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ANALYZING PRICE TRANSMISSION IN THE NIGERIAN CATTLE MARKET

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ABSTRACT

The study analysed price transmission in the Nigerian cattle market. Time series price data, for ten states (Borno, Cross River, Edo, Kano, Nassarawa, Osun, Oyo, Plateau, Yobe and Zamfara) for the years, 2002-2017 were used for the analysis. The summarised result on Threshold Vector Error Correction model showed that positive and negative deviations for eight states (Borno, Cross River, Edo, Nassarawa, Osun, Plateau, Yobe and Zamfara) exceeded their respective threshold values. Also all the values of the above threshold values are not equal to the below threshold values, indicating the presence of asymmetric transmission. The presence of asymmetric transmission showed price changes along the chain (from farmer/marketer to consumer) was greater than the market costs of handling cattle and agents will be in a greater position to implement price changes before transmission takes place. This indicates strong asymmetric price transmission since price changes moved from bottom of the chain to the top. There is need to improve on the market information system in the country so that information will flow to all the markets.

Key words: ***Price transmission, Threshold Vector Error Correction model, Asymmetric transmission, Nigerian cattle market.***

INTRODUCTION

Price transmission is defined as the price relationship between two related markets and the effect of change in price of one of the markets will have over the other (Bor and Tuncay, 2015). Price transmission can be symmetric or asymmetric, depending on the magnitude and speed of transmission. If the change in price of one market is transmitted to the other market quickly and fully, then we have symmetric transmission. In asymmetric transmission the change in price in one market is not quickly and fully transmitted to the other market (Meyer and von Cramon-Taubadel, 2002; Bor and Tuncay, 2015). It is assumed that symmetric price transmission arise from competitive markets while asymmetric relationships arise from lack of competition (Benni *et al*., 2014). According to Rapsomanikis (2011) price transmission in most developing countries is incomplete (asymmetric), due to high transaction costs arising from poor transport and communication infrastructure, among other reasons. Other causes of price asymmetry are: adjustment costs such as costs of making new labels and advertising; presence of imperfect competition among middlemen and the resulting market power; which is often expected to lead to positive asymmetry (Meyer and von Cramon-Taubadel, 2002).

Price transmission is the idea that price changes in one market are transferrable across markets through the arbitrage of goods between markets. These markets are temporally, spatially, vertically or horizontally separated. Unanticipated market information greatly influence price changes in the market. Price transmission results from transfer of information between separated markets for homogeneous and heterogeneous goods (Natcher and Weaver, 1999). Poor price transmission results in a reduction in the price information available and leads to decisions that may affect demand and supply responses (Rapsomanikis, 2011).

Spatial price analysis is important in market studies. Spatial patterns of marketing give rise to a setting of relationships among prices throughout the market (Fackler and Tastan, 2008). The spatial price transmission between two markets can be explained by the "Law of One Price", (LOP), which stipulates that if prices between two spatially separated markets (P_A and P_B) in time t and differ with transfer cost for movement from A to B, then, $P_A - P_B \leq T$, that is the price differences in A and B should be equal to or less than the transfer cost. When the price differences between two markets exceed the transfer cost, arbitrage activities trigger a reversion process which drives prices to their long-term equilibrium relationship. When trade takes place between two markets, it means the markets are integrated. If no trade occurs, then there is no price transmitted (Gannavel, 2013).

According to Vavra and Goodwin (2005) the analysis of price, particularly, spatial price relationships dates back to more than one hundred years. Prices are either vertically or horizontally transmitted along chains and between markets, respectively. Also spatial transmission of price shocks play a very important role in theories associated with market integration, particularly, the (LOP).

Price is therefore an important factor in market studies. This is because the issue of interest in market studies revolve around characteristic price changes and how the change in prices are transferred in the marketing system. The study of market prices has usually tried to characterise the degree transmission of prices across spatially separated markets by using reliable and available price information/data to analyse integration of markets, and the interdependence of price changes across spatially separated locations in a market (Natcher and Weaver, 1999).

Information transfer, which is a key function in both integration and volatility of market prices, is of paramount importance in determining the efficiency of markets. This is because it is through the flow of information that prices volatile (or otherwise) and integrated (or segmented) are transmitted across and between markets. Price transmission which means transfer of price changes from across markets (through the arbitrage of goods among them) results from transfer of information between (or among) separated markets (Natcher and Weaver, 1999). Therefore, poor information transfer which may arise from poor transportation and poor communication/infrastructure will lead to incomplete transmission of price changes from one market to another and poor integration among markets. Poor information transfer also has important implications on economic welfare as it results in inefficient markets (Rapsomanikis *et al*., 2002). Information on market prices is therefore essential in the study of markets.

Generally, markets, including that of cattle, in many developing nations are classified as inefficient due to poor roads, inadequate infrastructure (such as stores) and poor price information systems. This can be tackled by improving on the marketing systems and by effectively deploying efficient marketing strategies, in a bid to achieve efficient marketing. With adequate and timely transfer of cattle price information in Nigeria, cattle and cattle products can reach all parts of the country through an efficient marketing system. Thus, this study made use of available market price information to examine the price (transmission) symmetry/asymmetry in the Nigeria cattle market.

Listortis and Esposti (2012) observed that several studies have focused on few agricultural commodities, mostly, cereals, meat and vegetable oil markets, due to lack of appropriate data for most agricultural commodities. This research is therefore designed to fill some of the gap left in the agricultural sector, ie the market status, efficiency and transmission of cattle prices in Nigeria.

THEORETICAL FRAMEWORK

Studies on the issue of price transmission have tried to see whether price decreases are transmitted along the chain with equal speed and/or magnitude as price increases. That is why the issue of asymmetric price transmission is taking on renewed prominence due to its potentially important welfare and policy implications. Meyer and von Cramon-Taubadel (2002) observe that a possible implication of asymmetric price transmission is that consumers are not benefiting from a price reduction at the producers' level, or producers might not benefit from a price increase at the retail level. Thus, under asymmetric price transmission, the distribution of welfare effects across levels and among agents following shocks to a market will be altered relative to the case of symmetric price transmission. According to Miller and Hayenga (2001) recent research has recognized more complex aspects of price transmission relationships and explored the extent to which price adjustments may be asymmetric. The most commonly cited reasons include theories of local market power (such as collusion among firms in an oligopoly), adjustment and menu costs and inventory management strategies.

Meyer and von Cramon-Taubadel (2002) further explained that market power, adjustment and menu costs are the reasons for asymmetric transmission in prices. Adjustment costs arise if a firm increases or decreases its output or the price of its products. If these costs are asymmetric with respect to an increase or a decrease in output quantities and/or prices the adjustment will be asymmetric. In the case of price changes, adjustment costs are also called menu costs. They also explained that market power is often expected to lead to positive asymmetry. Hence, it is expected that increases in input prices which reduce marketing margins will be transmitted faster and more completely than decreases as a result of market power. That is why many publications on the topic of asymmetric price transmission includes considerations of non-competitive market structures, mostly oligopoly. Middlemen are known to make use of market power in agriculture (where farmers at the beginning and consumers at the end of a marketing chain) who are exploited in the less than perfect competition system in the processing and retailing sectors.

The reasons given by Meyer and von Cramon-Taubadel (2002) are also supported by Goodwin and Harper (2000). They noted that in imperfectly competitive markets, asymmetries in adjustment costs and price leaderships roles exhibited by major buyers or sellers give rise to asymmetric price adjustments. Kinnucan and Forker (1987) noted that in addition to these reasons, asymmetric price adjustments may arise as a result of government intervention through price floors (price supports) and marketing quotas aimed at price stabilization and the adoption of a new pricing strategy.

METHODOLOGY

The study made use of the quarterly prices of cattle from the National Bureau of Statistics (2018) to determine volatility and integration of cattle markets in Nigeria. Data of cattle prices from ten selected states, two each from five geopolitical zones of Nigeria, using a time frame of 16 years (2002-2017), were used for the analysis. One geo-political zone (south-east) was not included due to unavailable data since it is neither a major rearing or nor a major producing zone. A total of ten states were selected randomly by balloting.

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Unit Root or Stationarity Test

The two well-known stationarity tests in literature are the Augmented Dickey-Fuller (ADF) test (Dickey and Fuller, 1979), and the Phillips-Perron (PP) test (Perron, 1988).

The Phillips-Perron (PP) test is a non-parametric alternative to the Augmented Dickey-Fuller unit root test. Phillips and Perron developed a test that is robust to the departure of the stochastic error term from the independently and identically distributed (iid) assumption. Unlike the ADF test, which added lagged difference terms of the dependent variable to the test regression in order to address the possible serial correlation problem; the PP test employs non-parametric methods without the necessity of having a more overparameterized test regression.

For the purpose of this work, the ADF (Augmented Dickey-Fuller) test was used due to its simplicity and ease of interpretation of results. The test was conducted on the level and first differences of price series to obtain results at I(0) and I(1) orders respectively. The following ADF regression equation was used to test for stationarity:

$$\Delta Y_{it} = \beta_1 + \beta_2 t + \delta Y_{it-1} + \alpha_i \sum_{i=1}^{m} \Delta Y_{it-1} + \varepsilon_t \text{ ------------------ } 1.1$$

Where; β_1 is a constant, β_2 is the coefficient on a time trend;

δ is parameter that signifies the presence or absence of unit root;

Y_{it} is a vector to be tested for co-integration, that is the price of cattle in the ith market;
t is the time or trend variable; i=1, 2, 3, …,n (ith market) $\Delta Y_t = Y_t - Y_{t-1}$; ---------------- ---------------------------- 1.2
Y_t is the price time series; Δ is the first difference operator;

Y_{t-1} is the lagged value of the price series; α_i is the coefficients of the lagged values of Y_{t-1}; and ε_t is a pure white noise error term; and m is the lag order.

The null hypothesis that δ=0 (signifying unit root) is tested against the alternative that δ< 0 (which signifies that the time series is stationary). The price series for all the selected states were tested for their order of integration. The optimal lag length for each of the price series was selected using the Akaike Information Criterion (AIC). The AIC is a measure of the goodness of fit of an estimated statistical model.

A proiri Expectation

It is expected *a priori* that the null hypothesis of the presence of unit root would be rejected while the alternative would be accepted.

Price transmission

The price series of cattle were tested for asymmetric/symmetric transmission through the Threshold Vector Error Correction Model (TVECM). Several authors (Goodwin and Holt (1998), Goodwin and Harper (2000), Goodwin and Piggott (2001), Vavra and Goodwin (2005), Goodwin and Vavra (2009), Liu (2011) and Bor and Tuncay (2015) are of the opinion that the use of TVECM (threshold adjustment) to measure price transmission is crucial because it is non-linear and ensures that movement towards the long-run equilibrium would only take place when the divergence from equilibrium exceeds a certain threshold. They further explained that these threshold effects occur when larger shocks (ie shocks above some threshold) bring about a different response than do smaller shocks. Goodwin and Piggott added that threshold was introduced in to the auto regressive model to take care of transaction costs which is neglected by the linear model.

Asymmetric price transmission can be positive or negative depending on magnitude and speed of transmission. If, in the supply chain, the retail price reacts more fully or rapidly to an increase in farm price than to a decrease, the asymmetry is positive. If the retail price reacts more fully or rapidly to a decrease in farm price than to an increase, the asymmetry is negative (Peltzman, 2000). However, it is believed that increase in farm prices are rapidly transmitted to output (consumer) prices (than similar reductions), especially in agricultural markets where product has to move from farmer to consumer (Rajendran, 2015).

An important issue in the empirical application of price transmission is to test for linear (symmetric) transmission through the Vector Error Correction Model (VECM) and/against the non-linear (asymmetric) transmission through the Threshold Error Correction Model (TECM). This will establish whether the prices are transmitted symmetrically, by following a simple (theoretically) defined straight chain (LOP) or asymmetrically, by following an undefined chain of transmission.

Consider a co-integration relationship representing an economic equilibrium: $y_{1t} - \beta_1 y_{2t} - \beta_2 y_{3t} - \ldots \beta_k y_{kt} = v_t$ -------------------------- 1.3
Where $v_t = pv_{t-1}+\varepsilon_t$, is the autoregressive process of the kth order, n=1,2,3,…k; y_{it} is the co-integration variables (prices of cattle); $\beta_1 \ldots \beta_k$ are parameters to be estimated; p measures co-integration of the y_{it} variables.

Then, co-integration of the y_{it} variables will depend upon the nature of the auto regressive process for v_t. As p approaches one, deviations from the equilibrium become nonstationary and thus the y_{it} variables are not co-integrated. This linear auto regressive model has the limitation of inhibiting asymmetric responses to shocks, thus, Tong (1978) introduced the concept of non-linear threshold models which was applied to simple, univariate auto regressive models. This framework is further extended by Balke and Fomby (1997) to a case where v_t follows a threshold auto regression, which involved specification of an auto regressive model for the error correction term, written as:

$$p = \begin{cases} p^{(1)} \ \ if\ |v_{t-1}| \leq c \\ p^{(2)} \ \ if\ |v_{t-1}| > c \end{cases} \qquad \text{----------------------------- 1.4}$$

Where c is the threshold which delineates alternative regimes. A common case is that of $p^{(1)} = 1$, which implies that the relationship for small deviations from equilibrium is characterized by a random walk that is absence of co-integration. The work of Balke and Fomby (1997) which was further extended, modified and applied by Goodwin and Holt (1998), Goodwin and Harper (2000), Goodwin and Piggott (2001), Vavra and Goodwin (2005) and Goodwin and Vavra (2009) to form the Threshold Error Correction Model, was applied to this data.

An equivalent vector error correction representation of the threshold model can be written as:

$$\Delta y_t = \{ \quad \sum_{pi=1} \gamma(1)\, \Delta y_{t-i} + \theta(1) v_{t-1} + t(1) \ \ if\ |v_{t-1}| \leq c \qquad \text{-------------------- 1.5}$$

$$\sum_{i=1}^{p} \gamma_{(2)}\Delta y_{t-i} + \theta_{(2)}v_{t-1} + {}_{t(2)} \quad if|v_{t-1}| > c$$

Where ε_t is a mean zero residual; Δ is the difference operator;

γ_1 and γ_2 give the speed of adjustment;

Δy_t gives the long-run equilibrium;

$|v_{t-1}| \leq c$ defines the threshold and c is the threshold value. If $\gamma_1 < 0$ and $\gamma_2 < 0$, then cointegration exists. If $\gamma_1 = \gamma_2$ transmission is symmetric, if otherwise asymmetric. The analysis is started by first determining the lag orders in the TECM using the AIC criterion (as estimated in equation 1.1 above).

According to Vavra and Goodwin (2005) a two-dimensional grid search is then conducted to define thresholds. This involves defining the first thresholds between 1% and 99% of the largest negative (in absolute values) and the positive error correction terms which explains the percentage adjustment to equilibrium. The positive and negative threshold values represent deviations from the equilibrium relationships in the cattle prices. Asymmetric adjustment is said to occur if the positive and negative deviations exceed the threshold value while no adjustment occurs if the threshold value falls within the positive and negative deviations.

RESULTS AND DISCUSSION

Test of Stationarity

Quarterly cattle prices from first quarter 2002 to fourth quarter 2017 (a total of 68 observations) were used for the analysis. The result for test of stationarity in the cattle price series for Borno (BO), Cross-River (CR), Edo (ED), Kano (KN), Nassarawa (NS), Osun (OS), Oyo (OY), Plateau (PL), Yobe (YB) and Zamfara (ZM) is presented in Table 1.

Table 1: ADF unit root test results for cattle prices

Markets	0 level			1st level		
	ADF	Critical value	Remark	ADF	Critical value	Remark
Borno	-2.381129	-2.90766	Non-stationary	-7.619265***	-2.90842	Stationary
CrossRiver	-2.223833	-2.90766	Non-stationary	-3.708674***	-2.915522	Stationary
Edo	-2.221536	-2.90766	Non-stationary	-7.412621***	-2.90842	Stationary
Kano	-2.347207	-2.90766	Non-stationary	-8.034363***	-2.90842	Stationary

Nassarawa	-2.303043	-2.90766	Non-stationary	-7.714622***	-2.90842	Stationary
Osun	-2.145211	-2.90766	Non-stationary	-7.11486***	-2.90842	Stationary
Oyo	-2.664023	-2.90766	Non-stationary	-7.741753***	-2.90842	Stationary
Plateau	-2.32984	-2.90766	Non-stationary	-4.373243***	-2.912631	Stationary
Yobe	-2.215243	-2.90766	Non-stationary	-8.305384***	-2.90842	Stationary
Zamfara	-2.328488	-2.90766	Non-stationary	-4.370702***	-2.912631	Stationary

Note: *** indicates that unit root in the first differences were rejected at 1% significance levels. Source: Computed from cattle price data series, 2002-2017 (NBS, 2018).

The tests were applied with and without drift at level and first differences. The ADF test showed that the null hypothesis was rejected at first differences because the absolute values of the ADF statistics were greater than the critical values at 5 percent level of significance. This implies that the price series have achieved stationarity (absence of unit root) and are integrated of order one (I,1), and therefore, the series were further tested for symmetric/asymmetric transmission through the TVVECM.

Threshold Vector Error Correction Model (TVECM)

The result for price asymmetry transmission is presented on Table 2. Full result of the TVECM which includes the threshold values for each state and their corresponding Phi (φ) values are all presented in the Appendix.

Table: 2. Threshold Vector Error Correction (TVECM) Result

Market	Variable	Coefficient	Std. Error	T-value
Borno	Above Threshold	-0.9499	0.3048	-3.1***
	Below Threshold	-1.3325	0.3267	-4.1***
Cross river	Above Threshold	-0.9362	0.2313	-4.0***
	Below Threshold	-0.5063	0.1556	-3.3***
Edo	Above Threshold	-0.2437	0.1379	-1.8
	Below Threshold	-0.3737	0.2652	-1.4
Kano	Above Threshold	-0.5604	0.2187	-2.6**

	Below Threshold	-0.2489	0.2159	-1.2
Nassarawa	Above Threshold	-1.1204	0.2912	-3.8***
	Below Threshold	-0.6041	0.2038	-3.0***
Osun	Above Threshold	-0.7075	0.2111	-3.4***
	Below Threshold	-0.2727	0.1584	-1.7
Oyo	Above Threshold	-0.3031	0.2399	-1.3
	Below Threshold	-0.7449	0.2475	-3.0***
Plateau	Above Threshold	-1.4783	0.3138	-4.7***
	Below Threshold	-1.0372	0.2043	-5.1***
Yobe	Above Threshold	-0.7036	0.2511	-2.8***
	Below Threshold	-0.4963	0.1810	-2.7***
Zamfara	Above Threshold	-0.7036	0.2511	-2.8***
	Below Threshold	-0.4963	0.1810	-2.7***

Note: ** &*** are significant at 1% and 5% respectively
above threshold values = positive deviations = $\gamma 1$;
below threshold values = negative deviations = $\gamma 2$
Source: Computed from time series data, 2002-2017. (NBS, 2018)

It should be recalled that adjustment to equilibrium will occur under two conditions; if above threshold values (positive deviations) = $\gamma 1$ are not equal to below threshold values (negative deviations) = $\gamma 2$, then transmission is asymmetric, otherwise transmission is symmetric; and if the deviations exceed a specific positive and negative threshold level, adjustment is asymmetric while no adjustment occurs if the threshold value falls within the positive and negative threshold values.

The result on Table 2 showed that all the upper threshold values are not equal to all the lower threshold values for all the respective state prices. This indicates the presence of asymmetric price transmission in the whole system, which may not help the marketers because middlemen/agents possess the market power of setting prices that may be exploitative on the marketers. This type of situation leads to lack of competition and integration of the markets.

Table 2 also showed that positive and negative deviations for eight states (Borno, Cross River, Edo, Nassarawa, Osun, Plateau, Yobe and Zamfara) exceeded their respective threshold values. This showed price changes along the chain (from farmer/marketer to consumer) is greater than the market costs of handling cattle and agents will be in a greater position to implement price changes before transmission takes place. This indicates asymmetric price transmission since price changes move from bottom of the chain to the top.

The threshold values for Kano and Oyo fell in the interval between the positive and negative threshold values. This showed price changes were implemented by the cattle owners/marketers (at the top) and not the agents who are towards the bottom of the chain, suggesting the presence of symmetric price transmission in the prices of Kano and Oyo. The presence of symmetry in the prices of Kano and Oyo indicates the presence of competition in the two markets since it is assumed that symmetric price transmission usually arise from competitive markets.

It can be seen on Table 2 that the above and below threshold values for Borno, Cross River, Nassarawa, Plateau, Yobe and Zamfara and the above threshold values for Kano and Osun, and the below threshold value for Oyo were statistically significant at one percent except the above threshold value for Kano which was significant at five percent, hence rejection of the null hypothesis of no price asymmetry. The two threshold values for Edo, the lower threshold value for Kano and Osun, and the upper threshold values for Oyo were statistically insignificant, implying the acceptance of the null hypothesis of no price asymmetry. This indicates poor or incomplete price transmission from these states to the other states which implies inefficiency in the pricing system of cattle markets. This suggests Edo prices may not influence price transmission in the system.

The presence of price asymmetric transmission means change in price in one market is not quickly and fully transmitted to the other market. Also the presence of asymmetry is not favourable to the marketers, as it implies that prices are formed and controlled by middlemen towards the end of the chain and passed on to the marketers. This will therefore, distort the marketers marketing decisions and may subsequently prevent them from investing more in the marketing of cattle, leading to lack of competition in the markets and inefficiency in the marketing system.

CONCLUSION

The study concludes that price transmission in the Nigerian cattle market was asymmetric. This indicates that prices are formed and controlled by middlemen leading to lack of competition and inefficiency in the marketing system.

RECOMMENDATION

1. In order to ensure efficient price transmission and efficient pricing system in the markets, Government should improve on the deplorable conditions of roads in order to reduce loss of cattle due to accidents, robbery, clashes and stress. The loss of cattle due to these reasons and the high cost of transportation linked to bad roads can also be reduced with the rehabilitation of major railways that link the north and south. Also railways are cheaper and cattle are not subjected to so much stress as in road transportation. The loss of cattle through bad roads affects the price as well as supply decisions of the marketers/transporters.
2. Since lack of proper information dissemination is one of the reasons for asymmetric price transmission in the prices of cattle, there is need to improve on the market information system in the country so that information will flow to all the markets. This can be achieved in one way by the farmers forming an association whose major objective would be processing and dissemination of information. The other way to improve cattle price formation flow is by the intervention of the government by providing price information control centres/offices in all major cattle markets in the country.

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APPENDIX

Endogenous variables: BOR CROS EDO KANO NASS OSUN OYO PLAT YOBE ZAM
Exogenous variable(s): None
Method: Threshold (tau is determined by data)
Lags (defined by user): 4
Date: 04/14/18 Time: 08:45
Sample (adjusted): 2003Q2 2017Q4
Included observations: 59 after adjustments

Variable	Coefficient	Std. Error
Above Threshold	-0.949921	0.304782
Below Threshold	-1.332517	0.326686
Differenced Residuals(t-1)	0.294049	0.247409
Differenced Residuals(t-2)	0.261491	0.211493
Differenced Residuals(t-3)	0.164553	0.178223
Differenced Residuals(t-4)	-0.027786	0.136119
Threshold value (tau):	0.166378	

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F-equal:	1.911181	(4.623947)*
T-max value:	-3.116727	(-4.104034)*
F-joint (Phi):	8.606730	(13.917665)*

*Simulated critical values for 5% significance level.
Number of simulations: 1000
Elapsed simulation time: 0 hours 1 minutes 15 seconds.*

Endogenous variables: CROS
BOR EDO KANO NASS OSUN
OYO PLAT YOBE ZAM
Exogenous variable(s): None
Method: Threshold (tau is determined by data)
Lags (defined by user): 4
Date: 04/14/18 Time: 08:52
Sample (adjusted): 2003Q2 2017Q4
Included observations: 59 after adjustments

Variable	Coefficient	Std. Error
Above Threshold	-0.936188	0.231258
Below Threshold	-0.506335	0.155600
Differenced Residuals(t-1)	0.205998	0.150260
Differenced Residuals(t-2)	0.265279	0.140120
Differenced Residuals(t-3)	0.119556	0.137902
Differenced Residuals(t-4)	0.319871	0.126688
Threshold value (tau):	0.277166	
F-equal:	3.283620	(4.787692)*
T-max value:	-3.254072	(-4.063355)*
F-joint (Phi):	10.497750	(14.079785)*

*Simulated critical values for 5% significance level.
Number of simulations: 1000
Elapsed simulation time: 0 hours 1 minutes 14 seconds.*

Endogenous variables: EDO
BOR CROS KANO NASS
OSUN OYO PLAT YOBE
ZAM
Exogenous variable(s): None
Method: Threshold (tau is determined by data)
Lags (defined by user): 4
Date: 04/14/18 Time: 08:55
Sample (adjusted): 2003Q2 2017Q4
Included observations: 59 after adjustments

Variable	Coefficient	Std. Error
Above Threshold	-	
Below Threshold	-0.243718	0.137942
Differenced Residuals(t-1)	-0.373723	0.265200
Differenced Residuals(t-2)	-0.255314	0.169031
Differenced Residuals(t-3)	-0.198408	0.176982
Differenced Residuals(t-4)	-0.024159	0.170062
Threshold value (tau):	0.003841	0.150953
-		
F-equal:		
T-max value:	-0.241519	
F-joint (Phi):	0.221795	(4.777688)*
	1.409213	(-4.077611)*
	2.176433	(13.743975)*

**Simulated critical values for 5% significance level.
Number of simulations: 1000
Elapsed simulation time: 0 hours 1 minutes 14 seconds.*

Endogenous variables: KANO BOR
CROS EDO NASS OSUN
OYO PLAT YOBE ZAM

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Exogenous variable(s): None
Method: Threshold (tau is determined by data)
Lags (defined by user): 4
Date: 04/14/18 Time: 08:59
Sample (adjusted): 2003Q2 2017Q4
Included observations: 59 after adjustments

Variable	Coefficient	Std. Error
Above Threshold	-0.560386	0.218721
Below Threshold	-0.248919	0.215936
Differenced Residuals(t-1)	0.121489	0.204392
Differenced Residuals(t-2)	0.063057	0.188978
Differenced Residuals(t-3)	-0.030569	0.176753
Differenced Residuals(t-4)	0.157978	0.168112
Threshold value (tau):	0.299861	
F-equal:	2.092594	(4.555748)*
T-max value:	-1.152745	(-4.076242)*
F-joint (Phi):	3.297821	(13.976670)*

**Simulated critical values for 5% significance level.*
Number of simulations: 1000
Elapsed simulation time: 0 hours 1 minutes 17 seconds.

Endogenous variables:
NASS BOR CROS EDO
KANO OSUN
OYO PLAT YOBE ZAM
Exogenous variable(s): None
Method: Threshold (tau is determined by data)
Lags (defined by user): 4
Date: 04/14/18 Time: 09:02
Sample (adjusted): 2003Q2 2017Q4
Included observations: 59 after adjustments

Variable	Coefficient	Std. Error
Above Threshold	-1.120409	0.291173
Below Threshold	-0.604143	0.203753
Differenced Residuals(t-1)	0.352372	0.196929
Differenced Residuals(t-2)	0.373657	0.151741
Differenced Residuals(t-3)	-0.151414	0.147922
Differenced Residuals(t-4)	0.111450	0.136588
Threshold value (tau):	0.236365	
F-equal:	4.775144	(4.885915)*
T-max value:	-2.965071	(-4.161463)*
F-joint (Phi):	7.759872	(14.617120)*

**Simulated critical values for 5% significance level.*
Number of simulations: 1000
Elapsed simulation time: 0 hours 1 minutes 19 seconds.

Endogenous variables: OSUN BOR
CROS EDO KANO NASS OYO
PLAT YOBE ZAM
Exogenous variable(s):
None
Method: Threshold (tau is determined by data)
Lags (defined by user): 4
Date: 04/14/18 Time: 09:04
Sample (adjusted): 2003Q2 2017Q4
Included observations: 59 after adjustments

Variable	Coefficient	Std. Error
Above Threshold	-0.707507	0.211143

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Below Threshold	-0.272701	0.158405
Differenced Residuals(t-1)	0.057284	0.160590
Differenced Residuals(t-2)	0.030312	0.152038
Differenced Residuals(t-3)	-0.073460	0.144955
Differenced Residuals(t-4)	0.125392	0.135976

Threshold value (tau):	0.203103	
F-equal:	3.704114	(4.696281)*
T-max value:	-1.721544	(-4.109037)*
F-joint (Phi):	5.950760	(14.411460)*

**Simulated critical values for 5% significance level.*
Number of simulations: 1000
Elapsed simulation time: 0 hours 1 minutes 15 seconds.

Endogenous variables:
OYO BOR CROS EDO
KANO NASS
OSUN PLAT YOBE ZAM
Exogenous variable(s): None
Method: Threshold (tau is determined by data)
Lags (defined by user): 4
Date: 04/14/18 Time: 09:06
Sample (adjusted): 2003Q2 2017Q4
Included observations: 59 after adjustments

Variable	Coefficient	Std. Error
Above Threshold	-0.303147	0.239912
Below Threshold	-0.744945	0.247496
Differenced Residuals(t-1)	-0.137556	0.202092
Differenced Residuals(t-2)	-0.212513	0.186767
Differenced Residuals(t-3)	-0.025572	0.163914
Differenced Residuals(t-4)	-0.064059	0.134267

Threshold value (tau):	-0.365080	
F-equal:	2.933192	(4.782998)*
T-max value:	-1.263577	(-4.061793)*
F-joint (Phi):	4.532160	(13.675335)*

**Simulated critical values for 5% significance level.*
Number of simulations: 1000
Elapsed simulation time: 0 hours 1 minutes 19 seconds.

Endogenous variables:
PLAT BOR CROS EDO
KANO NASS
OSUN OYO YOBE ZAM
Exogenous variable(s): None
Method: Threshold (tau is determined by data)
Lags (defined by user): 4
Date: 04/14/18 Time: 09:08
Sample (adjusted): 2003Q2 2017Q4
Included observations: 59 after adjustments

Above Threshold	-1.478311	0.313849	-4.710267
Below Threshold	-1.037220	0.204302	15.390600
Differenced Residuals(t-1)	0.575074	0.189685	
Differenced Residuals(t-2)	0.531173	0.169109	
Differenced Residuals(t-3)	0.426044	0.156897	
Differenced Residuals(t-4)	0.349345	0.138418	

Threshold value (tau): 0.343859

F-equal: 2.863695 (5.009810)*
Variable Coefficient Std. Error T-max value: (-4.173240)*
F-joint (Phi): (14.607260)*

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**Simulated critical values for 5% significance level.*
Number of simulations: 1000
Elapsed simulation time: 0 hours 1 minutes 21 seconds.

Endogenous variables: YOBE BOR CROS EDO KANO NASS OSUN OYO PLAT ZAM
Exogenous variable(s): None
Method: Threshold (tau is determined by data)
Lags (defined by user): 4
Date: 04/14/18 Time: 09:10
Sample (adjusted): 2003Q2 2017Q4
Included observations: 59 after adjustments

Variable	Coefficient	Std. Error
Above Threshold	-0.703630	0.251144
Below Threshold	-0.496272	0.180982
Differenced Residuals(t-1)	0.112394	0.170322
Differenced Residuals(t-2)	0.156005	0.157836
Differenced Residuals(t-3)	0.074509	0.152556
Differenced Residuals(t-4)	0.140871	0.140430
Threshold value (tau):	0.268220	
F-equal:	0.631289	(4.868097)*
T-max value:	-2.742112	(-4.089392)*
F-joint (Phi):	5.889428	(13.868665)*

**Simulated critical values for 5% significance level.*
Number of simulations: 1000
Elapsed simulation time: 0 hours 1 minutes 16 seconds.

Endogenous variables: ZAM BOR CROS EDO KANO NASS OSUN OYO PLAT YOBE
Exogenous variable(s): None
Method: Threshold (tau is determined by data)
Lags (defined by user): 4
Date: 04/14/18 Time: 09:12
Sample (adjusted): 2003Q2 2017Q4
Included observations: 59 after adjustments

Variable	Coefficient	Std. Error
Above Threshold	-1.261088	0.321205
Below Threshold	-0.945563	0.232513
Differenced Residuals(t-1)	0.519656	0.207913
Differenced Residuals(t-2)	0.450418	0.190860
Differenced Residuals(t-3)	0.151530	0.171207
Differenced Residuals(t-4)	0.221104	0.150251
Threshold value (tau):	0.179405	
F-equal:	1.535570	(4.493523)*
T-max value:	-3.926115	(-4.148524)*
F-joint (Phi):	9.880248	(14.064460)*

**Simulated critical values for 5% significance level.*
Number of simulations: 1000
Elapsed simulation time: 0 hours 1 minutes 12 seconds.