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EFFECT OF TRANSACTION COST ON MARKET INTEGRATION OF COWPEA MARKET PRICE BETWEEN ADAMAWA STATE AND ABIA, IMO AND ENUGU STATES

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ABSTRACT
The study analyzed the effect transaction cost has on market integration. The study made use of secondary data of cowpea monthly price obtained from National Bureau of Statistic (NBS) (2016-2018). It aimed at looking 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 ascertained, that transaction cost has effect on market integration. This effect was proven by the market asymmetry of prices between the source and destination market prices of cowpea; with the threshold value of 1.121, 1.427 and 1.117 respective for Abia, Imo and Enugu States. There was an 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 (30.8%) and the OUT regime (69.2 %). The study therefore, recommends that policies that improves infrastructural development should be encouraged to reduce effect of transaction cost on market integration.

Keyword: Market, integration transaction and cost, cowpea

INTRODUCTION

Food legume crops are important components of agricultural food crops in developing countries and are considered, vital crops for achieving source of food for both poor producers and consumers; they complement cereal as sources of protein and mineral in human diet (Akibode, 2011). Cowpea (*Vigna Unguiculata L*) is the second world most important grain legumes; it is a popular and important leguminous crop in Africa commonly known as beans in Nigeria, Africa Agricultural Technology Foundation (AATF, 2012). Food and Agricultural Organization FAO, (2004) stated that, it is the most economically important indigenous African leguminous crop. It plays an important role in providing means of living to many people in Africa both producers and marketers. From its production and marketing rural families derive food, animal feed, and cash income (Akibode, 2011).

Market plays important roles in facilitating the exchange of goods and services and can be welfare enhancing for actors engaged in the exchanges (Moti and Berhanu, 2009**).** Marketing involves the movement of goods and services from one place to another, as well as embanking on transaction, making exchanges of goods and services in cash and kind. Markets are said to be integrated when a price increase or decrease (shocks) is transmitted to vertically or spatially connected distinct markets. Price transmission (integrated market) is the degree to which market shocks are transmitted up and down in the marketing chain.This phenomenon has long been considered as an important indicator of market performance. In other words, the extent to which a price shock in one market affects a price in another market can broadly indicate whether efficient arbitrage exists in the space that exists between the two points Worako**,** (2015). Markets prices are co-integrated when the individual price that are not stationary; but their linear combination become stationaries, and tend to move together or follow the same path in the long-run. More so, co-integration of price is said to occur when price shock (difference in price) between two markets A and B that are spatially located are transmited from A to market B or vice versa. This is a phenomenon of long run relationship between market prices which is also referred to as market integration; an indicator of market performance. When markets are integrated there will be free flow of produce from source

of production (source market) to destination market (consumption market) with little or no hindrance. On the other hand, high transaction cost hinders the free flow of produce. Transaction or exchange processes cost, are the cost incurred and are parts of the price each actor in the marketing chain put into consideration alongside her reward (profit) when fixing produce price; as prices change (transmit) from producers to middlemen (marketers, transporters, communicator etc) to consumer; These costs are parts of prices that provide signal and give the true cost of resources and guide allocation to their best use by resource owners; such that when the cost of transaction is high it leads to discouragement in investing on such venture thereby hindering trade flow. Worako (2015) posited that factors that contribute to higher transaction cost include inadequate infrastructure, transportation bottlenecks, lack of market information, information asymmetry, market power, menu cost and so on. These factors are common in developing countries' agricultural markets such as Nigeria. Therefore, measuring price transmission without taking into consideration the effect transaction cost has, gives a wrong verdict of the marketing system.

Stackelberg looked at markets that are cointegrated and determined which is the price leader among the wholesalers (producers or source markets) and the retailers (destination market). In the Stackelberg leadership model perspective, wholesalers are the vertical price leaders while retailers are the price takers. If two price series are cointegrated, in the long-run but diverge from each other in the short-run due to random shocks, an adjustment could restore equilibrium (Mohammad1 and Raghbendra ,2016) . Most studies assume that the speed of this adjustment behaviour is symmetric. But this may not be true if there is a non-linear adjustment due to threshold effects – particularly, in developing countries where large transaction costs, policy interventions are common. (Mohammad and Raghbendra , 2016). 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. Assessments of price transmission asymmetry (PTA) in the food system (Hansmire and Willett 1992; Zhang *et al*., 1995) studied price transmission. Von Cramon-Taubadel (1998) argue that these studies may be biased because they ignore the time series properties of the data.

Studies on market integration analysis were based on price data alone often neglecting the role of transaction costs in determining the direction of trade. Studies such as Mauyo *et al*, (2007); Kibiego *et al*, (2006) and Demise *et al*.,*(*2017), analyzed market integration without considering effect of transaction cost on market integration. This study in line with Mayaka (2013) endeavored to overcome this critique by applying the Threshold Autoregressive error correction model (TAR); the study accounted for the effects of transaction costs in price transmission without directly relying on transaction cost data. The TAR was used to fit the economic requirements for the analysis of price adjustment which was tested and included a "band of non-adjustment" (Meyer, 2002). It also presented the ability of capturing potential symmetric price adjustment processes based on the assumption of constant transaction costs through the analyzed period (Mayaka, 2013). TAR models in their traditional setting have been criticized on many grounds. Myers and Jayne (2012), and Burke and Myers (2014) provide four of the major criticisms. Firstly, nearly all applications for instance (Abdulai, 2000; Goodwin and Piggot, 2001) impose an implicit assumption that transaction costs remain constant overtime. Since transfer cost data is rarely available, analysts believe it is better to assume constant transfer costs than to ignore them altogether. However, easily observable time
varying factors driving transfer costs (such as fuel prices) may provide a better proxy of transfer
costs. Secondly, traditional TAR models are measured with price data alone. If trade flow data is available and explicitly included in the model, they may provide a better insight into the
spatial market relationship. Thirdly, traditional TAR models assume that the equilibrium relationship between prices remain the same with and without trade. It is possible however, that the relationship may vary with variations in trade levels. Finally, when transfer costs are

above intermarket price differences, theory suggests a lack of arbitrage opportunity. In contrast, traditional TAR models allow for a long run equilibrium during this period, which could result in considerable bias in parameter estimation. 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.

MATERIALS AN METHODS

The study was carried out in Adamawa State as the production State while Abia Enugu and Imo States are the consumption centre Nigeria. The study used secondary source of data. These are monthly prices data of cowpea from January 2016 to February 2018 obtained from National Bureau of Statistics(NBS). It established that prices of the different markets are co-integrated and tested the effect of transaction cost on market integration. The sole objective of the study was to estimate the effect of transaction cost on market integration using Threshold Autoregressive error correction model (TAR) as modified by (Burke and Myers, 2014) and used by Mayaka, (2017)
A spatial market equilibrium relationship is given as:

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

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 ($\beta_1 = 1$), (2) β_2 equate to one ($\beta_2 = 1$) and (3) the constant ($\beta_0 = 0$) (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:

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

In order to allow for the estimation of the speed of price transmission (λ). All other variables remain 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 markets locations considered in the study is: Adamawa State, while the destination markets considered in the study are: (1) Abia State, (2) Imo State, and (3) Enugu State.

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 Adamawa 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):

$\Delta\varepsilon\varepsilon tt=\rho\rho 1 IIttεεεεtt-1+\rho\rho 2(1-IItt)$ $\varepsilon\varepsilon tt-1+\mu\mu tt$ (7)

where $IItt$ is the Heaviside indicator function given as: $IItt=$□1 $iiii|qqtt-1|>\tau\tau 0$ $iiii|qqtt-1|\leq\tau\tau$

and $\varepsilon\varepsilon tt$ is the mean zero residuals from the co-integrating equation, $\mu\mu tt$ 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 ($\mu\mu$) (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 ($\mu\mu$). 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

RESULT AND DISCUSSIONS

The study estimated the threshold cointegration, test long-run asymmetry and the speed of adjustment using the threshold autoregressive model (TAR). The TAR performs threshold cointegration and long – run asymmetry that proves the effect of transaction cost on market integration. Having established that market prices of cowpea under study were integrated. The study considered two cases. First, threshold sets to zero (case 1) and second, threshold estimated (case 2). This was done to find the robust results from the models being analyzed. The study estimated effects of transaction cost in Adamawa State (source market) and the destination markets Abia, Imo and Enugu States.

Effect of transaction cost estimate for Adamawa- Abia, Imo and Enugu markets prices of cowpea when threshold is set at zero

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

Model parameters/ Hypotheses tests/ Model diagnostics	**Chain 1: ADP(c) -ABP(c)**		**Chain 2: ADP(c) -IMP(c)**		**Chain 3: ADP(c) -ENP(c)**	
	ADP(c)	ABP(c)	ADP(c)	IMP(c)	ADP(c)	ENP(c)
P_1	-0.610***	-0.719***	-0.317**	-0.832***	-0.457***	-0.640***
	(-4.326)	(-6.491)	(-2.344)	(-6.549)	(-11.476)	(-11.151)
P_2	-0.752***	-0.357**	-0.561***	-0.683***	-0.519***	-0.514***
	(-3.439)	(-2.154)	(-4.044)	(-4.636)	(-4.368)	(-5.272)
No. of lags and deterministic terms included in the model	l=2;Constant	l=2;Constant	l=2;Constant	l=2;Constant	l=2;Constant	l=2;Constant
AIC	2.468	2.873	2.292	3.086	3.051	3.737
BIC	2.673	3.013	2.396	3.175	3.144	3.540
Hypothesis tests						
ϕ_μ: Cointegration H_0: $P_1 = P_2 = 0$	21.150***	28.856***	10.493***	18.857***	27.118***	28.841***
Critical Values (5%)	5.98	6.52	5.98	6.01	5.98	6.02
Long-term symmetry (H_0: $P_1 = P_2$)	8.911*** (0.000)	12.482** * (0.000)	10.583*** (0.000)	11.001*** (0.000)	7.693*** (0.003)	16.121*** (0.000)
Model diagnostics						
LM test	0.968(0.398)	0.243(0.787)	1.418(0.648)	0.018(0.982)	0.994(0.693)	0.226(0.800)
ARCH Test	0.058(0.940)	1.592(0.101)	1.776(0.197)	0.457(0.640)	0.726(0.998)	0.727(0.497)
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 * means significant at 1%, 5% and 10%, respectively. Critical values are from Bai-Perron (Econometric Journal, 2003)

Adamawa- Abia market prices of cowpea:

In the destination market (Abia) price, the study rejected the null of $P_1 = P_2 = 0$, implying that the source market (Adamawa) and destination market (Abia) prices of cowpea are co-integrated. The F-statistics is found to be 21.150 and significant at 1 percent. The study found the signs of estimates P_1 and P_2 consistent and significant at 1 percent level. The study used t-statistics to test the significance of null hypotheses found to be 5.98. The model converges when both estimates P_1 and P_2 are negative (necessary conditions) (Enders and Siklos, 2001; Mohammad and Raghbendra, 2016). Estimates of the adjustment speed are P_1 = -0.610 and P_2 = -0.752 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 relationship. However, the study could not reject the null H: $P_1 = P_2 = 0$ of long-term asymmetry meaning that, there is no long term symmetry. In other word there is price asymmetry. The estimated F-statistics is 8.911 and significant at 1% level of significance, -suggesting that the two speed of adjustments are statistically different. This result supports the Stackelberg model -the upstream price dominates the price at downstream. The study found similar results that – Adamawa and Abia States market prices of cowpea are cointegrated when it estimated Abia State- market price of cowpea with respect to Adamawa State market price of cowpea. The estimates of the speed of adjustment p_1 = -0.719 and p_2= -0.357 are significant at 1 and 5 percent levels respectively. The model converges as the sign of both parameters are negative. It could reject the null of co-integration $P_1 = P_2 = 0$ by Φ at 1 percent significant level. The test statistics was found to be 6.520. It could not reject the null of long-term asymmetry. Similar to the destination market (Abia State) price, the study rejected the null of no cointegration. Implying that Adamawa and Abia State market price were cointegrated; and there is price asymmetry between Adamawa and Abia States markets. The finding is 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. Price asymmetry is an 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 is price asymmetry between Adamawa and Abia State market for cowpea and the difference was due to transaction cost effect.

Adamawa- Imo market prices of cowpea

In the Adamawa →Imo States cowpea price, the study rejected the null of $P_1 = P_2 = 0$, implying that Adamawa and Imo States markets prices of cowpea are cointegrated. The F-statistics is found to be 10.493 and significant at 1 percent. The study found that the signs of estimates P_1 and P_2 are consistent and significant at 1 and 5 percent levels. The estimated speeds of adjustment were P_1 = -0.317 and P_2 = -0.561 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 relationship. However, the study could not reject the null H: $P_1 = P_2 = 0$ of long-term asymmetry. The estimated F-statistics is 10.583 and significant at 1% level of significance, suggesting that the two speed of adjustments are statistically different. This result supports the Stackelberg's position on price transmission between markets that upstream price dominates the price at downstream. The study found similar results that – Adamawa and Imo States market prices of cowpea are co-integrated when it estimated Adamawa State market price of cowpea with respect to Imo State market price of cowpea. The estimates of the speed of adjustment P_1 = -0.832 and P_2= -0.683 are significant at 1 percent level. The model converges as the sign of both parameters were negative. It could reject the null of co-integration $P_1 = P_2 = 0$ by Φ at 1 percent significant level. The test statistics is found to be 6.520. However, the study could not reject the null of long term asymmetry. Implying that there is no long tem symmetry between Adamawa and Imo States market prices of cowpea. Similar to the Abia State cowpea market price, it rejected the null of no co-integration meaning that there is market price asymmetry between Adamawa and Imo State market prices of cowpea. This is also an 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 is price asymmetry between Adamawa and Imo State markets for cowpea due to transaction cost effect. The finding is in agreement 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.

Adamawa- Enugu market prices of cowpea

In the Adamawa →Enugu States cowpea prices, the study rejected the null of $P_1 = P_2 = 0$, implying that Adamawa and Enugu State markets prices of cowpea are cointegrated. The F-statistics is found to be 27.118 and significant at 1 percent. The signs of estimates P_1 and P_2 are consistent and significant at 1 percent level. The estimated speed of adjustment are P_1 = -0.457 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 relationship. However, it could not reject the null H: $P_1 = P_2 = 0$ of long-term asymmetry. The estimated F-statistics is 7.693 and significant at 1% level of significance, suggesting that the two speed of adjustments are statistically different. This result supports the Stackelberg's position on price transmission between markets that upstream price dominates the price at downstream. The study found similar results – Adamawa and Enugu States market prices of cowpea are co-integrated when it estimated Adamawa market price of cowpea with respect to Enugu State market price of cowpea. The estimates of the speed of adjustment P_1 = -0.640 and P_2= -0.514 are significant at 1 percent level. The model converges as the sign of both parameters are negative. It could reject the null of co-integration $P_1 = P_2 = 0$ by Φ at 1 percent significant level. The test statistics was found to be 6.02. However, it fails to reject the null of long term symmetry. Similar to the Abia State cowpea market price, the study rejected the null of no co-integration meaning that there is market price asymmetry between Adamawa

and Enugu States market prices of cowpea. This also is an 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 us that there is price asymmetry between Adamawa and Enugu State markets for cowpea and it was due to transaction cost effect. The study corroborates the work of Mohammad and Raghbendra (2016) who used the TAR model to establish the price asymmetry in wholesale and retail wheat and flour market in Bangladesh.

Threshold Autoregressive (TAR) Estimated (Case 2)

The consistent TAR approach was undertaken to confirm the estimated effect of transactions cost on market integration between the source markets in the north and the destination markets in the south-east Nigeria using grid search approach in line with Chan's (1993). Here the TAR model was estimated based on the estimated thresholds value above each vertical market relationship. In total, it estimated six different prices in one vertical chains. The results are presented in Table 2:

Table 2: Consistent-TAR estimates and hypotheses test (Adamawa State)

Normalized equations & model estimates/ Hypotheses tests	**Chain 1: TAP(c) -ABP(c)**		**Chain 2: TAP(c) -IMP(c)**		**Chain 3: 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)	6.887***	7.867***	5.741**	6.342**	5.614**	6.376**
Threshold cointegration test (bootstrap p-value)	6.393** (0.010)	4.767* (0.050)	5.422** (0.031)	5.265 ** (0.045)	6.643*** (0.009)	4.398** (0.039)
Estimated threshold (γ) using Chan`s (1993) grid search	1.342	1.121	0.629	1.427	0.673	1.117
Cointegration (H_0: $P_1 = P_2 = 0$) (F-stat)	13.642***	14.579***	15.113***	16.132***	12.467***	11.106***
Long-run asymmetry across regimes (H: $\rho_1 = \rho_2$) (F-stat)	4.171**	2.343**	7.531***	3.893**	2.033**	7.804***
P_1	-0.611*** (7.934)	-0.161** (2.202)	-0.559*** (8.674)	-0.260** (2.617)	-0.411*** (5.351)	-0.602*** (6.823)
P_2	-0.340*** (4.672)	-0.578*** (5.166)	-0.732*** (5.629)	-0.583*** (6.003)	-0.513*** (5.672)	-0.454*** (5.378)
Number and percentage of observation in regime `IN`	11 (42.3%)	12(46.2%)	11(42.3%)	9(34.6%)	10(38.5%)	8(30.8%)
Number and percentage of observation in regime `OUT`	15 (57.7%)	14(53.8%)	15(57.7%)	17(65.4%)	16(61.5%)	18(69.2%)
Optimal lag length	0	0	0	0	0	0
Delay parameter (d)	5	8	4	5	8	4

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

Adamawa State -Abia, Imo and Enugu States market prices of cowpea

The study estimated the prices for the destination and source markets separately. First, it estimated source market (Adamawa State market) prices of cowpea with respect to Abia, Imo and Enugu State (destination markets) prices of cowpea. Then it estimated Abia, Imo and Enugu State (destination markets) prices of cowpea with respect to Adamawa State market prices of cowpea. It estimated the consistent-TAR model and test for cointegration and long-run symmetry (symmetry in the speed of adjustments). The study identified optimal lag length using SBC. The model is validated by interpreting the F-statistics of joint null hypothesis, $P_1 = P_2 = 0$ by Φ_μ. The F-statistics of Φ_μ is compared with the values tabulated by Enders and Siklos (2001). It rejected the null of $P_1 = P_2 = 0$ in the consistent-TAR model implying that the source market (Adamawa market) prices of cowpea with respect to Abia, Imo and Enugu States (destination markets) prices of cowpea are cointegrated in the long-run. The result is similar to result found by Johansen cointegration test and model estimated using null threshold. The signs of estimates P_1 and P_2 are consistent and significant at 1 percent and 5 percent levels. The model converges when both

P_1 and P_2 are negative (necessary conditions) (Enders and Siklos, 2001). The result of the consistent- TAR error correction estimates and hypotheses tests for transaction cost effect on the varying prices of cowpea between Adamawa State cowpea market price as the source market and the destination markets at Abia, Imo, Enugu States when the threshold is estimated is presented in Table 2

Adamawa - Abia market prices of cowpea (Chain I)

For Adamawa and Abia States market chain, the estimates of the adjustment speed P_1= -0.611 and P_2= -0.340 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. It used AIC and BIC to select the optimal lag length. The delay parameter `d` is identified based on the Tsay (1989) (i.e choosing `d` that maximizes the F-statistics ;(Lee and Miguel 2013; Mohammad and Raghbendra, 2016). For Adamawa-Abia price of cowpea, the Tsay (1989) test found strong evidence of non-linearity in the error correction term (ε). The estimated F-statistics was 6.887 and was rejected at 1 percent level. This implies that the null of a linear AR process in the cointegrated vector is rejected at 1 percent level. The percent share of observation in the inside regime (i e deviations from the long-run in the interval [-θ, θ]) is 11 and outside regime is 15. This is a well distribution of observations, indicating that identified threshold was 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 sum of square errors (SSE). The estimated threshold was 1.342 that minimizes the SSE. Conventional test is not appropriate here according to Hansen (1997) since null of linearity in the AR process does not follow a standard distribution. Hansen proposes a Chow tests for threshold values using simulations and provides asymptotic p-values based on bootstrapping (Hansen 1997; and Miguel 2013). Hansen (1997) tests also reject the null hypothesis of no threshold effects at 5 percent level of significance. The max- F statistics value was 6.393 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 (Adamawa market) prices and the destination (Abia State market) prices of cowpea. 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 presence of nonlinearities in the error correction term. It rejected the null (H_0:P_1= P_2) of long-term symmetry. It arrived at similar conclusions when it estimated Abia State market prices of cowpea with respect to Adamawa State market prices. For Abia and Adamawa States market chain, the study found the estimates of the adjustment speed to be P_1= -0.161 and P_2= -0.578 suggesting model convergence. The estimates are statistically significant at 1 and 5 percent levels. 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 deviation from the long-run equilibrium which is the resultant effect of transaction cost. The model converges as the signs of both estimates are negative. It could reject the null of no cointegration ($P_1 = P_2 = 0$) by Φ_μ at 1 percent significant level. The threshold value was found to be 1.121. It 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 `IN` regime (46.2 percent) and the OUT regime (53.8 percent). The study corroborates the work of Mohammad and Raghbendra (2016) who used the TAR model to establish the price asymmetry in wholesale and retail wheat and flour market in Bangladesh.

Adamawa - Imo market prices of cowpea (Chain 2)

For Adamawa and Imo State market chain, it found out that the estimates of the adjustment speed P_1= -0.559 and P_2= -0.732 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 Adamawa-Imo price of cowpea, the Tsay (1989) test finds strong evidence of non-linearity in the error correction term (ε). The estimated F-statistics was 5.741 and was rejected at 5 percent level. This implies that the null of a linear AR process in the cointegrated vector was rejected at 5 percent level. The percent share of observation in the inside regime (i e deviations from the long-run interval [-θ, θ]) was 11 and outside regime was 15. This was a well distribution of observations, indicating that identified threshold was useful. Since, nonlinearities are found in the error correction term, the study proceed to estimate the threshold value (θ) using Chan`s (1993) approach. The threshold values are estimated through a search over all possible threshold values minimizing sum of square errors (SSE). The estimated threshold was 0.629 that minimizes the SSE. Conventional test was not appropriate according to Hansen (1997) since null of linearity in the AR process does not follow a standard distribution. Hansen (1997) tests also rejected the null hypothesis of no threshold effects at 5 percent level of significance. The max- F statistics value was 5.422 and was significant at 5 percent level. This result provides additional evidence of threshold effects (transaction cost effect) in the co-integrating vector between the source market (Adamawa State market) prices and the destination (Imo State market) prices of cowpea. 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 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 estimates Imo State market prices of cowpea with respect to Adamawa market prices. For Imo and Adamawa State market chain, it found that the estimates of the adjustment speed P_1= -0.260 and P_2= -0.583 suggesting model convergence. The estimates were statistically significant at 5 and 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 were negative. It could reject the null of no cointegration ($P_1 = P_2 = 0$) by Φ_μ at 1 percent significant level. The threshold value was found to be 1.427. The study found an 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 `IN` regime (34.6 percent) and the OUT regime (65.4 percent). The study corroborates the work of Mohammad and Raghbendra (2016) who used the TAR model to establish the price asymmetry in wholesale and retail wheat and flour market in Bangladesh.

Adamawa - Enugu market prices of cowpea (Chain 3)

For Adamawa and Enugu States market chain, the estimates of the adjustment speed P_1= -0.411 and P_2= -0.513 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 Adamawa-Enugu price of cowpea, the Tsay (1989) test found strong evidence of non-linearity in the error correction term (ε). The estimated F-statistics was 5.614 and was rejected at 5 percent level. This implies that the null of a linear AR process in the cointegrated vector is rejected at 5 percent level. The percent share of observation in the inside regime (i e deviations from the long-run interval [-θ, θ]) is 10 and outside regime is 16. This is a well distribution of observations, indicating that identified threshold is useful. Since, nonlinearities are found in the error correction term, it proceeded 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 sum of square errors (SSE). The estimated threshold is 0.673 that minimizes the SSE. Conventional test is not appropriate here according to Hansen (1997) since null of linearity in the AR process does not follow a standard distribution. Hansen (1997) tests also reject the null hypothesis of no threshold effects at 5 percent level of significance. The max- F statistics value is 6.643 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 (Adamawa market) prices and the destination (Enugu State market) prices of cowpea. 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 presence of nonlinearities in the error correction term. It rejected the null (H_0:P_1= P_2) of long-term symmetry. The study could arrive at similar conclusions when it estimated Enugu State market prices of cowpea with respect to Adamawa State market prices.

For Enugu State and Adamawa market chain, it found that the estimates of the adjustment speed P_1= -0.602 and P_2= -0.454 suggesting model convergence. The estimates are statistically significant at 1percent 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 1 percent significant level. The threshold value is found to be 1.117. It arrived at 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 `IN` regime (30.8 percent) and the OUT regime (69.2 percent). Therefore, transaction cost is responsible for the difference in prices between Adamawa 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 cowpea between the markets.

SUMMARY AND CONCLUSION

The study was carried out to investigate the effect of transaction cost on market integration of cowpea between Adamawa State (source market) and Abia , Imo and Enugu States (destination markets) The study ascertained that transaction cost has effect on market integration. This effect was proven by the market asymmetry of prices between the source and destination market prices of the cowpea; with the threshold values of 1.121, 1.427 and 1.117 respective for Abia, Imo and Enugu States. This was evident by 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 (30.8%) and the OUT regime (69.2 %). Therefore, transaction cost is responsible for the difference in price (transmission) between Adamawa State cowpea market as the source market and the destination markets of Abia State, Imo State, and Enugu State. This caused price asymmetry in the price of cowpea between the markets. We therefore conclude that transaction cost has negative effect on market integration. The higher the transaction cost the less the level of integration of markets.

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