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Effect of Transaction Costs on Market Integration of Cowpea between Gombe and Abia, Imo and Enugu State, Nigeria

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Abstract
In recent times studies on market integration have been able to prove the performance of the marketing system; indicating its efficiency or its inefficiency. But in most cases, the role transaction cost plays in the integration of the market is always ignored, focusing on the degree of integration only. In order to bring to mind the effect of transaction cost on the level of integration of the market, the study analyzed the effect of transaction cost on market integration. It made use of secondary data on cowpea monthly prices obtained from the National Bureau of Statistics (NBS) (2016-2018). It aimed at looking at the effect of transaction cost on market integration in the study area. It used the Threshold Autoregressive error correction model (TAR) to realize the objective. It ascertained that transaction cost has an 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 0.983, 0.861 and 1.087 respective for Abia, Imo and Enugu States. There was evidence of nonlinearity in the error correction and long-run asymmetry (asymmetry in the speed of adjustment) and well distribution of observation in the `IN` regime (30.8, 42.3 and 38.5 percent) respectively and the OUT regime (69.2, 57.7 and 61.5 percent) respectively for Abia, Imo and Enugu State. Therefore, the transaction cost is responsible for the price asymmetry. The study, therefore, recommends that policies that improve infrastructural development, communication hub and facilities should be encouraged to reduce the effect of transaction costs on market integration.

***Keywords:** Effect, market, transaction, cost, price, asymmetry*

Introduction

Cowpea make a major contribution to the nutrition of poor populations because it is a good source of plant protein. It is consumed regularly, in one form or the other, as bean porridge, bean soup, bean cake, popularly known as moin moin, "akara" (Adekunle and Momoh, 2016). Oyelade and Anwanane (2013) posited that it provides protein to rural and urban dwellers as a substitute for animal protein. Cowpea production in Nigeria is concentrated in the Northern part of the country, particularly Niger, Borno and Yobe, Adamawa Gombe and Taraba States. As a cheaper and alternative source of protein, it is generally consumed across all part of Nigeria. Ewan, *et al.,* (2014) affirmed that most of the cowpea consumed in southern Nigeria are produced and transported from northern Nigeria. Marketing of agricultural produces is essential in the distribution of produces from surplus zone to deficit zone thereby bridging the gap of shortage of supply at the deficit region and curtailed price fall in the surplus region especially at harvest time. The activities carried out by producers, middlemen, transporters and service providers build up the prices of the commodities borne by the final consumers of the commodity. The longer the marketing chain, the higher the price paid by the final consumer which creates inefficiency in the marketing chain and system. Onubogu and Dipeolu (2019) posited that Nigerian food commodities markets have been identified with inefficiencies in the food distribution system between surplus and deficient areas; that market imperfections creates local food supply shortfalls in some parts of a country, while some areas have surpluses. Marketing involves services delivery and creation of utility to satisfy human need. In the course of marketing, actors in the marketing chain make profit. The transfer of the price (price shock) of a commodity from one market to another in relation to the transportation cost and other cost of the commodity is market integration. It shows how well the marketing system is, hence it is used as a measure of market performance or efficiency. Akpan, and Udo (2014) posited that marketing efficiency of agricultural products has always been an issue of interest, and the attainment of efficient market performance is determined by the extent to which price signals are transmitted across markets. Market integration is concerned with the way in which prices of homogeneous commodity sells in different market place or locations. In the domestic markets, a price increase passes very quickly through the supply chain compared to a price decrease. For example, when the price of beans increases at the farm level, it is being transferred immediately to the retail level and ultimately to the consumers by market intermediaries to capture the benefit. Limon *et al*. (2020) affirmed that when the price of rice decrease at the producer level in Bangladesh, it barely a ects the retail price at a quick interval of time but the reverse is the case when there is an increase in prices. As a result, the perception of consumers shows that the market is being manipulated, raising food prices unfairly, at the expense of the poor households who are net buyers and for whom food takes a major expenditure share of about 40–50 percent. This creates inefficiency in the marketing system of agricultural produces all over the Less Developing Country (LDCs) Nigeria inclusive.

In the course of moving and distributing produce from one place to another, services of other actors that facilitate the movement of the commodities earn some margins which is a component of the transaction cost. In most studies of market integration, the effect of transaction cost on market integration has been neglected focusing on the degree of integration. Transaction cost comprises of cost of searching for information; in terms of purchase area, price of goods, cost of transportation, cost of communication and others. However, studies have shown that transaction cost has a negative effect on market integration. Alejandro (2012) stated that high transaction cost leads to the partial transmission of price signal or not at all between two market locations. Rodrigo *et al.* (2015) affirmed that high exchange costs make the transaction process more expensive and insulate the market. Therefore, the study stated that all things being equal, the higher the exchange costs, the lower the probability of different markets being integrated. Worako (2015) posited that factors that contribute to higher transaction costs include inadequate infrastructure, transportation bottlenecks, lack of market information, information asymmetry, market power, menu cost and so on. 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 and 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 the 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 and assessment of price transmission asymmetry (PTA) in the food system. This study in line with Mayaka (2013) endeavoured 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 to capture 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 (Goodwin and Piggot, 2001) impose an implicit assumption that transaction costs remain constant over time. 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 remains 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 inter-market 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 order to overcome the fallout of the traditional TAR the study modified the TAR model in a way that transmission mechanisms are varied and the TAR models allow for multiple trade regimes (multiple thresholds validity is primarily established on a single threshold (two regimes) model.

Methodology

The study was carried out in Gombe State as the production State while Abia Enugu and Imo States are the consumption centers. The study used secondary sources of data. These are monthly price data of cowpea from January 2016 to February 2018 obtained from the 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 the Threshold Autoregressive error correction model (TAR) as modified by (Burke and Myers, 2014).

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

P^B_t = 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 follows:

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

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 market 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 behaviour 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 a 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 the 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 the 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 the 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). The Enders and Siklos (2001) approach 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):

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

where *IItt* is the Heaviside indicator function given as:

$$IItt = \square 1\ iiii|qqtt-1| > \tau\tau 0\ iiii|qqtt-1| \leq \tau\tau$$

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 models (*n*=1). If the null hypothesis is rejected, the procedure is repeated to test for the 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

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

The result of the threshold vector error correction estimates and hypotheses tests for transaction cost effect on the varying prices of cowpea between Gombe State cowpea market as the source market and the destination markets (Abia, Imo and Enugu States) , when the threshold is null (set to zero), is presented in Table 1.

(a) Gombe- 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 (Gombe) and destination market (Abia) prices of cowpea are cointegrated. The F-statistics is found to be 35.679 and significant at 1 percent. The study found the signs of estimates P_1 and P_2 are consistent and significant at 1 percent level. It used t-statistics to test the significance of null hypotheses. The model converges as both estimates of P_1 and P_2 are negative. Estimates of the adjustment speed are $P_1 = -0.392$ and $P_2 = -0.487$ are negative and significant at 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 was 10.984 and significant at 1% level of significance, suggesting that the two speeds of adjustments are statistically different. This is the resultant effect of transaction cost inclusion in the price of cowpea being offered to consumers at the destination market. Furthermore, similar results – Gombe and Abia State market prices of cowpea are cointegrated when estimated, Gombe market price of cowpea with respect to Abia State market price of cowpea. The estimates of the speed of adjustment $P_1 = -0.560$ and $P_2 = -0.409$ are significant at 1 percent level. The model converges as the sign of both parameters are negative. The study rejected the null of cointegration $P_1 = P_2 = 0$ by Φ at 1 percent significant level. The test statistics were found to be 14.961. The study could not reject the null of price symmetry in both markets. Similar to the destination market (Abia) price, it rejected the null of no cointegration meaning that the prices of cowpea in both the source and destination markets are cointegrated. However, it could not reject the null of long-term price symmetry between the prices of cowpea in Gombe and Abia States markets for cowpea, indicating that there is market price asymmetry between Gombe 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 is price asymmetry between Gombe and Abia States market for cowpea 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 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 1.469 and 2.095 for Gombe-Abia States price and Abia-Gombe price respectively. These values were insignificant and indicate that the price models are free of the problem of autocorrelation. Also, the ARCH test estimated values of 0.073 and 1.382 were insignificant, suggesting that the models are not having multicollinearity issues. For the stability test, the CUSUM of squares test shows that the models are stable while the recursive coefficients for the two price models were Inside ± 2 S.E. Thus, the results of the price models are reliable for making policy inferences.

(b) Gombe- Imo market prices of cowpea

In the destination market (Imo State) price, the study rejected the null of $P_1 = P_2 = 0$, implying that the source market (Gombe State) and destination market (Imo State) prices of cowpea are cointegrated. The F-statistics is found to be 11.409 and significant at 1 percent. The study found the signs of estimates P_1 and P_2 are consistent and significant at 1 percent level. It used t-statistics to test the significance of null hypotheses. The model converges as both estimates of P_1 and P_2 are negative. Estimates of the adjustment speed are $P_1 = -0.687$ and $P_2 = -0.716$ are negative and significant at 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, the study could not reject the null H: $P_1 = P_2 = 0$ of long-term symmetry. The estimated F-statistics is 7.116 and significant at 1% level, suggesting that the two speeds of adjustments are 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 findings are 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 commodity. The study found similar results that – Gombe and Imo States market prices of cowpea are cointegrated when it estimated Gombe market price of cowpea with respect to Imo State market price of cowpea. The prices of cowpea in the source and destination markets are cointegrated as the F-statistics was found to be 13.574 and significant at 1 percent. The estimates of the speed of adjustment $P_1 = -0.454$ and $P_2 = -0.368$ are significant at 1 percent level. The model converges as the sign of both parameters are negative. It could not reject the null of cointegration $P_1 = P_2 = 0$ by Φ at 1 percent significant level. The test statistics was found to be 13.285. However, the study could not reject the null of long term symmetry. Similar to the destination market (Imo) price, it rejected the null of no cointegration meaning that the prices of cowpea in both the source market and the destination markets are cointegrated. However, it could not reject the null of long-term price symmetry between the prices of cowpea in Gombe and Imo States markets for cowpea, indicating that there is market price asymmetry between Gombe 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 is able to show that there is price asymmetry between Gombe and Imo States market for cowpea due to the transaction cost effect. The findings agree 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 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 0.328 and 0.679 for Gombe-Imo State prices and Imo-Gombe State prices respectively. These values were insignificant and indicate that the price models are free of the problem of autocorrelation. Also, the ARCH test estimated values of 1.817 and 0.125 were insignificant, suggesting that the models are not having multicollinearity issues. For the stability test, the CUSUM of squares test shows that the models are stable while the recursive coefficients for the two price models were Inside ± 2S.E. Thus, the results of the price models are reliable for making policy inferences.

(c) Gombe- 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 (Gombe State) and destination market (Enugu State) prices of cowpea are cointegrated. The F-statistics is found to be 14.296 and significant at 1 percent. The study found that the signs of estimates P_1 and P_2 are consistent and significant at 1 percent level. It used t-statistics to test the significance of null hypotheses. The model converges as both estimates of P_1 and P_2 are negative. Estimates of the adjustment speed are $P_1 = -0.529$ and $P_2 = -0.669$ are negative and significant at 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 8.012 and significant at 1% level, suggesting that the two speeds of adjustments are 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 – Gombe and Enugu States market prices of cowpea are cointegrated when it estimated Gombe State market price of cowpea with respect to Enugu State market price of cowpea. The prices of cowpea in the source and destination markets are cointegrated as the F-statistics was found to be 15.871 and significant at 1 percent. The estimates of the speed of adjustment $P_1 = -0.586$ and $P_2 = -0.537$ are significant at 1 percent level. The model converges as the sign of both parameters is negative. The study could not reject the null of cointegration $P_1 = P_2 = 0$ by Φ at 1 percent significant level. The test statistics are found to be 12.616 and thus the study rejected the null of symmetry. Similar to the destination market (Enugu State) price, it rejected the null of no cointegration meaning that the prices of cowpea in both the source market and the destination markets are cointegrated. However, it could not reject the null of long-term price symmetry between the prices of cowpea in Gombe and Enugu States markets for cowpea, indicating that, there is market price asymmetry between Gombe and Enugu 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 is able to show that there is price asymmetry between Gombe and Enugu States market prices for cowpea was due to transaction cost effect. The findings corroborate 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 commodity. 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 1.380 and 0.181 for Gombe-Enugu States price and Enugu-Gombe State price respectively. These values were insignificant and indicates that the price models are free of the problem of autocorrelation. Also, the ARCH test estimated values of 0.241and 1.365 were insignificant, suggesting that the models are not having multicollinearity issues. For the stability test, the CUSUM of squares test shows that the models are stable while the recursive coefficients for the two price models were Inside ±2S.E. Thus, the results of the price models are reliable for making policy inferences.

Consistent- Threshold Autoregressive error Model (TAR)

The consistent TAR that shows the effect of transaction cost using the threshold values is presented in Table 2

(a) Gombe - Abia market prices of cowpea (Chain 2)

For Gombe and Abia States market chain, the estimates of the adjustment speed $P_1 = -0.373$ and $P_2 = -0.512$ 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. It used

AIC and BIC to select the optimal lag length. The delay parameter `d` is identified based on the Tsay (1989). For Gombe-Abia price of cowpea, the Tsay (1989) test found strong evidence of non-linearity in the error correction term (ε). The estimated F-statistics is 6.662 and was rejected at 1 percent level. This implies that the null of a linear AR process in the cointegrated vector was rejected at 1 percent level. The percent share of observation in the inside regime (i e deviations from the long-run equation in the interval [-θ, θ]) is 10 and outside regime is 16. This is a good distribution of observations, indicating that identified threshold is useful. Since nonlinearities are found in the error correction term, the study proceed to estimate the threshold value (θ) using Chan`s (1993) approach. Here the threshold values were estimated through a search over all possible threshold values minimizing the sum of square errors (SSE). The estimated threshold is 1.442 which minimizes the SSE. Conventional test was 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; Lee and Miguel 2013). Hansen (1997) tests also rejected the null hypothesis of no threshold effects at 1 percent level of significance. The max- F statistics value is 7.113 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 (Gombe State market) prices and the destination (Abia State market) prices of cowpea. The F-statistics to test the null of symmetry presented in Table 4.28 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 null (H_0:P_1= P_2) of long-term symmetry. The study arrived at similar conclusions when it estimates Abia State market prices of cowpea with respect to Gombe State market prices. For Abia and Gombe States market chain, the estimates of the adjustment speed P_1= -0.448 and P_2= -0.413 suggest model convergence. The estimates were statistically significant at 5 and 1 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 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 0.983. The study 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 (30.8 percent) and the OUT regime (69.2 percent). The study corroborates the work of Mohammad and Raghbendra (2016) who used the TAR and consistent TAR model to establish the price asymmetry in wholesale and retail wheat and flour market in Bangladesh.

(b) Gombe - Imo market prices of cowpea (Chain 2)

For Gombe and Imo States market chain, the estimates of the adjustment speed P_1= -0.611 and P_2= -0.799 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 Gombe-Imo 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 6.173 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 9 and outside regime was 17. This is a good distribution of observations, indicating that identified threshold is useful. Since nonlinearities were found in the error correction term, the study 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 is 1.106 which 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 5.783 and was significant at 5 percent level. This result provides additional evidence of threshold effects (transaction cost effect) in the cointegrating vector between the source market (Gombe market) prices and the destination (Imo State market) prices of cowpea. The F-statistics to test the null of symmetry presented in Table 4.28 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 null (H_0:P_1= P_2) of long-term symmetry. It could arrive at similar conclusions when it estimates Imo State market prices of cowpea with respect to Gombe market prices. For Imo and Gombe States market chain, it found estimates of the adjustment speed P_1= -0.513 and P_2= -0.422 suggesting model convergence. The estimates are 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 were negative. It rejected 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 0.861. The study 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 (42.3 percent) and the OUT regime (57.7 percent). The study corroborates the work of Mohammad and Raghbendra (2016) who used the TAR and consistent TAR approach to establish the price asymmetry in wholesale and retail wheat and flour market in Bangladesh.

(C) Gombe - Enugu market prices of cowpea (Chain 3)

For Gombe and Enugu States market chain, it found out that the estimates of the adjustment speed P_1= -0.426 and P_2= -0.601 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 Gombe-Enugu States price of cowpea, the Tsay (1989) test found strong evidence of non-linearity in the error correction term (ε). The estimated F-statistics was 7.614 and was rejected at 1 percent level. This implies that the null of a linear AR process in the cointegrated vector was rejected at 1 percent level. The percent share of observation in the inside regime (deviations from the long-run in the interval [-θ, θ]) was 11 and outside regime was 15. This is a well distribution of observations, indicating that identified threshold is useful. Since nonlinearities are found in the error correction term, we proceed 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 was 1.225 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 (1997) tests also rejected the null hypothesis of no threshold effects at 1 percent level of significance. The max- F statistics value was 6.904 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 (Gombe State market) prices and the destination (Enugu State market) prices of cowpea. The F-statistics to test the null of symmetry presented in Table 4 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 estimates Enugu State market prices of cowpea with respect to Gombe State market prices. For Enugu State and Gombe market chain, it found that the estimates of the adjustment speed P_1= -0.617 and P_2= -0.596 suggest model convergence. The estimates were 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 were negative. It rejected 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 1.087. 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 `IN` regime (38.5 percent) and the OUT regime (61.5 percent). Therefore, transaction cost was responsible for the price transmission between Gombe State cowpea market as the source market and the destination markets of Abia, Imo and Enugu States. It causes price asymmetry in the price of cowpea between the markets. The work is in tandem with the work of Mohammad and Raghbendra (2016) who used the TAR and consistent TAR to establish the price asymmetry in wholesale and retail wheat and flour market in Bangladesh.

Conclusion

The study was carried out to investigate the effect of transaction cost on the market integration of cowpea between Gombe State (source market) and Abia, Imo and Enugu States (destination markets) The study ascertained that transaction cost has an effect on the market integration. This effect was proven by the market asymmetry of prices between the source and destination market prices of cowpea; with the threshold values of 0.983, 0.861 and 1.087 respectively 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 good distribution of observation in the `IN` regime (30.8, 42.3 and 38.5 percent) respectively and the OUT regime (69.2, 57.7 and 61.5 percent) respectively for Abia, Imo and Enugu State. Therefore, the study concluded that transaction cost has an effect on market integration. Tis affirm the assertion of Rodrigo *et al* (2015) that higher transaction cost can insulate the market and reduce trade flow.

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Table 1: Threshold vector error correction estimates and hypotheses tests for the

Model parameters/ Hypotheses tests/ Model diagnostics	Chain 1: GOP(c) -ABP(c)		Chain 2: GOP(c) -IMP(c)		Chain 3: GOP(c) -ENP(c)	
	GOP(c)	ABP(c)	GOP(c)	IMP(c)	GOP(c)	ENP(c)
P_1	-0.392*** (-5.896)	-0.560** (-3.508)	-0.687*** (5.975)	-0.454*** (-4.883)	-0.529*** (-7.989)	-0.586*** (-4.022)
P_2	-0.487*** (-7.415)	-0.409*** (-6.321)	-0.716*** (-9.023)	-0.368*** (3.537)	-0.669*** (-8.423)	-0.537*** (-2.922)
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	2.058	2.068	3.011	2.163	2.232	2.761
BIC	2.159	2.187	3.164	2.284	2.479	2.866
Hypothesis tests						
:Cointegration H_0: $P_1 = P_2 = 0$	35.679***	25.323***	11.409***	13.574***	14.296***	15.871***
Critical Values (5%)	6.51	6.51	5.98	6.51	5.98	6.01
Long-term symmetry (H_0: $P_1 = P_2$)	10.984***	14.961***	7.116***	13.285***	8.012***	12.616***
Model diagnostics						
LM test	1.469(0.253)	2.095(0.151)	0.328(0.725)	0.9(0.520)	1.380(0.413)	0.181(0.831)
ARCH Test	0.073(0.930)	1.382(0.251)	1.817(0.284)	0.125(0.883)	0.241(0.789)	1.365(0.537)
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

Source market (Gombe) and the destination markets (Abia, Imo and Enugu)

*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)*

Table 2: Consistent-TAR estimates and hypotheses test for Gombe-Abia, Imo and Enugu

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)	6.662***	5.843**	6. 173**	6.342**	7.614***	6.986**
Threshold cointegration test (bootstrap p-value)	7.113*** (0.000)	6.222*** (0.004)	5.783** (0.011)	4.968 ** (0.024)	6.904*** (0.000)	5.553 (0.027)
Estimated threshold (γ) using Chan`s (1993) grid search	1.442	0.983	1.106	0.861	1.225	1.087
Cointegration (H_0: $P_1 = P_2 = 0$) (F-stat)	11.639***	13.488***	12.662***	14.429***	12.006***	16.117***
Long-run asymmetry across regimes (H: $\rho_1 = \rho_2$) (F-stat)	3.991**	5.231***	5.211***	6.817***	4.195**	6.003***
P_1	-0.373*** (-5.783)	-0.448** (-3.436)	-0.611*** (7.717)	-0.513*** (-6.169)	-0.426*** (-5.776)	-0.617*** (-5.118)
P_2	-0.512*** (-6.337)	-0.413*** (-5.446)	-0.799*** (-8.563)	-0.422*** (4.917)	-0.601*** (-6.181)	-0.596*** (-4.289)
Number and percentage of observations in regime `IN`	10(38.5%)	8(30.8%)	9(34.6%)	11(42.3%)	11(42.3%)	10(38.5%)
Number and percentage of observations in regime `OUT`	16(61.5%)	18(69.2%)	17(65.4%)	15(57.7%)	15(57.7%)	16(61.5%)
Optimal lag length	0	0	0	0	0	0
Delay parameter	6	7	6	6	6	8

*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.*