null hypotheses of $\rho_1 = \rho_2 = 0$ and $\rho_1 = \rho_2$ imply the existence of threshold cointegration and the asymmetric adjustment.

According to Enders and Granger (1998), this model is especially valuable when adjustment is asymmetric such that the series exhibits more 'momentum' in one direction than the other. Instead of estimating equation (2) with the Heaviside indicator depending on the level of μ_{t-1} , the decay could also be allowed to depend on the previous period's change in μ_{t-1} . The Heaviside indicator could then be specified as:

$$I_t = \begin{cases} 1 & \text{if} \quad \Delta\mu_{t-1} \geq \tau \\ 0 & \text{if} \quad \Delta\mu_{t-1} < \tau \end{cases}$$

where τ is the threshold value. This model is termed as momentum-threshold autoregression model (M-TAR). The TAR model can capture 'deep' cycle process if, for example, positive deviations are more prolonged than negative deviations. The M-TAR model allows the autoregressive decay to depend on $\Delta\mu_{t-1}$. As such, the M-TAR representation can capture 'sharp' movements in a sequence.

In the most general case, the value of τ is unknown, it needs to be estimated along with the values of ρ_1 and ρ_2 . By demeaning the $\{\mu_t\}$ sequence, the Enders and Granger (1998) test procedure employs the sample mean of

the sequence as the threshold estimate of τ. However, the sample mean is a biased threshold estimator in the presence of asymmetric adjustments. For instance, if autoregressive decay is more sluggish for positive deviations of μ_{t-1} from τ than for negative deviations, the sample mean estimator will be biased upwards. A consistent estimate of the threshold τ can be obtained by using Chan's (Chan 1993) method of searching over possible threshold values to minimize the residual sum of squares from the fitted model.

Enders and Siklos (2001) applied Chan's methodology to a Monte Carlo study to obtain the F-statistic for the null hypothesis of $\rho_1 = \rho_2 = 0$ when the threshold τ is estimated using Chan's procedure. The critical values of this non-standard F-statistic for testing the null hypothesis of $\rho_1 = \rho_2 = 0$ are also tabulated in their paper. As there is generally no presumption as to whether to use TAR or M-TAR model, the recommendation is to select the adjustment mechanism by a model selection criterion such as the Akaike information criterion (AIC) or Schwartz Bayesian information criterion (SBC).

Threshold Error-Correction Model (TECM)

If evidence supporting asymmetric adjustment of threshold cointegration is found, an asymmetric error-correction model can be used to investigate the movement adjustment process of variables to the long-run equilibrium relationship. The conventional error-correction models do not represent whether the value of threshold exists true, above or under fundamental value τ, which will have different adjustment process. We estimate the set of equations in (7) for asymmetric error-correction models in Nigeria since asymmetric adjustment of threshold cointegration is found.

$$\Delta e_t = \mu_{10} + \sum_{i=1}^{k} a_{1i}\Delta e_{t-1} + \sum_{i=1}^{k} b_{1i}\Delta p^*_{t-1} + \sum_{i=1}^{k} c_{1i}\Delta p_{t-1} + \lambda_{1e} z^+_{t-1} + \lambda_{2e} z^-_{t-1} + \varepsilon_t \quad (7)$$

Where $z^+_{t-1} = I_t \mu_{t-1}$ and $z^-_{t-1} = (1 - I_t)\mu_{t-1}$. μ_{t-1} is residual from (7),

$$I_t = \begin{cases} 1 & \text{if} \quad \mu_{t-1} \geq \tau \\ 0 & \text{if} \quad \mu_{t-1} < \tau \end{cases}$$

For the TAR.

Moreover, z^+_{t-1} and z^-_{t-1} represent the shock of adjustment for $\mu_{t-1} \geq \tau$ and $\mu_{t-1} < \tau$ respectively. The estimated coefficients of z^+_{t-1} and z^-_{t-1}, λ_1 and λ_2, determine the speed of adjustment for positive and negative deviations from long-run PPP, respectively. The choice of the appropriate lag length is based on the multivariate AIC (Su et al. 2010).

Estimation approaches

Apart from the threshold error correction model, the break date threshold regression was considered in getting the long-run estimates. The equation for breakpoint threshold regression searching for breaks in the sample and can be written as:

$$\begin{aligned} e_t = {} & \beta_1 I\left(t \leq k_1\right)\left[c_0 + b_{0,1}p^*{}_t + b_{0,2}p_t\right] \\ & + \beta_2 I\left(k_1 + 1 \leq t \leq k_2\right)\left[c_1 + b_{1,1}p^*{}_t + a_{1,2}p_t\right] \\ & + \beta_3 I\left(k_2 + 1 \leq t \leq T\right)\left[c_2 + a_{2,1}p^*{}_t + a_{2,2}p_t\right] + u_t \end{aligned} \quad (8)$$

for two break dates model where k_1 and k_2 are the break dates. In this study, we used the Bai and Perron (1998) test of L+1 breaks vs. L to sequentially determine two break dates. The break dates k_1 and k_2 have divided the sample period into three sub-periods, i.e., $(t \le k_1)$ $(k_1 + 1 \le t \le k_2)$ and $(k_2 + 1 \le t \le T)$. Apart from the break dates threshold regression, we also applied the DOLS and FMOLS for consistency check.

RESULTS

We applied the threshold cointegration tests to test for the PPP hypothesis. Before the TAR and MTAR cointegration tests, time series unit-root tests were conducted to check for the stationarity of variables. The time series unit-root tests include the ADF and PP. The Engle and Granger (1987) and, Phillips and Ouliaris (1990) linear cointegration tests were also conducted to check if there is linear cointegration. Below are the results of the analyses.

Table 1. presents the results of time series unit root tests. The table shows results for Augmented Dickey-Fuller (ADF) (Said and Dickey 1984) and Phillips-Perron (PP) (Phillips & Perron 1987) unit root tests. The results provide evidence for unit root in the log of nominal exchange rate (LEXRATE) and the log of respective price levels i.e. the log of consumer price index for Nigeria and also the log of the consumer price index for US (LCPI and LCPIus) when we applied the ADF and the PP test. But after first differenced (ΔLEXRATE ΔLCPI and ΔLCPIus), these variables become stationary confirming that they are integrated of order one. Therefore, we fail to reject the null hypothesis of a unit root. Meaning that our variables of interest are not stationary at levels but stationary at first difference. This shows that all our variables are integrated of order one, therefore, we can go ahead with the cointegration tests to see if the combination of these variables will be stationary.

Furthermore, Table 2. Presents the results of linear cointegration tests. Here we conducted the linear cointegration tests of Engle and Granger (1987) and, Phillips and Ouliaris (1990). Both tests results reject the null hypothesis of no cointegration at 5% to show evidence of cointegration in Nigeria. This shows that there is a long run relationship between exchange rate and the relative price levels in Nigeria.

Additionally, Table 3. Presents the results of the threshold cointegration tests in Nigeria. Here we have the TAR and the MTAR with threshold values and when the threshold value is zero (that is when τ has a consistent estimate and when $\tau = 0$ **).** For the TAR model, the null hypothesis of no cointegration and symmetry are rejected, indicating the presence of cointegration and asymmetric adjustment in Nigeria. However, results of MTAR rejects the null hypothesis of no cointegration but not that of symmetry, indicating the presence of cointegration and a symmetric adjustment. Both results show that PPP in valid in Nigeria, but only the TAR model indicates the presence of asymmetric adjustment towards equilibrium in Nigeria. We have seen from the methodology that the TAR model is able to capture 'deep' cycle process and the MTAR model is able to capture 'sharp' movement in a sequence. We can now say that the asymmetric adjustment towards equilibrium in Nigeria is a 'deep' cycle process that is why it was captured by the TAR model. We therefore go ahead with the threshold error correction model.

Table 1: Unit-root tests

Variable	ADF test statistic	PP test statistic
LEXRATE(e_t)	1.6408(0.9753)	1.7735(0.9816)
Δ LEXRATE(Δe_t)	-9.0938(0.0000)**	-9.1023(0.0000)**
LCPI(p_t)	5.7106(1.0000)	7.7643(1.0000)
Δ LCPI(Δp_t)	-7.2031(0.0000)**	-7.2771(0.0000)**
LCPIus(Δp_t^*)	4.2913(1.0000)	5.3755(1.0000)
Δ LCPIus(Δp_t^*)	-6.7629(0.0000)**	-6.7629(0.0000)**

Where ** indicate significance at 5% level.

Table 2: Linear cointegration tests

	Engle-Granger test	Phillips-Ouliaris test
z-statistic(Prob.)	-72.1518(0.0000)**	-30.9705(0.0157)**

** indicates significance at 5% level.

Table 3: Threshold cointegration test

Model	τ	ρ_1	ρ_2	No Cointegration	Symmetry
				$\rho_1 = \rho_2 = 0$	$\rho_1 = \rho_2$
TAR	0.0000	-0.1869	-0.3640	9.6801(7.2312)**	2.2253(2.0720)**
	-0.0454	-0.1466	-0.5033	13.2808(7.0902)**	8.7260(2.2691)**
MTAR	0.0000	-0.2454	-0.3101	8.6056(7.7383)**	0.2841(3.7735)
	-0.0135	-0.3513	-0.1502	9.9203(7.7719)**	2.6580(3.9410)

Where ** indicate significance at 5% level.

Finally, Table 4. Shows the results of estimated symmetric and asymmetric error correction madels for all the variables. The estimated coefficients λ_1 and λ_2 of z_{t-1}^+ and z_{t-1}^- determine the speed of adjustment for positive and negative deviations from the long run PPP. It is obvious from our results that both coefficients for the domestic price in Nigeria are statistically significant. In Nigeria, λ_2 the coefficient z_{t-1}^- (the short-run adjustment parameter measuring the speed of adjustment to equilibrium) is statistically significant while λ_1, the coefficient of z_{t-1}^+ is not significant, showing that negative deviations from PPP are eliminated more quickly than positive deviations. The speed of adjustment from short-term positive deviation to the long-term equilibrium is at the rate of 344.43% per Month. The symmetric error correction model was also estimated for comparison. The result of the linear error correction model is consistent with that of the asymmetric error correction model, it is also negative and significant.

Table 4: Estimated symmetric and asymmetric Error Correction Models

Variable	Linear ECM	Threshold ECM	
	λ	λ_1	λ_2
ΔLEXRATE(Δe_t)	-0.1637*** (-2.7256)	-0.0406 (-0.4303)	0.2789*** (-3.4448)
Δ LCPI(Δp_t)	0.0604*** (2.7560)	0.0817** (2.3647)	0.0605** (2.0423)
Δ LCPIus(Δp_t^*)	-0.0079 (-1.5134)	0.0002 (0.0203)	-0.0139* (-1.9527)

The table presents the estimated coefficients and t-statistics in brackets. ***, ** and * indicate significance at 1%, 5% and 10% levels of significance respectively.

Finally, Table 5. Shows coefficients for the break date threshold regression, dynamic ordinary least squares (DOLS) and fully modified ordinary least squares (FMOLS) for Nigeria. From the results of the break dates threshold regression, the sequential determination searching procedure was used to detect two break dates which break the samples into three different sub-periods for Nigeria (2003M01-2008M12, 2009M01-2014M08 and 2014M09-2016M08). The coefficients of the variables for the break dates threshold regression are statistically significant for 2003M01-2008M12 and 2014M09-2016M08 except for 2009M01-2014M08. It is obvious that the local and foreign prices both have a significant impact on the nominal exchange rates for 2003M01-2008M12 and 2014M09-2016M08 periods. 1unit increase in the domestic price (LCPI) leads to a depreciation of 0.38 units in the nominal exchange rate, and 1unit increase in the foreign price (LCPIUS) leads to an appreciation of 2.01 units in nominal exchange for 2003M01-2008M12. In the same way, 1unit increase in the domestic price (LCPI) leads to a depreciation of 1.81 units in the nominal exchange rate, and 1unit increase in the foreign price (LCPIUS) leads to an appreciation of 5.84 units in nominal exchange for 2014M09-2016M08. All the variables for DOLS estimators are significant in Nigeria. The local and foreign prices both have a significant impact on the nominal exchange rate. We can say that 1unit increase in the domestic price (LCPI) leads to a depreciation of 1.27 units in the nominal exchange rate, and 1unit increase in the foreign price (LCPIUS) leads to an appreciation of 4.67 units in the nominal exchange rate for Nigeria. The results of DOLS is consistent with that of FMOLS we can see that local and foreign prices both have a significant impact on the nominal exchange rate for Nigeria.

CONCLUSION

This paper investigate if there exist a long run validity of purchasing power parity and asymmetric adjustment in Nigeria using the threshold cointegration test of Enders & Siklos (2001). We applied the threshold cointegration tests to test for the PPP hypothesis. Prior to the TAR and MTAR cointegration tests, time series unit-root tests were conducted to check for the stationarity of variables. The time series unit-root tests include the ADF and PP. results of the time series unit root tests revealed that all our variables are integrated of order one, which gave us the confidence to proceed with the cointegrations tests. The Engle and Granger (1987) and, Phillips and Ouliaris (1990) linear cointegration tests were also conducted to

check if there is linear cointegration. Both tests gave evidence of linear cointegration. With the application of the threshold cointegration test, we found evidence for asymmetric cointegration, meaning that PPP is valid in Nigeria with asymmetric adjustment. Additionally, based on the asymmetric error correction model, negative deviations from PPP are eliminated more quickly than positive deviations. The speed of adjustment from short-term positive deviation to the long-term equilibrium is at the rate of 344.43% per Month. Results of the symmetric error correction model is consistent with that of the asymmetric error correction model.

Moreover, we conducted the break date threshold cointegration, DOLS and FMOLS. Results of the break date threshold regression provides deeper results, i.e. provides estimates on the PPP long-run relationship under different time frames due to break dates. In Nigeria, PPP relationship holds in the periods of 2003M01 – 2008M12 and 2014M10-2016M08 but does not hold during 2009M01-2014M09. The results imply that PPP relationship may not necessarily hold for all periods. On the other hand, results of DOLS confirms the validity of PPP in the long-run in Nigeria as both domestic price and foreign price are significant determinants of the exchange rate. To be specific, an increase in domestic price leads to exchange rate depreciation while an increase of foreign price causes exchange rate appreciation. The magnitude of foreign price effect (appreciation of exchange rate) is much larger the effect of domestic price (depreciation in exchange rate).

In conclusion, PPP theory may not hold all the time, exchange rate may adjust asymmetrically, where negative deviations from PPP are eliminated more quickly than positive deviations and foreign prices tend to have larger effect on exchange rate than domestic prices. From this study, it is evident that foreign price causes appreciation of exchange rate while the domestic price leads to depreciation of exchange rate. Consequently, depreciation causes exports to be cheaper, imports to be more expensive, thereby causing inflation to increase. On the other hand, appreciation of the nominal exchange rate will cause export to be more expensive, imports cheaper, thereby reducing inflation in Nigeria. In general, the foreign price contributes more to the adjustments in the nominal exchange rates, thereby making the effect of nominal exchange rate appreciation more pronounced than depreciation in Nigeria.

REFERENCES

Aliyu, J. & Tijjani, M., (2015). Asymmetric cointegration between exchange rate and trade balance in Nigeria. *Cogent Economics & Finance*, 3(1), pp.1–19.

Ang, A. L., Thum, Y. T. & Sek S. K., (2021). Does trade opennes explain the deviation from purchasing power parity and exchange rate movement? J. Phys: Conf. Ser. 1988 01287.

Arouri, M.E.H. & Fouquau, J., (2009). How do oil prices affect stock returns in GCC markets ? An asymmetric cointegration approach . *Bankers, Markets & Investors*, 111, pp.1–14.

Bahmani-Oskooee, M., Chang, T. & Lee, K.-C., (2015). Panel asymmetric nonlinear unit root test and PPP in Africa. *Applied Economics Letters*, 23(8), pp.554–558.

Bai, J. & Perron, P., (1998). Estimating and Testing Linear Models with Multiple Structural Changes. *Econometrica*, 66(1), pp.47–78.

Baum, C.F., Barkoulas, J.T. & Caglayan, M., (2001). Nonlinear adjustment to purchasing power parity in the post-Bretton Woods era. *Journal of International Money and Finance*, 20(3), pp.379–399.

Beirne, J., (2010). *International exchange rate dynamics and purchasing power parity*. (PhD Thesis, Brunel University, UK).

Chan, K.S., (1993). Consistency and Limiting Distribution of the Least Squares Estimator of a Threshold Autoregressive Model. *The Annals of Statistics*, 21(1), pp.520–533.

Chen, J., Lee, C. & Goh, L., (2013). Exchange rate and oil price : asymmetric adjustment. *Applied Economic Letters*, 20(10), pp.987–991.

Chen, L.H., Finney, M. & Lai, K.S., (2005). A threshold cointegration analysis of asymmetric price transmission from crude oil to gasoline prices. *Economics Letters*, 89(2), pp.233–239.

Cook, S., (2007). Threshold adjustment in the long-run relationship between stock prices and economic activity Threshold adjustment in the long-run relationship between stock prices and economic activity. *Applied Financial Economics Letters*, 3(February 2014), pp.37–41.

Enders, W. & Granger, C.W.J., (1998). Unit-Root Tests and Asymmetric Adjustment With an Example Using the Term Structure of Interest Rates Unit-Rsst Tests and Asymmetric Adjustn2ent \/ Vi % h an Examp e Using the Term Structure of Bnterest Rates. *Journal of Business & Economic Statistics*, 16(3), pp.304–311.

Enders, W. & Siklos, P.L., (2001). Cointegration and Threshold Adjustment. *Journal of Business & Economic Statistics*, 19(2), pp.166–176.

Engle, R.F. & Granger, C.W.J., (1987). Cointegration and Error Correction: Representation, estimation, and Testing. *Econometrica*, 55(2), pp.251–276.

Haughton, A.Y. & Iglesias, E.M., (2012). Interest rate volatility, asymmetric interest rate pass through and the monetary transmission mechanism in the Caribbean compared to US and Asia. *Economic Modelling*, 29(6), pp.2071–2089.

Lardic, S. & Mignon, V., (2008). Oil prices and economic activity: An asymmetric cointegration approach. *Energy Economics*, 30(3), pp.847–855.

Lu, Y., Chang, T. & Yu, C.-P., (2011). Long run Purchasing Power Parity With Asymmetric Adjustment: Evidence From Mainland China and Taiwan. *Romanian Journal of Economic Forecasting*, 3, pp.59–70.

Olaniran, S. F. & Ismail, M. T., (2021). Purcchasing Power Party: The West African Experience. AIP Conference Procedings. 2423, 070013.

Phillips, A.P.C.B. & Ouliaris, S., (1990). Asymptotic Properties of Residual Based Tests for Cointegration Published by : The Econometric Society Stable URL :

http://www.jstor.org/stable/2938339. *Econometrica*, 58(1), pp.165–193.

Phillips, P.C.B. & Perron, P., (1987). *Testing for Unit Root in Time Series Regression*, Biometrica, **75**, 2, pp. 335-346.

Said, S.E. & Dickey, D.A., (1984). Testing for unit roots in autoregressive-moving average models of unknown order. *Biometrika*, 71(3), pp.599–607.

Schorderet, Y., (2003). *Asymmetric Cointegration*, (Université de Genève, 40 Boulevard du Pont-d'Arve, CH - 1211 Genève 4*)*.

Su, C.-W., Horng, Y. & Wu, Y.-L., (2010). Asymmetric Adjustment and Long-run purchasing power parity in BRICs. *Applied Economics Letters*, 17(11), pp.1083–1087.

iwari, A.K. & Shahbaz, M., (2014). Revisiting Purchasing Power Parity for India using threshold cointegration and nonlinear unit root test. *Economic Change and Restructuring*, 47(2), pp.117–133.