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EFFECT OF TRANSACTION COST ON MARKET INTEGRATION OF COWPEA BETWEEN KANO AND ABIA, IMO AND ENUGU STATES, NIGERIA

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ABSTRACT

*The study analyzed the effect transaction cost has on market integration. The study used secondary data of cowpea monthly price obtained from National Bureau of Statistic (NBS) (2016-2018). It looked at the effect of transaction cost on market integration in the study area. It used Threshold Autoregressive error correction model (TAR) to realize the objective. It was ascertained that transaction cost had effect on market integration. The effect of transaction cost was determined by the market asymmetry of prices between the source and destination market prices of cowpea; with the threshold value of 0.929, 1.011 and 1.327 respectively for Abia, Imo and Enugu States. The result indicated evidence of nonlinearity in the error correction and long-run asymmetry (asymmetry in the speed of adjustment) and a well distribution of observation in the `IN` regime: variation of values smaller than the threshold θ, that is, it is inside threshold interval, 38.5, 38.5 and 46.2%) as well as the OUT regime: deviation of values outside the threshold, 61.5, 61.5and 53.8 %)***.** *The study therefore, recommended that policies that improve infrastructural development (good road network) should be encouraged to reduce effect of transaction cost on market integration.*

Keywords: Market, transaction cost, price, asymmetry and nonlinearity

INTRODUCTION

Transaction cost affects farmers' decision choices of distribution between alternative marketing options of their produce as reported by Mabuza *et al.,* 2014; and Siddique *et al.,* 2017. Marketing ensures that goods and services get to the hands of final consumers, providing utility to the consumers. It is a medium that brings different actors in the chain together with the aim of earning profit as a means of livelihood. The basis of market integration involves the concepts of spatial arbitrage and the Law of One Price (LOP). The LOP states that regional markets that are linked by trade and arbitrage will have a common, and unique price except for a transaction costs difference. It gives rise to a specific set of price relationships at a particular point in time, which in turn gives rise to a high degree of price integration over time.

However, the process of arbitrage (market integration) involves other costs, other than the purchasing cost. These other costs include communication cost, bargaining cost and many more, collectively referred to as transaction cost. Transaction costs are defined as costs incurred in the process of an exchange and are categorized into fixed and variable transaction costs (Offor, 2023). Fixed transaction costs are invariant to the volume of output traded and may include the costs of searching for a partner, screening potential trading partner, bargaining with potential trading partner, monitoring the agreement, and enforcing the exchange agreement.

The distribution (marketing) of beans in Nigeria involves a process where the produce is transported through a long-distance dues to the geographical and natural endowment of different regions in the country. The production regions are the north, serving as the source markets, while the consumption regions are the South - South, South -West and South- East, serving as the destination markets. In the course of moving the produce from production center to consumption centers, transaction cost are incurred, the higher the transaction cost, the lower the trade flow. Hence, understanding price behavior of produce is very useful to assess the production, distribution and the effect of transaction cost on integration or price transmission level (Limon *et al* ,2020). Testing for non-linear behaviour of price asymmetries and adjustment in the short- and long-run, based on the identified price leader, for instance in the wholesale (source market) and retail (destination markets) of cowpea (beans) is a primary focus of the work. Retail prices respond faster when source market price increases than when it falls. This is the so-called `rocket and feather` principle in the literature on price transmission in the vertical markets. Studies on market integration analysis were based on price data alone often neglecting the role of transaction costs in determining the direction of trade flow. The direction of trade flow indicates the price leadership role between markets in question which shows the upstream and downstream prices of produce. In attempt to address some of these issues, the study modified the TAR model in a way that transmission mechanisms could vary, but their model can only handle two regimes (one threshold). However, the challenges were addressed by modifying TAR models to allow for multiple trade regimes (multiple thresholds validity is primarily established on a single threshold (two regime) model.

METHODOLOGY

The study used Kano State as the production State, while Abia Enugu and Imo States are the consumption centers. Kano State is located in the Northern part of Nigeria while Abia, Enugu and Imo States are located in the South Eastern part of Nigeria. The study used secondary data. These were monthly prices data of cowpea from January 2016 to February 2018 obtained from National Bureau of Statistics (NBS). A test of co-integration was conducted, it was established that prices of the different markets are co-integrated thus tested the effect of transaction cost on market integration. The major objective of the study was to estimate the effect of transaction cost on market integration using Threshold Autoregressive error correction model (TAR) used by Mayaka, (2013).

A spatial market equilibrium relationship is given as:

$P_t^A = \beta_{0i} + \beta_{1i} P_t^B + \beta_{2i} K_t + \mu_{it}$ ….(1)

Where,

P_t^A = commodity price in the source market (A)

P_t^B = commodity price for the destination market (B),

β_{0i} is the constant,

β_{1i} = long run equilibrium relationship between cowpea prices in the two markets A and B,

K_t = the transaction cost

β_{2i} is the long run relationship between cowpea prices in the source market (A) and the transaction cost

μ_{it} = error term.

Markets A and B will attain perfect spatial arbitrage condition when, (1) β_1 equate to one (β_1 =1), (2) β_2 equate to one (β_2 =1) and (3) the constant (β_0 =0) (Burke, 2012).

The researcher also followed Myers and Jayne (2012) and Burke (2012) to extend the equation above into a Single Equation Error Correction Model (SEECM) framework shown as follow:

$$\Delta P_t^A = \mu_i + \beta_{0i} + \beta_{1i}\Delta P_t^B + \beta_{2i}\Delta K_t + \lambda_i\left(P_{t-1}^A - \beta_{1i}P_{t-1}^B - \beta_{2i}K_{t-1}\right) + \theta_{1i}P_{t-1}^B + \theta_{2i}K_{t-1} + \sum_{j=1}^{n} b_{ji}\left(\Delta P_{t-j}^A - \beta_{1i}\Delta P_{t-j}^B - \beta_{2i}\Delta K_{t-j}\right) + \rho_{1i}\Delta P_t^B + \sum_{j=1}^{n} c_{ji}\left(\Delta P_{t-j}^B\right) + \rho_{2i}\Delta K_t + \sum_{j=1}^{n} d_{ji}\,\Delta K_{t-j} + \mu_{it} \text{...(2)}$$

In order to allow for the estimation of the speed of price transmission (λ). All other variables remained as defined in equation (1), but θ_1, θ_2, b_i, d_i, ρ_1, and ρ_2 are parameters to be estimated.

The model is flexible and can take various forms, depending on the stochastic properties of the underlying data. The same model was employed for the destination market price equation. The source market locations considered in the study is: Kano State, while the destination markets considered in the study were: Abia, Imo, and Enugu States.

The empirical model was explained using Meyers (2002) argument, which States that, spatial competitive behavior can be presented as shown in equations 3, 4. and 5 based on spatial arbitrage

$P_{it} - P_{jt} < C$ if $q = 0$ (regime 1)…(3.)

$P_{it} - P_{jt} < C$ if $q > 0$ (regime 2)…(4.)

$P_{it} - P_{jt} < C$ if $q < 0$ (regime 3)…(5.)

P_{it} was the price in source market *i* at time *t*; where *i* represents Kano State,

P_{jt} was the price in destination market *j* at time *t*; where *j* represents 1= Abia State, 2 = Imo State, and 3= Enugu State.

q was the quantity of commodity traded between the markets in two-way direction;

If $q > 0$ amount of commodity traded from market *i* (source market) to *j* (destination market)

If $q < 0$ amount of commodity traded from market *j* (destination market) to (source market), and

c was the marginal transfer cost and it was assumed symmetric irrespective of the direction of trade flow.

The first regime (equation 3) occurs when there is no trade between markets; hence the absolute value of the price spread should be less than transfer cost. The second regime (equation 4) implies that if trade flows from *i* to *j*, then the price in market *j* should be equal to the price in market *i* plus transfer cost. The third regime (equation 5) indicates that if trade flows from *j* to *i*, then the price in *i* market should be equal to the price in *j* plus the transfer cost. The above regimes were tested using the Threshold Autoregressive Error Correction Time Series

Statistical Model since it allowed for deviations from the efficiency conditions to occur both in short and long run. Following Meyers (2008), the Threshold Autoregressive Error Correction Time Series Statistical Model was presented as shown in equation (6).

$$\Delta d_t = \varphi + \beta_0 d_{t-1} + \sum_{k-1}^{k} \binom{n}{k} x^k a^{n-k} \ldots (6)$$

More so variants of TAR models have been applied in several empirical studies including, Enders and Siklos (2001), Hansen (2002). The Enders and Siklos (2001) approach is particular which is a single threshold model estimate procedure, was applied by adding a Heaviside indicator function (*IItt*) directly into the Engle Granger (1987) residual regression equation
estimated as (Mann, 2012):

Δ*εεtt*=*ρρ*1*IIttεεεtt*−1+*ρρ*2(1−*IItt*) *εεtt*−1+*μμtt* (7)
where *IItt* is the Heaviside indicator function given as: *IItt*=□1 *iiii*|*qqtt*−1|>*ττ*0 *iiii*|*qqtt*−1|≤*ττ*
and *εεtt* is the mean zero residuals from the co-integrating equation, *μμtt* is the constant. Furthermore, the study used the bootstrapping approach. The method by Hansen (1999) uses a bootstrap procedure to test for thresholds. Unlike Tsay (1989) and Chan (1993), this method aims at identifying the number of thresholds (*n*) *i.e.* regimes, as opposed to locating the actual values (*μμ*) (Mann, 2012). Given a sample of *x* observations, Hansen's (1999) test uses linear regression in a sequential threshold estimation procedure, to select the number of regimes (*n*). Step 1 tests the null hypothesis of a linear model (*n*=0) against the alternative hypothesis of two regime model (*n*=1). If the null hypothesis is rejected, the procedure is repeated to test for 3 regimes (n=2) model, which equals 2 thresholds (*μμ*). The procedure continues with an addition of a potential threshold (*n*) in every subsequent test until the first rejection of the null hypothesis of (*n+1*) regimes. The decision of whether a threshold is significant or not is based on an F-statistic. However, since the distribution of the F-statistic is non-standard due to problems associated with nuisance parameters (Mann, 2012), Hansen (1999) employs the Hansen (1996) bootstrap procedure to determine the significance of the F test. The final decision therefore is based on the *p* value of the F-statistic

RESULTS AND DISCUSSION

Hypotheses tests for the source market (Kano) and the destination markets (Abia, Imo and Enugu)

(a)Kano- Abia market prices of cowpea:
In the destination market (Abia State) price, the study rejected the null of $P_1 = P_2 = 0$, implying that the source market (Kano State) and destination market (Abia State) prices of cowpea were cointegrated. The F-statistics is found to be 15.468 and significant at 1 %. The study found the signs of estimates P_1 and P_2 consistent and significant at 1 % level. The model converges as both estimates of P_1 and P_2 were negative. Estimates of the adjustment speed were $P_1 = -0.359$ and $P_2 = -0.440$ were negative and significant at 1 % level, suggesting model convergence. However, it could not reject the null H: $P_1 = P_2 = 0$ of long-term symmetry.

Table 1: Threshold vector error correction estimates and hypotheses tests for the source market (Kano) and the destination markets (Abia, Imo and Enugu)

Model parameters/ Hypotheses tests/ Model diagnostics	**Chain 1: KAP(c) -ABP(c)**		**Chain 2: KAP(c) -IMP(c)**		**Chain 3: KAP(c) -ENP(c)**	
	KAP(c)	ABP(c)	KAP(c)	IMP(c)	KAP(c)	ENP(c)
P_1 (Regime 1)	-0.359** (-2.190)	-0.635*** (-7.808)	-0.291*** (-5.269)	-0.463*** (-4.913)	-0.299** (2.348)	-0.737*** (-12.802)
P_2 (Regime 2)	-0.440*** (-5.954)	-0.478*** (-4.698)	-0.458*** (-6.846)	-0.320** (2.431)	-0.366*** (-4.349)	-0.592*** (-8.196)
No. of lags and deterministic terms included in the model	l=2;Constant	l=1;Constant	l=2;Constant	l=3;Constant	l=2;Constant	l=2;Constant
AIC	3.903	3.477	2.379	2.395	3.682	3.106
BIC	3.957	3.549	2.403	2.411	3.777	3.248
Hypothesis tests						
ϕ_μ:Cointegration H_0: $P_1 = P_2 = 0$	15.468***	16.189***	15.741***	16.758***	13.493***	15.279***
Critical Values (5%)	6.01	6.28	5.98	5.98	5.98	5.98
Long-term symmetry (H_0: $P_1 = P_2$)	8.445*** (0.000)	12.638** * (0.000)	9.529*** (0.000)	7.302*** (0.001)	8.877*** (0.000)	13.999*** (0.000)
Model diagnostics						
LM test	1.698(0.742)	0.659(0.664)	1.365(0.281)	1.436(0.263)	2.497(0.114)	0.282(0.231)
ARCH Test	0.070(0.933)	0.962((1.365)	0.010(0.990)	0.972(0.396)	0.393(0.681)	0.207(0.658)
Stability test						
CUSUM of squares test	Stable	Stable	Stable	Stable	Stable	Stable
Recursive coefficients	Inside ±2S.E	Inside ±2S.E	Inside ±2S.E	Inside ±2S.E	Inside ±2S.E	Inside ±2S.E

Note: Parentheses indicate the number of selected lags; ***, **, and * mean significant at 1%, 5%, and 10%, respectively. Critical values are from Enders and Siklos (2001).

The estimated F-statistics is 8.445 and significant at 1% level of significance, suggesting that the two speed of adjustments were statistically different. This is the resultant effect of transaction cost inclusion in the price of cowpea being offered to consumers at the destination market. The study found similar results – Kano and Abia States market prices of cowpea were cointegrated when it estimated Kano market price of cowpea with respect to Abia State market price of cowpea. The estimates of the speed of adjustment P_1 = -0.635 and P_2= -0.478 were significant at 1 % level. The model converges as the sign of both parameters were negative. The study could not reject the null of cointegration $P_1 = P_2 = 0$ by Φ at 1 % significant level. The test statistics was found to be 16.189. Although it could not reject the null of price symmetry in both markets. Similar to the destination market (Abia State) price, it rejected the null of no cointegration meaning that the prices of cowpea in both the source market and the destination markets were cointegrated. However, it could not reject the null of long- term price symmetry between the prices of cowpea in Kano and Abia States markets for cowpea, indicating that there is market price asymmetry between Kano and Abia State market prices of cowpea in the long-run. This is evidence of the effect of transaction cost that is built into the prices of cowpea at the destination market, that does not allow for long run price symmetry between the markets. The TAR model is able to show that, there was price asymmetry between Kano and Abia States market for cowpea; and it was due to transaction cost effect.

The models for both market relations were subjected to a diagnostic test of multicollinearity, heteroskedasticity and stability. The LM test for both market relation models were 1.698 and 0.659 for Kano-Abia price and Abia-Kano price respectively. These values were insignificant and indicated that the price models were free of the problem of autocorrelation. Also, the ARCH test estimated values of 0.070 and 0.962 were insignificant, suggesting that the models were not having multicollinearity issues. For the stability test, the CUSUM of squares test showed that the models were stable, while the Recursive coefficients for the two price models were Inside ±2S.E. Thus, the results of the price models were reliable for making policy inferences.

(b) Kano- Imo market prices of cowpea:

In the destination market (Imo) price, the study rejected the null of $P_1 = P_2 = 0$, implying that the source market (Kano) and destination market (Imo) prices of cowpeas were cointegrated. The study found the signs of estimates P_1 and P_2 were consistent and significant at a 1 % level. The model converges as both estimates of P_1 and P_2 were negative. Estimates of the adjustment speed of $P_1 = -0.291$ and $P_2 = -0.458$ were negative and significant at the 1 percent level, suggesting model convergence. The speed of adjustment to negative price deviations (ρ) is higher than the speed of adjustment to positive price deviations ρ in absolute terms, implying that positive price deviations in previous periods (months) tend to persist compared to negative price deviations from the long-run equilibrium relationship. However, it could not reject the null H: $P_1 = P_2 = 0$ of long-term symmetry. The estimated F-statistics is 9.529 and significant at 1% level, suggesting that the two speeds of adjustments were statistically different. This was the resultant effect of transaction cost inclusion in the price of cowpea being offered to consumers at the destination market. The prices of cowpeas in the source and destination markets were cointegrated. The estimates of the speed of adjustment $P_1 = -0.463$ and $P_2= -0.320$ were significant at a 1 % level. The study could not reject the null of cointegration $P_1 = P_2 = 0$ by Φ at a 1 % significant level.

Similar to the destination market (Imo State) price, the study rejected the null of no cointegration meaning that the prices of cowpea in both the source market and the destination markets were cointegrated. However, it could not reject the null of long-term price symmetry between the prices of cowpea in Kano and Imo States markets for cowpea, indicating that there is market price asymmetry between Kano and Imo States market prices of cowpea in the long run. This is evidence of the effect of transaction cost that is built into the prices of cowpea at the destination market, that does not allow for long run price symmetry between the markets. The TAR model was able to show that there was price asymmetry between the Kano and Imo States markets for cowpeas and was due to the transaction cost effect.

The models for both market relations were subjected to a diagnostic test of multicollinearity, heteroskedasticity, and stability. The LM test for both market relation models were 1.365 and 1.436 for Kano-Imo price and Imo-Kano price respectively. These values were insignificant and indicate that the price models were free of the problem of autocorrelation. Also, the ARCH test estimated values of 0.010 and 0.972 were insignificant, suggesting that the models did not have multicollinearity issues. For the stability test, the CUSUM of squares test showed that the models were stable while the Recursive coefficients for the two price models were Inside ± 2S.E. Thus, the results of the price models were reliable for making policy inferences.

(c) Kano- Enugu market prices of cowpea:

In the destination market (Enugu State) price, the study rejected the null of $P_1 = P_2 = 0$, implying that the source market (Kano State) and destination market (Enugu State) prices of cowpea were cointegrated. The study found the signs of estimates P_1 and P_2 are consistent and significant at 1 % level. The model converges as both estimates of P_1 and P_2 were negative. Estimates of the adjustment speed $P_1 = -0.299$ and $P_2 = -0.366$ were negative and significant at a 1 % level, suggesting model convergence. The speed of adjustment to negative price deviations (ρ) was higher than the speed of adjustment to positive price deviations ρ in absolute terms. Implying that positive price deviations in previous periods (months) tended to persist, compared with negative price deviations from the long-run equilibrium relationship. However, it could not reject the null of $P_1 = P_2 = 0$ of long-term symmetry. The estimated F-statistics is 8.877 and significant at 1% level, suggesting that the two speeds of adjustments were statistically different. That was the resultant effect of transaction cost inclusion in the price of cowpea being offered to consumers at the destination market. It found similar results that – the Kano and Enugu States market prices of cowpea were cointegrated when it estimated Kano market price of cowpea with respect to Enugu State market price of cowpea. The prices of cowpeas in the source and destination markets were cointegrated. The estimates of the speed of adjustment $P_1 = -0.737$ and $P_2 = -0.592$ were significant at a 1 % level. It could not reject the null of cointegration $P_1 = P_2 = 0$ by Φ at a 1 % significant level.

Similar to the destination market (Enugu) price, it rejected the null of no cointegration, meaning that the prices of cowpea in both the source market and the destination markets were cointegrated. However, the study could not reject the null of long-term price symmetry between the prices of cowpea in the Kano and Enugu States markets for cowpea, indicating that there was market price asymmetry between Kano and Enugu State market prices of cowpea in the long run. This is evidence of the effect of transaction cost that is built into the prices of cowpea at the destination market, which does not allow for long-run price symmetry between the markets. The TAR model is able to show that, there is price asymmetry between the Kano and Enugu States markets for cowpeas due to the transaction cost effect. The findings are in line with the work of Ghoshray, (2011) who reported that there was price transmission for a large proportion of the commodities (rice, wheat, and edible oil) studied as well as price asymmetry between domestic and international market prices among agricultural commodities.

The LM test for both market relation models were 2.497 and 0.282 for Kano-Enugu prices and Enugu-Kano price respectively. These values were insignificant and indicates that the price models are free of the problem of autocorrelation. More so, the ARCH test estimated values of 0.393 and 0.207 were insignificant, suggesting that the models do not have multicollinearity issues. For the stability test, the CUSUM of squares test showed that the models were stable while the Recursive coefficients for the two price models were Inside ±2S.E. Thus, the results of the price models were reliable for making policy inferences.

Threshold autoregressive (TAR) estimated (Case 2)

(a) Kano - Abia market prices of cowpea (Chain 1):

For the Kano and Abia States market chain, the estimates of the adjustment speed $P_1 = -0.487$ and $P_2 = -0.399$ suggest model convergence. The speed of adjustment to negative price deviations (ρ) was higher than the speed of adjustment to positive price deviations ρ in absolute terms. This implied that positive price deviations in previous periods tended to persist compared to negative price deviations from the long-run equilibrium.

Table 2: Consistent-TAR estimates and hypotheses test for the Kano market and the destination markets at Abia, Imo, and Enugu State

Normalized equations & model estimates/ Hypotheses tests	Chain I: TAP(c) -ABP(c)		Chain I: TAP(c) -IMP(c)		Chain I: TAP(c) -ENP(c)	
	TAP(c)	ABP(c)	TAP(c)	IMP(c)	TAP(c)	ENP(c)
Tsay test & probability value (F-stat) (H: No linear process)	8.284***	5.966**	7. 148***	5.009**	7.714***	7.020***
Threshold cointegration test (bootstrap p-value)	6.732*** (0.000)	7.630*** (0.000)	5.063** (0.010)	6.836** (0.000)	5.895*** (0.002)	6.718*** (0.000)
Estimated threshold (γ) using Chan`s (1993) grid search	0.893	0.929	0.964	1.011	1.361	1.327
Cointegration (H_0: $P_1 = P_2 = 0$) (F-stat)	14.158***	10.460***	11.119***	12.666***	13.279***	9.816***
Long-run asymmetry across regimes (H: $\rho_1 = \rho_2$) (F-stat)	6.634***	5.110***	5.472***	6.526***	5.153***	5.779***
P_1	-0.487*** (-5.980)	-0.616*** (-8.320)	-0.368*** (-5.101)	-0.496*** (-5.111)	-0.312*** (4.733)	-0.531*** (-7.079)
P_2	-0.399*** (-4.673)	-0.546*** (-4.989)	-0.519*** (-6.392)	-0.362*** (3.010)	-0.300*** (-4.588)	-0.382*** (-5.919)
Number and percentage of observation in regime `IN`	9(34.6%)	10(38.5%)	11(42.3%)	10(38.5%)	8(30.8%)	12(46.2%)
Number and percentage of observation in regime `OUT`	17(65.4%)	16(61.5%)	15(57.7%)	16(61.5%)	18(69.2%)	14(53.8%)
Optimal lag length	0	0	0	0	0	0
Delay parameter	4	5	5	4	6	6

Notes: Delay parameters are chosen by the lags giving the largest TAR-F statistics from the Tsay test. Optimal lags are determined by SBC. The null hypothesis of the Tsay test is that AR follows a linear process in a recursive least square estimation. The null hypothesis of the Hansen test (1997) is `no threshold effects in the autoregressive representation of variable`. The F-test for no threshold effects in the autoregressive representation of a variable. ***, **, and * indicates level of significance at 1 percent, 5 percent, and 10 percent, respectively. The F-test for no threshold effects and parenthesis indicates an asymptotic p-value of bootstrap simulations with 208 replications.

The delay parameter `d` is identified based on the Tsay (1989) For the Kano-Abia State price of cowpea, the Tsay (1989) test found strong evidence of non-linearity in the error correction term (ε). The estimated F-statistics was 8.284 and was rejected at a 1 percent level. This implies that the null of a linear AR process in the cointegrated vector was rejected at a 1 percent level. The percent share of observation in the inside regime (i deviations from the long-run in the interval [-θ, θ]) was 9 and the outside regime was 17. This is a good distribution of observations, indicating that the identified threshold is useful. Since nonlinearities were found in the error correction term, it proceeded to estimate the threshold value (θ) using Chan`s (1993) approach. The threshold values were estimated through a search over all possible threshold values minimizing the sum of square errors (SSE).

The estimated threshold was 0.893 which minimizes the SSE. The conventional test is not appropriate here according to Hansen (1997) since the null of linearity in the AR process does not follow a standard distribution. Hansen proposes a Chow test for threshold values using simulations and provides asymptotic p-values based on bootstrapping (Hansen 1997; Lee and Miguel 2013). Hansen's (1997) tests also rejected the null hypothesis of no threshold effects at a 1 percent level of significance. The max- F statistics value is 6.732 and is significant at 1 percent level. This result provides additional evidence of threshold effects (transaction cost effect) in the cointegrating vector between the source market (Kano market) prices and the destination (Abia State market) prices of cowpeas. The F-statistics to test the null of symmetry presented in Table 2: confirms the existence of the long-run asymmetry across regimes supporting the null of the presence of nonlinearities in the error correction term. The study rejected the P1=P2 of long-term symmetry. It could arrive at similar conclusions when it estimates Abia State market prices of cowpeas with respect to Kano market prices.

For the Abia and Kano States market chain, the study found that the estimates of the adjustment speed P_1= -0.616 and P_2= -0.546 suggest model convergence. The estimates were statistically significant at 1 % levels. The speed of adjustment to negative price deviations (P_2) was not higher than the speed of adjustment to positive price deviations (P_1) in absolute terms. This implies that negative price deviations in previous periods tend to persist compared to positive price deviations from the long-run equilibrium – the resultant effect of transaction cost. The model converges as the signs of both estimates are negative. It rejected the null of no cointegration ($P_1 = P_2 = 0$) by Φ_μ at a 1 percent significant level. The threshold value is found to be 0.929. It obtained evidence of nonlinearity in the error correction and evidence of long-run asymmetry (asymmetry in the speed of adjustment) and a well distribution of observation in the `IN` regime (38.5 percent) and the OUT regime (61.5 percent).

(b) Kano - Imo market prices of cowpea (Chain 2):

For the Kano and Imo States market chain, the study found that the estimates of the adjustment speed P_1= -0.368 and P_2= -0.519 suggesting model convergence. The speed of adjustment to negative price deviations (ρ) is higher than the speed of adjustment to positive price deviations ρ in absolute terms. This implies that positive price deviations in previous periods tend to persist compared to negative price deviations from the long-run equilibrium. The optimal lag length was selected using AIC and BIC criteria. For the Kano-Imo State price of cowpea, the Tsay (1989) test finds strong evidence of non-linearity in the error correction term (ε). The estimated F-statistics was 7.148 and rejected at a 1 percent level. This implies that the null of a linear AR process in the cointegrated vector is rejected at a 1 percent level. The percent share of observation in the inside regime (i deviations from the long-run equation in the interval [-θ, θ]) is 11 and the outside regime is 15. This is a well distribution of observations, indicating that the identified threshold is useful. Since nonlinearities are found in the error correction term, it proceeds to estimate the threshold value (θ) using Chan`s (1993) approach. Here the threshold values are estimated through a search over all possible threshold values minimizing the sum of square errors (SSE).

The estimated threshold is 0.964 which minimizes the SSE. The conventional test was not appropriate here according to Hansen (1997) since the null of linearity in the AR process does not follow a standard distribution. Hansen's (1997) tests also rejected the null hypothesis of no threshold effects at a 1 percent level of significance. The max- F statistics value is 5.063 and is significant at 5 percent level. This result provides additional evidence of threshold effects (transaction cost effect) in the cointegrating vector between the source market (Kano market) prices and the destination (Imo State market) prices of cowpeas. The F-statistics to test the null of symmetry presented in Table 4.29 confirms the existence of the long-run asymmetry across regimes supporting the null of presence of nonlinearities in the error correction term. The study rejected the null (H_0:P_1= P_2) of long-term symmetry. The study also arrived at similar conclusions when it estimated Imo State market prices of cowpeas with respect to Kano market prices.

For the Imo and Kano States market chain, it found that the estimates of the adjustment speed P_1= -0.496 and P_2= -0.362 suggesting model convergence. The estimates were statistically significant at 1 percent levels respectively. The speed of adjustment to negative price deviations (P_2) is not higher than the speed of adjustment to positive price deviations (P_1) in absolute terms. This implies that negative price deviations in previous periods tend to persist compared to positive price deviations from the long-run equilibrium – the resultant effect of transaction cost. The model converges as the signs of both estimates are negative. It can reject the null of no cointegration ($P_1 = P_2 = 0$) by Φ_μ at a 1 percent significant level. The threshold value is found to be 1.011. It found evidence of nonlinearity in the error correction and evidence of long-run asymmetry (asymmetry in the speed of adjustment) and a good distribution of observation in the `IN` regime (38.5 percent) and the OUT regime (61.5 percent).

(c) Kano - Enugu market prices of cowpea (Chain 3):

For the Kano and Enugu States market chain, the study found that the estimates of the adjustment speed P_1= -0.312 and P_2= -0.300 suggest model convergence. The speed of adjustment to negative price deviations (ρ) is higher than the speed of adjustment to positive price deviations ρ in absolute terms. This implies that positive price deviations in previous periods tend to persist compared to negative price deviations from the long-run equilibrium. The optimal lag length was selected using AIC and BIC criteria. For Kano-Enugu price of cowpea, the Tsay (1989) test found strong evidence of non-linearity in the error correction term (ε). The estimated F-statistics is 7.714 and was rejected at a 1 percent level. This implies that the null of a linear AR process in the cointegrated vector was rejected at a 1 percent level. The percent share of observation in the inside regime (i deviations from the long-run equation in the interval [-θ, θ]) is 8 and the outside regime is 18. This is a good distribution of observations, indicating that the identified threshold is useful. The nonlinearities were found in the error correction term, it proceeded to estimate the threshold value (θ) using Chan`s (1993) approach. The threshold values were estimated through a search over all possible threshold values minimizing the sum of square errors (SSE).

The estimated threshold was 1.361 which minimizes the SSE. The conventional test was not appropriate according to Hansen (1997) since the null of linearity in the AR process does not follow a standard distribution. Hansen's (1997) tests also rejected the null hypothesis of no threshold effects at a 1 percent level of significance. The max- F statistics value was 5.895 and was significant at 1 percent level. This result provides additional evidence of threshold effects (transaction cost effect) in the cointegrating vector between the source market (Kano State market) prices and the destination (Enugu State market) prices of cowpeas. The F-statistics to test the null of symmetry presented in Table 2: confirmed the existence of the long-run asymmetry across regimes supporting the null of the presence of nonlinearities in the error correction term. The study rejected the null (H_0:P_1= P_2) of long-term symmetry. It arrived at similar conclusions when it estimated Enugu State market prices of cowpeas with respect to the Kano State market price of cowpeas.

For the Enugu and Kano states market chain, it also found that the estimated speed of adjustment was P_1= -0.531 and P_2= -0.382 suggesting model convergence. The estimates were statistically significant at a 1 percent level. The speed of adjustment to negative price deviations (P_2) is not higher than the speed of adjustment to positive price deviations (P_1) in absolute terms. This implies that negative price deviations in previous periods tend to persist compared to positive price deviations from the long-run equilibrium – the resultant effect of transaction cost. The model converges as the signs of both estimates are negative. The study rejected the null of no cointegration ($P_1 = P_2 = 0$) by Φ_μ at a 1 percent significant level. The threshold value was found to be 1.327. The study also found evidence of nonlinearity in the error correction and evidence of long-run asymmetry (asymmetry in the speed of adjustment) and a well distribution of observation in the `IN` regime (46.2 percent) and the OUT regime (53.8 percent). Therefore, transaction cost was responsible for the price transmission between the Kano State cowpea market as the source market and the destination markets of Abia State, Imo State, and Enugu State. It causes price asymmetry in the price of cowpeas between the markets. The study corroborates the work of Mohammad and Raghbendra (2016) who used the TAR and consistent TAR model to establish the price asymmetry in the wholesale and retail wheat and flour market in Bangladesh.

CONCLUSION AND RECOMMENDATIONS

In conclusion, the study ascertained that transaction costs affected market integration. This effect was proven by the market asymmetry of prices between the source and destination market prices of cowpea for Abia, Imo, and Enugu States respectively. There was evident nonlinearity in the error correction and long-run asymmetry (asymmetry in the speed of adjustment) and well distribution of observation in the`IN` regime ((38.5, 38.5, and 46.2percents) and the OUT regime (61.5, 61.5and 53.8 percents) respectively for Abia, Imo and Enugu State. The study therefore recommended that policies that encourage road infrastructure should be supported, as this will reduce transaction costs. Low transaction cost enhances market integration all things being equal.

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