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# Analysis of Spatial Market Integration and Price Transmission of Cowpea between Kano and Abia, Imo and Enugu States

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**Abstract**
The study of market integration has gained attention in recent times due to differences in the natural endowment of different regions. Regions with comparative advantage are encouraged to produce goods that can predominantly do well in their region and purchase their deficit. This suggests that there will be an inter dependence of one region on the other to meet their local needs. Market integration tries to measure the degree of change in price of similar goods as they move from one location to another especially from the source of production to consumption centre. The work investigated into price transmission of cowpea between source market of Kano State and destination markets of Abia, Enugu and Imo States. It used secondary data sources of monthly cowpea prices obtained from National Bureau of Statistics (NBS). The study tested the stationarity of the data series, then used the first difference of the series for the study. The researcher also conducted a cointegrated tested using the Johansen model. The trace and eigenvalue tests indicated one cointegrating vector between the source market and destination market prices of cowpea implying that the two price series were cointegraed. The ARDL model was used to establish the existence of long run relationship in the prices of cowpea in the different markets. The result of the bound test of the ARDL showed that there was a long run relationship between source and destination markets since the computed F- statistic was greater than both lower and the upper bound values at all level of significance tested ranging from 1-10 levels of significance. The study therefore concluded that there was a long run relationship in the prices of cowpea among the markets. An ECM value of -0.417295 was obtained. This implies that, the rate of adjustment of price of 42%, was relatively a slow rate of adjustment of the markets prices to equilibrium. The study recommends policies that ensure stability in prices of agricultural produces should be made; also government should provide good road network system between the source market and the destination markets which could further enhance market integration.

***Keywords: Market, prices, integration, transmission, shook, transfer***

## Introduction

Cowpea (*Vigna unguiculata* L. Walp) is one of the most economically and nutritionally important indigenous African grain legumes produced throughout the tropical and subtropical areas of the world (Yusuf and Aubakar, 2016). It plays a crucial role in the food supply of many as a major source of dietary protein that nutritionally complements staple low-protein cereal and tuber crops; a valuable commodity that produces income for both farmers and traders. It is widely utilized in the diet of man and animal with the nutritional values of about 25% of protein and 64% of carbohydrate (Akibode, 2011). With its nutritional values, it can be said that beans is one among the high source of plant protein to both man and animal that is affordable and easily prepared by many household hence, it is used as a food security crop to many in sub-Sahara region where food insecurity is high. Rusike *et al.* (2013) posited that, it sustains people who live on the very edge of existence, important for food security both as a major vegetable and grain sold in both forms in urban markets. Marketing is a component and complement of production, this is because production without sales is a complete loss and no individual ventures into production or business to incur loss. However, with efficient marketing of agricultural produces in general and cowpea in particular, wastage of produces can be curtailed. This could be achieved when there is a flow of trade between markets that are geographically separated; (market integration). Integrated markets can be defined as the markets that are connected through a process of arbitrage (Offor *et al.*, 2020).

Spatial integration /efficiency permits distant places to absorb excess local supply preventing excessive price falls that would otherwise hurt the profitability of local producers. There are mainly two forms of market integration, vertical market integration and spatial market integration (Meyer, 2004 in Yusuf and Abubakar, 2016). While vertical market integration refers to transmission of price signals from one marketing channel to another, spatial market integration means transmission of price signals between markets in different locations (Minot, 2010 cited in Yusuf and Abubakar 2016). Price transmission, the core of market integration, occurs when a change in one price in a market causes another price in another market to change. Spatial price efficiency examines how prices of homogenous produces in different markets over space are related, especially as a function of transportation cost. When spatial trade is efficient, food shortages in deficit regions are transmitted to surplus regions via prices and arbitrage triggers flow of food across space (Nuhu *et al*., 2009). Through efficient spatial arbitrage, the risk of crop failure in some regions is shared over a large market area, and prices are more stable and food shortage may be prevented. An important step toward improving the functioning of markets in this case is to understand the nature and manner of flow of the prices of produce in this case cowpea from the production area (source market) to consumption centre (destination market) hence the study analyzed spatial transmission of price of cowpea between Kano and Abia,Enugu and Imo States, Nigeria.

**Methodology**

The study was carried out in Kano state and three southeastern states of Nigeria namely Abia, Imo and Enugu states. Kano state is situated in the northern part of Nigeria; it represents the source market due to the fact that cowpea production is carried out in large capacity. While Abia, Imo and Enugu States represent the destination markets (consumption center). The study made use of cowpea (beans) monthly price data from secondary sources obtained from National Bureau of Statistics Abuja (NBS). The monthly price data obtained were from January 2016 to February 2018.According to Tomek and Robinson (1972), the relationship between prices in different markets which are physically separated could be analyzed using the spatial market integration concept. This can be done by utilizing the spatial equilibrium model. This model is developed by using the excess demand and excess supply curves from two regions involved in trade so that it is possible to make forecast of the prices formed in each market and the amount of the commodities to be traded. Some of the previous studies concerning the market integration of agricultural commodities referred to the Ravallion model McNew (1996). The study followed the Baylis *et al*. (2013) approach using the ADF test stationarity.

***Test for Stationarity***

The study used the Augmented Dickey-Fuller test as it is a widely used test for unit root of the series. The ADF is generated following the procedure of Baylis, *et al*. (2013).

$$\Delta PKa_t = \beta_0 + \beta_1 \Delta Ka_{t-1} + \beta_2 \Delta PAb_{t-1} + \cdots . + \beta_k \Delta PIm_{t-1} + \varepsilon_i \;....(1)$$

Where;

The vector PKa and PAb, PEn and PIm represents the price series in different markets representing the source market (Kano state, production centre) and the destination market (consumption centre) respectively, t is the regression residuals that behave as a white noise series. It is the deterministic part which can either be 0, a constant or a constant plus a linear time trend. The null hypothesis of ADF test is that the process has a unit root (non-stationary). A non - stationary time series is said to be integrated at order 1 denoted by I (1).

$$\Delta P_t = P_t - P_{t-1}, {}^{K}/_{t_3^1} \to \infty$$

The study similarly used the Johansen test to test the null hypothesis that there are at most r cointegration vectors in the system. The Johansen test involves the use of the trace test statistic and maximum eigenvalue test.

$$\lambda_{Trace} = -T \sum_{i=r+1}^{n} In(1 - \hat{\lambda}_{t)} .... \;.(2)$$

$$\lambda_{Max} = -TIn(1 - \hat{\lambda}_{r+1)} ....(3)$$

Market integration was analyzed using the Autoregressive Distributed Lag model (ARDL) adopted from Davids, (2017). The source market was Kano states while the destination markets were Abia, Enugu and Imo State. The general ARDL model is stated thus

$$PKa_t = C_0 + Ci_t + \sum_{i=1}^{PKa} \phi_1 \; PKa_{t-1} + \sum_{i=0}^{PAb} \beta_i \; Ab_{t-1} + \mu_{t....(4)}$$

Where;

$Pka_t$ = the monthly retail price in the source market during the time t Kano State Ka,

$Pkb_t$= the monthly retail price at destination markets at timet [Abia, (Ab) , Enugu (En), and Imo (Im) state] for each market pair.

Re-parameterization yields the error correction specification thus:

$$\Delta PKa_t = c_0 + c_{it} - \alpha(pka_{t-1} - \theta Pab_t) + \sum_{i=1}^{p-1} \delta p \; k_i \Delta Pka_{t-1} + \sum_{i=1}^{q-1} \delta^1 Pab_i \Delta PAb_{t-1} + \mu_{t....(5)}$$

$$\alpha = 1 - \sum_{j-1}^{p} ....(6)$$

The speed of adjustment and the long run coefficient

$$\theta = \frac{\sum_{j=0}^{q} \beta_j}{\alpha} ...... (7)$$

$\mu$ = error term, co, cit, $\delta$, $\delta^2$ are parameters estimated

The coefficient on the error correction term gives an indication of the length of time required for a shock that causes dis-equilibrium to be absorbed through the system. A negative coefficient confirms convergence back to equilibrium conditions following an external shock, while the magnitude of the coefficient is an indicative of the time required to return to equilibrium.

***Diagnostics Tests, Normality Test***

Jargue-Bera is a test statistic for testing whether the series is normally distributed. The test statistic measures the difference of the skewness and kurtosis of the series with those from the normal distribution. The statistic is computed as:

$$\text{Jarque-Bera } \frac{N}{6}\left\{S^2 + \frac{(k-3)^2}{4}\right\} \ldots (8)$$

Where S is the skewness, and K is the kurtosis. Under the null hypothesis of a normal distribution, the Jarque-Bera statistic is distributed as X 2 with 2 degrees of freedom. The reported Probability is the probability that a Jarque-Bera statistic exceeds (in absolute value) the observed value under the null hypothesis—a small probability value leads to the rejection of the null hypothesis of a normal distribution.

***Serial Correlation Lagrange Multiplier (LM) Test***

Unlike the Durbin-Watson statistic for autoregressive (AR) (1) errors, the LM test is used to test for higher order autoregressive moving average (ARMA) errors and is applicable whether there are lagged dependent variables or not. It is used when there is possibility that the errors exhibit autocorrelation. The null hypothesis of the LM test is that there is no serial correlation up to lag order P, where P is a pre-specified integer. The local alternative is ARMA (r, q) errors, where the number of lag terms P =max ®, q). This alternative includes both AR(P) and MA(P) error processes, so that the test may have power against a variety of alternative autocorrelation structures. The test statistic is computed by an auxiliary regression as follows. From an estimated regression;

$$Y_t - X_t\,\beta + \epsilon_t \ldots.(9)$$

Where, β are the estimated coefficients and E are the errors. The test statistic for lag order P is based on the auxiliary regression for the residuals e =

$Y - X\hat{B}$.....(10) and

$$\epsilon_t = x_t y + \left(\textstyle\sum_{\varepsilon=1}^{p} \alpha\varepsilon\,\epsilon_{t-\varepsilon}\right) + V_t \ldots(11)$$

Where, $y_t$ and $x_t$ = dependent and independent variables at period t.

***Heteroskedasticity***

Test The Breusch-Pagan-Godfrey test is a Lagrange multiplier test of the null hypothesis of no heteroskedasticity against heteroskedasticity of the form.

$$\sigma_t{}^2 = \sigma_h{}^2(Z_t\,\alpha\ ) \ldots (12)$$

Where, $z_t$ is a vector of independent variables. Usually this vector contains the repressor from the original least squares regression. From a given regression equation of

$$Y_t = \beta_1 + \beta_2 X_t + \beta_3 Z_t + e_t \ldots (13)$$

Where the b are the estimated parameters and e the residual. The test statistic is then based on the auxiliary regression

$$e^2{}_t = \alpha_0 + \alpha_1 X_t + \alpha_2 Z_t + \alpha_3 x^2{}_t + \alpha_4 Z^2{}_t + \alpha_5 X_t + v_{t....}$$

Where, Xt and Zt are independent variables, α0 – α5 are the estimated parameters and Yt = dependent variable.

***Ramsey's RESET Test***

RESET means for Regression Specification Error Test and was proposed by Ramsey (1969). The classical normal linear regression model is specified as:

Y = XB + e ….(15)

Where the disturbance vector e is presumed to follow the multivariate normal distribution $N(0,\sigma^2 I)$, Specification error is an omnibus term which covers any departure from the assumptions of the maintained model. Serial correlation, heteroskedasticity, or non-normality of all violates the assumption that the disturbances are distributed. In contrast, RESET is a general test for the following types of specification errors:

Omitted variables; X does not include all relevant variables; Incorrect functional form; some or all of the variables in Y and X should be transformed to logs, powers, reciprocals, or in some other way; Correlation between X and e, which may be caused, among other things, by measurement error in X, simultaneity, or the presence of lagged Y values and serially correlated disturbances.

Under such specification errors, LS estimators will be biased and inconsistent, and conventional inference procedures will be invalidated. Ramsey (1969) showed that any or all of these specification errors produce a non-zero mean vector for e. Therefore, the null and alternative hypotheses of the RESET test are:

$$H_{0;\,,}\ e \sim N(0, \sigma^2 I),$$
$$H_{1;\,,}\ e \sim N(\mu, \sigma^2 I), \quad (\mu \neq 0) \ldots.(16)$$

The test is based on an augmented regression:

$$y = X\beta + Zy + e \ldots (17\ )$$

The test of specification error evaluates the restriction Y = 0.

CUSUM of Squares Test

The CUSUM of squares test (Brown, Durbin, and Evans, 1975) is based on the test statistic

$$S_t = (\sum_{r=k+1}^{t} \omega^2 \ )/(\sum_{r=k+1}^{T} \omega^2 \ )....(18)$$

The expected value of $S_t$ = under the hypothesis of parameter constancy is:

$$E(S_t) = (t - k/T - K) \ .... (19)$$

Which goes from zero at t = k to unity at t = T. The significance of the departure of S from its expected value is assessed by reference to a pair of parallel straight lines around the expected value.

The CUSUM of squares test provides a plot of St against t and the pair of 5 percent critical lines. As with the CUSUM test, movement outside the critical lines is suggestive of parameter or variance instability. The cumulative sum of squares is generally within the 5% significance lines, suggesting that the residual variance is somewhat stable.

**Results and Discussion**

***ADF (Augmented Dickey Fuller) Test for Stationarity of the Series***

The result in Table 1 shows that the prices of cowpea at the different markets were not stationary at level. The null hypothesis was that, there was a unit root among the time series. For the source markets, the price of cowpea at Kano States was integrated at first difference I (1), with a deterministic constant. For prices of cowpea at the destination markets, Abia and Enugu States were integrated at first difference I(1) while Imo State was integrated at order zero I(0), with a deterministic constant and trend, Abia and Imo States were integrated at order zero I(0) while Enugu was integrated at first difference I(1) .This shows that there was a mixed specification of the order implying that the series were not consistent over time and cannot be trusted for making effective policy decisions. The prices of cowpea at both source and destination markets were influenced by time. The first differences of the price series of cowpea at the source and destination markets were generated and used in the study. Having establish the stationarity of the prices the study conducted the cointegration test to show the relationship between price of cowpea in the source and destination markets.

***Johansen cointegration test***

The result in Table 2 showed Kano State market of cowpea (source market) and the various markets of cowpea in Abia, Imo and Enugu States (destination markets), the null hypothesis of no cointegration was rejected against the alternative of at least one cointegration vector with p-value of 1 percent (LRtrace=26.874 and LRmax=20.542) whereas null of one cointegration vector could not be rejected (LRtrace = 4.332 and LRmax = 4.332) with p-value of greater than 10 percent for Kano-Abia State market chain. The study found similar result for Kano-Imo State market prices of cowpea where the null hypothesis of no cointegration was rejected against the alternative of at least one cointegration vector with p-value of 1 percent (LRtrace=22.550 and LRmax=17.405) whereas null of one cointegration vector could not be rejected (LRtrace = 4.145 and LRmax = 4.145) with p-value of greater than 10 percent. The study found Kano-Enugu State market prices of cowpea where the null hypothesis of no cointegration was rejected against the alternative of at least one cointegration vector with p-value of 1 and 5 percents (LRtrace=25.664 and LRmax=5.482) whereas null of one cointegration vector could not be rejected (LRtrace = 4.295 and LRmax = 5.482) with p-value of reater than 10 percent. Therefore, the Kano State (source market) price of cowpea and destination markets (Abia Imo and Enugu States) prices of cowpea are cointegrated. The study is similar to the work of Mayaka, (2013) who reported a trace statistic value greater than the critical value of 15.41 at 5 percent to establish a co-integrating relationship between Nairobi, Nakuru, Eldoret and Kitale markets of beans prices.

***Speed of adjustment of price of cowpea between the source and the destination markets***

The result in Table 3 showed the speed of adjustment estimate in Abia State (independent market) price of cowpea in Kano State (dependent) market price of cowpea was -0.049 with the p-value of 5 percent while the speed of adjustment estimate in Kano State (independent market) price of cowpea with respect to Abia State (dependent market) price of cowpea was -0.037 with the p-value of 5 percent. This indicates that the Kano market price for cowpea adjusts to the changes in Abia State market price of cowpea and vice versa and estimating both the Kano market price of beans and Abia State market price of cowpea might suffice the purpose. The result further indicates that it takes at most a month to correct the disequilibrium errors in both markets. For Imo State (independent market) prices of beans to Kano State (dependent market) the speed of adjustment estimate was -0.297 and was significant at 5% level, but the reverse of the estimate was insignificant (t = -0.772, P > 0.05). This indicates that only the Kano State market price for cowpea adjusts to the changes in Imo State market price of cowpea and it takes at most 3 months to correct the disequilibrium error. The result is similar to Sunga, (2017) who reported price transmission values between 4 months and considered it moderate transmission. For Enugu State (independent market) prices of beans with respect to Kano State (dependent market) price, the speed of adjustment estimate was -0.449 and was significant at 1% level, but the reverse of the estimate was insignificant (t = -1.136, P > 0.05). This indicates that only the Kano State market price for cowpea adjusts to the changes in Enugu State market price of cowpea and it takes at most 2 months to correct the disequilibrium error.

The causality (weak exogeneity, short-run causality and strong causality) tests were performed based on the estimated VECM Johansen framework. Table 4: Kano market price of cowpea as the source market and the destination market prices of cowpea in Abia, Imo and Enugu States, weak exogeneity results show unidirectional causality between the source market prices of cowpea and destination market prices of cowpea. The study is similar to Assunção and Wandez (2015) who reported weak exogeinty in the markets of Cristalina and Unaí at the 1% level. The $X^2$-test statistics 7.132, 6.508 and 9.440 for Kano-Abia, Kano-Imo and Kano-Enugu market prices of cowpea respectively were rejected at 5 percent level. In addition, strong exogeneity supports similar conclusions. The $X^2$-test statistics 13.761, 11.545 and 17.989 for Kano-Abia, Kano-Imo and Kano-Enugu market prices of cowpea respectively are rejected at 1 percent level. The study did not find short-run causality relationship for Kano-Abia, Kano-Imo and Kano-Enugu market prices of cowpea. These findings conform to *a prior* expectation of upstream prices dominating the prices at downstream. Also Mayaka, (2013) reported that Nairobi market Granger caused Kitale market. In order to confirm if there is integration (long run relationship) between price of cowpea at source and destination markets, the ARDL technique was used to establish market integration after testing the direction of price flow using the wald causality test.

***Estimation of the ARDL to ascertain market integration***

Table 5 showed the non - parameterized estimate of market integration of cowpea between source market (Kano State) price and the destination markets prices of Abia, Enugu and Imo State. The Autoregressive Distributed Lag (ARDL) result showed that cowpea prices at source market (Kano State) are integrated with prices at the destination markets in the South - east which are Enugu and Imo States. The $R^2$ value of 0.909476 implies that 90.9% of total variation in prices of cowpea in the source market (Kano State) was accounted for by changes in prices at the destination markets, Enugu and Imo States and vice versa. The F statistics value was 17.58188 and was significant at 1% level of significance. This implies the goodness of fit of the model. The variables that significantly influenced Kano were Enugu and Imo States.

The coefficient of the price of cowpea in Kano State at lag 1 was positively related and significant at 5%. This implies that previous periods in the own price of cowpea in Kano State leads to a significant change in its current price. The regression coefficient of lag 1 was 0.331526. This implies that increase in the previous month price of cowpea at Kano State leads to an increase in prices of cowpea in the current month and vice versa. The increase in price of cowpea at the source market (Kano State) in the previous month leads to an increase in supply by marketers in the current month. However, the glut supply in the current month leads to fall in price and hence increase in demand in the current month. The increase in demand in the current month causes prices to rise again until an equilibrium price is reached. The coefficient of price of cowpea in Enugu State at lag 2 was negatively related and significant at 5%, while Enugu price at lag 3 was positively signed and significant at 5%. The net effect of the lags price of cowpea in Enugu State was -0.449122. This implies that an increase in price of cowpea in the destination market (Enugu State) leads to a decrease in price of cowpea in the source market (Kano State). The net regression coefficient of -0.449122 implies that a unit increase in price of cowpea in the destination market (Enugu State) leads to a decrease in the price of cowpea at the source market (Kano State) by N 0.449122. The increase in prices of cowpea at the destination market leads to increase in demand for cowpea at the source market. This increase in demand leads to increase in price of cowpea at source markets. The increase in price could further leads to large supply and consequently fall in price in the source market. The findings corroborate the work of Hossain and Verbeke (2010) who reported that a unit increase in rice prices in Chittagong the importing or destination market leads to a decrease in rice prices in Rajshahi the exporting or source market by 0.2%. This implies that gains of cowpea price increases in the destination market Enugu State do not transfer to source market (Kano). The gains from increase in price are captured by marketers in the destination market. The coefficient of price of cowpea in Imo State at level was negatively signed and significant at 1%. This implies that an increase in price of cowpea in the destination market (Imo State) leads to a decrease in price of cowpea in the source market (Kano State). The coefficient of the regression of -0.150629 implies that a unit increase in price of cowpea in the destination market (Imo State) leads to an inelastic decrease in the price of cowpea at the source market Kano State by N 0.150629. The finding is in tandem with the work of Hossain and Verbeke, (2010) who ascertained that a unit increase in price of rice in the destination market leads to decrease in the price of rice in the source market by 0.2%, implying that gains from increase in price in the destination market were enjoyed by the marketers only.

***ARDL bound test for long run relationship between the source market (Kano) and the destination markets (Abia, Imo and Enugu) States***

The result of the bound test from Table 6 showed that there existed a long run relationship since the computed F- statistic is greater than both lower and the upper bound values at all level of significance tested. The study therefore rejected the null hypothesis that there is no long run relationship between price in the source market (Kano State) and the destination markets (Abia, Enugu and Imo States) and concluded that there existed a long run relationship in the price of cowpea among the markets.

***Long, short run and error correction mechanism (ECM) estimate of market integration between source market (Kano State) and destination Markets***

Table 7 shows the Autoregressive Distributed Lag (ARDL) result of the long run estimate of price of cowpea at source market (Kano State) and prices of cowpea at destination markets of Abia, Enugu and Imo States. The $R^2$ value of 0.852974 implies that 85.3% of total variation in prices of cowpea in the source market (Kano State) was accounted for by changes in prices at the destination markets, Abia, Enugu and Imo States and vice versa. The F- statistics value was 19.72511 and was significant at 1% level. This implies the goodness of fit of the model. The destination market price that showed significant long relationship with source market (Kano State) in the long run was Imo State while on the short run Enugu State had a relationship with Kano. The coefficient of Imo State had a negative sign and was significant at 10% level. This implies that there existed a long run relationship between the price of cowpea at source market prices (Kano State) and Imo State. This implies that a unit increase in the price of cowpea in the destination market (Imo State), leads to a decrease in price of cowpea at the source market (Kano State). The regression coefficient of -0.360965, implies that a unit naira increase in the price of cowpea at the destination market leads to an elastic decrease by N -0.360965 in the price of cowpea in the source market (Kano State). This is not in line with *a priori* expectation but could occur if the increase in price of cowpea in Imo State leads to reduction in the demand for cowpea by consumers and hence decrease in demand by marketers at the source market. The reduction in demand from both markets could lead to reduction in price of cowpea in the source market all things being equal. The findings are in consonance with the work of Hossain and Verbeke, (2010) who reported that a unit increase in the market price of rice in the destination market leads to a decrease in price of rice in the source market.

Table 7 also shows the short run estimate of price of cowpea at source market (Kano State) and prices of cowpea at destination markets of Enugu and Imo States. The coefficient of cowpea price of Enugu State at lag 1 had a positive sign and was significant at 5 % level while price at lag 2 was negative and significant at 5%. This implies that there existed a short run relationship or equilibrium condition between the price of cowpea at source market price (Kano State) and Enugu State. The net effect of the lags of price was 0.211088. This implies that a unit increase in the price of cowpea in the destination market (Enugu State), leads to an increase in the price of cowpea at the source market (Kano State). The net regression coefficient of 0.211088 implies that a unit naira increase in the price of cowpea at the destination market leads to an increase by N 0.211088 in the price of cowpea in source market (Kano State). This work is in agreement with the work of Anzaku *et al* ., (2016) who reported that a unit change in the price of sesame in Akwanga the destination market leads to an increase in the price of sesame in Keffi by 0.10077%.

The coefficient of Imo State cowpea prices had a negative sign and was significant at 1% level. This implies that there existed a short run relationship between the prices of cowpea at Kano and Imo State. However, a unit increase in price of cowpea in Imo leads to a reduction in the price of cowpea in Kano State. The regression coefficient of -0.150629 implies that a unit naira increase in the price of cowpea at the destination market leads to a decrease by N 0.150629 in the price of cowpea in source market (Kano State). The finding is in agreement with Hossain and Verbeke, (2010) who reported that a unit increase in the market price of rice in the destination market leads to a decrease in price of rice in the source market.

The Error Correction Mechanism estimate had a negative sign and was significant at 5%. This implies the speed of adjustment or the rate of feedback or shock of prices that is transmitted or transferred to another market that is spatially separated from one another. ECM value was -0.417295 which implies the rate of adjustment of price is 41.7 percent suggesting a relatively slow rate of adjustment of the two markets to equilibrium. Zakari *et al*. (2014) had a similar findings that Togo market price of maize had a negative effect on the Niger market; that the error correction term (ECT) that measured the speed of adjustment to the equilibrium level had a negative sign and statistically significant and that the rate of correction was about 48.23 percent. This further suggest that it takes exactly 15 months and 2 days for prices disequilibrium between the source market of Kano State and the destination markets of Enugu and Imo States to adjust to equilibrium in the long run. This slow transmission could be due to long distance between source and destination market.

Breusch-Godfrey Serial Correlation LM was conducted to test for serial correlation of variables, the test shows that they were not significant hence we concluded that variables were not serially correlated. More so the heteroskedasticity test was also carried out using the Breusch-Pagan-Godfrey test. The test result showed that independent variables were not correlated with error term. This implies that the error term is independent of the exogenous variables.

***Cusum squares test of stability of the time series for Kano State***

The cusum square test of stability of price of cowpea of Kano –Abia, Imo and Enugu States are presented in Figure 1. The result of the Cusum of squares test that detects the stability of the model when the blue line is within the bound of the red line also proved that the model was stable. Therefore, it concluded that there existed a log run relationship between the prices of cowpea in the source market (Kano State) and destination markets Abia, Enugu and Imo States.

**Conclusion**

The study looked into price transmission and integration of beans price between Kano and Abia, Imo and Enugu States. The Autoregressive Distributed Lag (ARDL) result showed a long run estimate of price of cowpea at source market (Kano State) and prices of cowpea at destination markets of Abia, Enugu and Imo States. The $R^2$ value of 0.852974 implies that 85.3% of total variation in prices of cowpea in the source market (Kano State) was accounted for by changes in prices at the destination markets, Abia, Enugu and Imo States and vice versa .The result showed that the market prices were integrated, but the rate of shook transmission was relatively low. The study therefore recommends that policies that ensures price stability of agricultural produce be put in place, also government should improve on road infrastructure in order to enhance higher integration of the market prices in the study area.

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**Table1: Unit root test Kano State**

| | Constant Level | $1^{st}$ diff. | Order of integration | Constant and trend Level | $1^{st}$ diff. | Order of integration |
|---|---|---|---|---|---|---|
| Source market | | | | | | |
| Kano | -3.414 | -7.360*** | I(1) | -2.884 | -8.483*** | I(1) |
| Destination Market | | | | | | |
| Abia | -1.746 | -5.475*** | I(1) | -5.742*** | | 1(0) |
| Enugu | -2.154 | -5.370*** | I (1) | -1.456 | -6.164*** | I(1) |
| Imo | 3.776*** | | I(0) | -5.700*** | | I(0) |

***MacKinnon (1996) one-sided p-values *, ** and *** indicates 1 %,5% and 10% level of significance***

**Table 2: Johansen cointegration rank test**

| | Tests | Chains | Test statistics | Critical values | Decision |
|---|---|---|---|---|---|
| KAP(c) -ABP(c) | $\lambda_{trace}$ | r = 0 vs r ≥ 1 | 26.874*** | 18.398 | Rejected |
| (l=2; AIC, BIC) | | r ≤ 1 vs r ≥ 2 | 4.332 | 3.841 | Not rejected |
| | $\lambda_{max}$ | r = 0 vs r ≥ 1 | 20.542*** | 17.148 | Rejected |
| | | r ≤ 1 vs r ≥ 2 | 4.332 | 3.841 | Not rejected |
| KAP(c) -IMP(c) | $\lambda_{trace}$ | r = 0 vs r ≥ 1 | 22.550*** | 18.398 | Rejected |
| (l=2; AIC, BIC) | | r ≤ 1 vs r ≥ 2 | 4.145 | 3.841 | Not rejected |
| | $\lambda_{max}$ | r = 0 vs r ≥ 1 | 17.405** | 17.148 | Rejected |
| | | r ≤ 1 vs r ≥ 2 | 4.145 | 3.841 | Not rejected |
| KAP(c) -ENP(c) | $\lambda_{trace}$ | r = 0 vs r ≥ 1 | 25.664*** | 18.398 | Rejected |
| (l=2; AIC, BIC) | | r ≤ 1 vs r ≥ 2 | 5.482 | 3.841 | Not rejected |
| | $\lambda_{max}$ | r = 0 vs r ≥ 1 | 19.182** | 17.148 | Rejected |
| | | r ≤ 1 vs r ≥ 2 | 5.482 | 3.841 | Not rejected |

***Notes: Model includes only drift in the cointegration space; *** and ** indicates significant at 1 percent and 5 percent, respectively. LR =likelihold ratio***

**Table 3: Test for Speed of adjustment**

| Vertical markets | Estimates | Standard errors | t-statistics |
|---|---|---|---|
| KAP(c) -ABP(c) | -0.049** | 0.023 | -2.081 |
| | -0.037** | 0.015 | -2.492 |
| KAP(c) -IMP(c) | -0.297** | 0.142 | -2.094 |
| | -0.446 | 0.577 | -0.772 |
| KAP(c) -ENP(c) | -0.449*** | 0.153 | -2.942 |
| | -0.134 | 0.118 | -1.136 |

***Note: *** and ** indicates level of significance at 1 percent and 5 percent, respectively***

**Table 4: Wald causality test of prices of beans prices**

| Chains | Causations | Hypotheses | $\chi^2$-test statistics | Causality |
|---|---|---|---|---|
| Kano-Abia | Weak exogeneity | $\alpha_1 = 0$ *vs* $\alpha_1 \neq 0$ | 7.132** | KP(c) → ABP(c) |
| | | $\alpha_2 = 0$ *vs* $\alpha_2 \neq 0$ | $1.996^{ns}$ | |
| | Short-run causality | $\Sigma\beta_i = 0$ *vs* $\Sigma\beta_i \neq 0$ | $0.474^{ns}$ | KP(c) ≠ ABP(c) |
| | | $\Sigma\beta_j = 0$ *vs* $\Sigma\beta_j \neq 0$ | $1.627^{ns}$ | |
| | Strong exogeneity | $\Sigma\beta_i = 0, \alpha_1 = 0$ *vs* $\Sigma\beta_i \neq 0, \alpha_1 \neq 0$ | 13.761*** | KP(c) → ABP(c) |
| | | $\Sigma\beta_j = 0, \alpha_2 = 0$ *vs* $\Sigma\beta_j \neq 0, \alpha_2 \neq 0$ | $1.545^{ns}$ | |
| Kano- Imo | Weak exogeneity | $\alpha_1 = 0$ *vs* $\alpha_1 \neq 0$ | 6.508** | KP(c) → IMP(c) |
| | | $\alpha_2 = 0$ *vs* $\alpha_2 \neq 0$ | $1.448^{ns}$ | |
| | Short-run causality | $\Sigma\beta_i = 0$ *vs* $\Sigma\beta_i \neq 0$ | $0.195^{ns}$ | KP(c) ≠ IMP(c) |
| | | $\Sigma\beta_j = 0$ *vs* $\Sigma\beta_j \neq 0$ | $0.651^{ns}$ | |
| | Strong exogeneity | $\Sigma\beta_i = 0, \alpha_1 = 0$ *vs* $\Sigma\beta_i \neq 0, \alpha_1 \neq 0$ | 11.545*** | KP(c) → IMP(c) |
| | | $\Sigma\beta_j = 0, \alpha_2 = 0$ *vs* $\Sigma\beta_j \neq 0, \alpha_2 \neq 0$ | $1.485^{ns}$ | |
| | Weak exogeneity | $\alpha_1 = 0$ *vs* $\alpha_1 \neq 0$ | 9.440*** | KP(c) → ENP(c) |
| Kano- Enugu | | $\alpha_2 = 0$ *vs* $\alpha_2 \neq 0$ | $1.876^{ns}$ | |
| | Short-run causality | $\Sigma\beta_i = 0$ *vs* $\Sigma\beta_i \neq 0$ | $1.548^{ns}$ | KP(c) ≠ ENP(c) |
| | | $\Sigma\beta_j = 0$ *vs* $\Sigma\beta_j \neq 0$ | $1.806^{ns}$ | |
| | Strong exogeneity | $\Sigma\beta_i = 0, \alpha_1 = 0$ *vs* $\Sigma\beta_i \neq 0, \alpha_1 \neq 0$ | 17.989*** | KP(c) → ENP(c) |
| | | $\Sigma\beta_j = 0, \alpha_2 = 0$ *vs* $\Sigma\beta_j \neq 0, \alpha_2 \neq 0$ | $2.194^{ns}$ | |

***es: → and ≠ means unidirectional causality and no causality, respectively. ***and ** indicates level of significance at 1 percent and 5 percent, respectively***

**Table 5: Non parameterized ARDL result of market integration of cowpea between source market (Kano State) price and the destination markets Abia, Enugu and Imo States prices**

| Variable | Coefficient | Std. Error | t-Statistic |
|---|---|---|---|
| LOG(KANO(-1)) | 0.331526 | 0.154838 | 2.141117** |
| LOG(KANO(-2)) | 0.251179 | 0.146959 | 1.709177 |
| LOG(ABIA) | -0.012593 | 0.230496 | -0.054636 |
| LOG(ENUGU) | 0.160475 | 0.269720 | 0.594970 |
| LOG(ENUGU(-1)) | 0.390793 | 0.275252 | 1.419765 |
| LOG(ENUGU(-2)) | -0.839915 | 0.302487 | -2.776695** |
| LOG(ENUGU(-3)) | 0.628827 | 0.268188 | 2.344724** |
| LOG(IMO) | -0.150629 | 0.033156 | -4.542984*** |
| Constant | 1.314987 | 0.600312 | 2.190507** |
| R-squared | 0.909476 | | |
| Adjusted R-squared | 0.857748 | | |
| F-statistic | 17.58188*** | | |
| Durbin-Watson stat | 2.259642 | | |

***Source: Computed from NBS, January 2016-February 2018 (data on cowpea Kano, Abia , Enugu and Imo States)***

**Table 6: ARDL bound test for long run relationship between the source market and the destination markets**

| **F-Bounds Test** | | **Null Hypothesis: No levels relationship** | | |
|---|---|---|---|---|
| Test Statistic | Value | Significance. | I(0) | I(1) |
| F-statistic | 9.639590 | 10% | 2.72 | 3.77 |
| K | 3 | 5% | 3.23 | 4.35 |
| | | 2.5% | 3.69 | 4.89 |
| | | 1% | 4.29 | 5.61 |
| t-Bounds Test | | Null Hypothesis: No levels relationship | | |
| Test Statistic | Value | Significance. | I(0) | I(1) |
| t-statistic | -6.842578 | 10% | -2.57 | -3.46 |
| | | 5% | -2.86 | -3.78 |
| | | 2.5% | -3.13 | -4.05 |
| | | 1% | -3.43 | -4.37 |

***Source: Computed from NBS, January 2016-February 2018 (data on cowpea Kano, Abia, Enugu and Imo States)***

**Table 7: Long, Short Run and Error Correction Mechanism (ECM) Estimate of Market Integration Between Source Market (Kano State) and Destination Markets**

| Variable | Coefficient | Std. Error | t-Statistic |
|---|---|---|---|
| **Long Run** | | | |
| LOG(ABIA) | -0.030179 | 0.553458 | -0.054527 |
| LOG(ENUGU) | 0.815207 | 0.563331 | 1.447119 |
| LOG(IMO) | -0.360965 | 0.185054 | -1.950592* |
| C | 3.151219 | 2.225414 | 1.416015 |
| **Short Run** | | | |
| DLOG(KANO(-1)) | -0.251179 | 0.146959 | -1.709177 |
| DLOG(ABIA) | -0.012593 | 0.230496 | -0.054636 |
| DLOG(ENUGU) | 0.160475 | 0.269720 | 0.594970 |
| DLOG(ENUGU(-1)) | 0.839915 | 0.302487 | 2.776695** |
| DLOG(ENUGU(-2)) | -0.628827 | 0.268188 | -2.344724** |
| DLOG(IMO) | -0.150629 | 0.033156 | -4.542984*** |
| CointEq (-1) | -0.417295 | 0.177725 | -2.347977** |
| R –Squared | 0.852974 | | |
| Adjusted R –Squared | 0.809731 | | |
| F-statistic | 19.72511*** | | |
| Durbin-Watson stat | 2.159642 | | |
| Breusch-Godfrey Serial Correlation LM Test | 1.142166 | | |
| Heteroskedasticity Test: Breusch-Pagan-Godfrey | 0.824401 | | |

***Source: Computed from NBS, January 2016-February 2018 (data on cowpea Kano, Abia, Enugu and Imo States)***

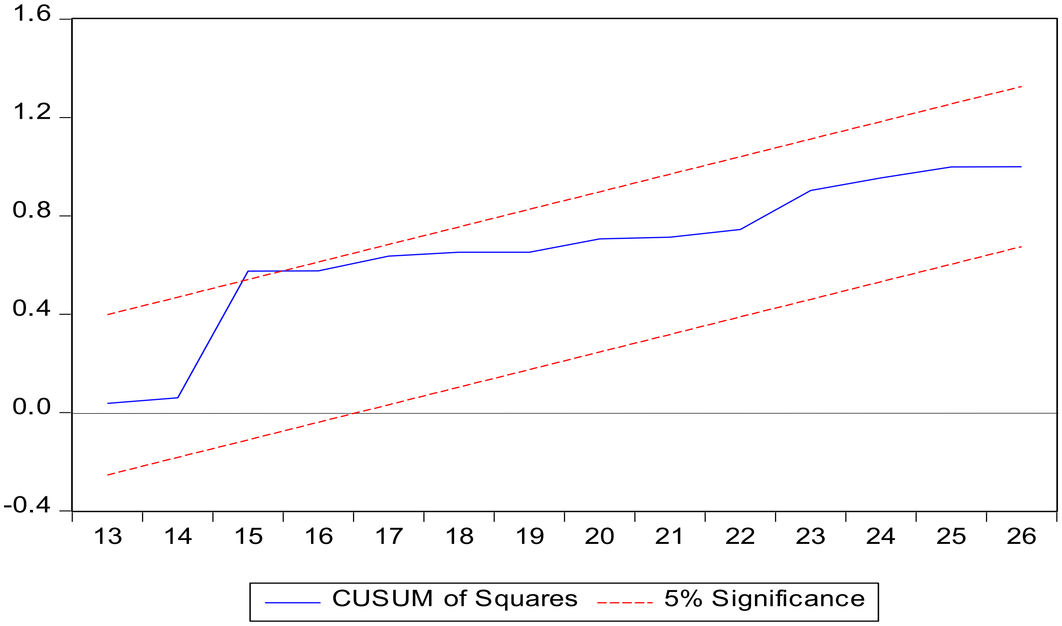


***Figure 1: Cusum square test of stability***
***Source: Computed from NBS, January 2016-February 2018 (data on cowpea Kano, Abia, Enugu and Imo States)***