Analysis of Rice Market Integration and Price Transmission in the North East/West Zones, Nigeria

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ABSTRACT

The study analyses rice market integration in the North East and the North West zones in Nigeria. Rice price data from 1999 - 2018 was obtained from the National Bureau of Statistics (NBS), National Agricultural Extension Research and Liaison Services (NAERLS), and Federal Ministry of Agriculture and Rural Development (FMARD). The data were subjected to analysis using the Augmented Dickey-Fuller test, Johansen Cointegration test, Error Correction Model, and Multiple Regression model. The result reveals that market price series were not stationary at level, but became stationary after first difference at either $p < 0.01$ or $p < 0.05$. The findings also establish that 58% of the markets were integration. However, the speed of price adjustment to long-run equilibrium for most states is very slow. The result also reveals that the significant factors that determine the cointegration of rice markets are: the distance between markets ($p < 0.001$) and per capita production ($p < 0.001$) in the supplying market. Also, good road infrastructure leads to a higher degree of market integration. The study recommends the implementation of viable pricing policies, rehabilitation of the existing road networks, construction of feeder roads, and adoption of measures to increase rice production.

Keywords: Cointegration, ECM, Rice market, Price transmission.

1.0 INTRODUCTION

Agricultural marketing plays a vital role in economic development of a nation. It serves as a link between production sector and other sectors such as processing and consumption sectors. As such, marketing aspect should be given due consideration as production aspect was given (Mafimisebi, 2012). Economically, it could be argued that an increase in production without a corresponding well-developed and efficient marketing system may amount to wastage of resources. An efficient marketing system is one where there are a perfect integration and an instantaneous price adjustment to changes from within or outside the system (Adesola, and Rahji, 2015). Market integration is generally defined through the Law of One Price (LOP), which states thatgiven free tradearbitrage would equalize prices of the same good in different markets up to the transaction cost (Nzeyimana, 2016). Therefore, spatial market integration refers to a situation in which prices of a commodity in spatially separated markets move together and price signals and information transmitted smoothly across the markets. Stabilization of prices or reducing price volatility for agricultural produce remains one of the present administration's policies (Federal Ministry of Agriculture and Rural Development, FMARD, 2016). In most cases, prices are stabilized when markets are well integrated and thus operated as a single market. A scenario that makes price chocks be transmitted from one market to another.

Since Northern Nigeria remains the most producing region in terms of rice production, rice markets in the region should be integrated in such a way that prices in all the markets would move together. A price increase in one market should induce price increase in another market and vice versa. However, the current situation of lousy road networks across the Northeast and the Northwest zones and the inconsistency in government policies concerning price stabilization might lead to market segregation. Where each market will act independently of the other. If such happens, there will be high rice price variation across the region, and only intermediaries will benefit at the expense of both consumers and producers (Layade and Adeoye, 2014).

Therefore, this article studies rice market integration in the Northeast and the Northwest zones to ascertain how they operate. Specifically, the objectives of the study are to: identify integrated rice markets in the zones, assess the degree of the integration, determine the order and direction of the short- and long-term equilibrium relationship of the cointegrated markets, and determine factors that influence market integration. This will go a long way in helping policymakers to design and implement rice production policies for ensuring food security in the country.

2.0 MATERIALS AND METHODS

The study area is the North-East zone which comprises Adamawa, Bauchi, Borno, Gombe, Taraba, and Yobe states; and the North West zone which comprises of Kaduna, Kano, Jigawa, Katsina, Kebbi, Sokoto, and Zamfara states. Secondary data from the National Bureau of Statistics (NBS), National Agricultural Extension Research and Liaison Services (NAERLS), and Federal Ministry of Agriculture and Rural Development (FMARD) were used. The data were subjected to Augumented Dickey Fuller unit root test, Johansen Cointegration Test, and Error Correction Model (ECM). Multiple Regression was separately used to determine factors influencing market integration, where trace statistics generated from the cointegration analysis were used as the dependent variable in the multiple regression. Overall, Eviews version 7.1 was used to generate all the required parameter estimates.

2.1 Specification of the Co-integration Test

All the states in the North East and the North West zones were paired based on the existence of trade between them. Each pair consists of two markets: market *i* and market *j*. Monthly prices, P_i and P_j, for thirty-six months from each market was used for the analysis. The analysis begins by testing for stationarity of the price series using Augmented Dickey Fuller (ADF) test.

2.1.1 Unit Root Test

The general form of the ADF test is estimated by the following regression:

$$\Delta y_t = \alpha_0 + \beta y_{t-1} + \sum_{i=1}^{n} \alpha_1 \Delta y_{t-i} + e_t \quad \ldots\ldots\ldots (1)$$

Where y is the price series, Δ is the first difference operator, is a constant, n is the optimum number of lags in the dependent variable and is the random error term. The ADF test relies on rejecting the null hypothesis of unit root in favour of the alternative hypotheses of stationarity. A unit root is present if the coefficient of the lagged dependent variable is zero (i.e β = 0), that means the series is not stationary. But if β is not equal to zero, it signifies that the series is stationary; it has constant mean, variance and covariance. Therefore, it can be used for modelling and forecasting.

2.1.2 Cointegration Test

The Johansen cointegratio test method is mostly used to test for cointegration in a system of equations while Engle granger two steps is the preferred method for testing cointegration in a bivariate equation. The Johansen's methodology takes its starting point in the vector auto regression (VAR) of order P given by

$$Y_t = \mu + \Delta_1 y_{t-1} + \ldots + \Delta p y_{t-p} + e_t \quad \ldots\ldots\ldots\ldots\ldots (2)$$

Where Yt is an nx1 vector of variables that are integrated of order commonly denoted by (1) and εt is an nx1 vector of innovations. This VAR can be rewritten as

$$\Delta_t = \mu + \Pi_{t-i} + \sum_{i-1}^{p-1} \tau \Delta y_{t-1} + \varepsilon_t \quad \ldots\ldots\ldots\ldots\ldots (3)$$

Where $\Pi = \sum_{j-1}^{p} A_{i=1}$ and $\tau = -\sum_{j=i+1}^{p} Aj$ .... (4)

To determine the number of co-integrating vectors, Johansen and Juselius (1990) suggested two statistic tests. The first one is the trace test (λ trace). It tests the null hypothesis that the number of distinct cointegrating vector is less than or equal to q against a general unrestricted alternatives q = r. The test is calculated as follows:

$$J_{trace} = -T \sum_{i=r+1}^{n} \ln(1 - \lambda_i) \quad \ldots\ldots\ldots (5)$$

Where T is the number of usable observations, and the λ,s are the estimated eigenvalue from the matrix.

The Second statistical test is the maximum eigenvalue test (λ max) that is calculated according to the following formula

$$J_{max}(r, r+1) = -T \ln(1 - \lambda_{r+1}) \quad \ldots\ldots\ldots\ldots (6)$$

The test concerns a test of the null hypothesis that there is r of co-integrating vectors against the alternative that r + 1 co-integrating vector.

However, despite the fact that the Johansen Cointegration method is usually applied to system of equations, we still use it on the bivariate markets price series in this study so that the trace statistics generated can be further used as the dependent variable when analysing the factors influencing rice market cointegration later on. This method is adopted from the methodology used by Gonzalo, *et al.* (2015). The process involves using Eviews 7.1 to run the Johansen cointegration test on price series of two tradable markets *i* and *j*. The software automatically generates the trace statistics, and the trace is used to determine the nature of the cointegration between the market price series. Intuitively, if the values of the trace statistics is higher than the critical value (15.0), then we conclude that there is cointegration between the series, but if the values are lower than the critical value we can now say there is absence of cointegration between the series. Thus, the higher the values of the trace statistics the higher the degree of cointegration between series and vice versa.

Error Correction Model

This is only carried out when cointegration is proven to exist; it requires the construction of error correction mechanism to model dynamic relationship. The purpose of the error correction model is to indicate the speed of adjustment from the short-run equilibrium to the long-run equilibrium state. The greater the co-efficient of the parameter, the higher the speed of adjustment of the model from the short-run to the long-run. The error correction model (ECM) is formulated as follows:

$$\Delta Y_t = \alpha + \beta \Delta X_t + \delta \mu_{t-1} + V \quad \text{..................} (7)$$

Where: Y = price in market i; X = price in market j; β = short-run coefficient; Δ = the first difference operator; δ = the error correction coefficient; and = one period lag residual obtained from the regression of Y_t on X_t (both at level). The term,, is known as error correction term; it guides the variables of the system to restore back to equilibrium. The sign before δ should be negative after estimation. The coefficient δ tells us at what rate it corrects the previous period disequilibrium of the system. When δ is significant and contains negative sign, it validates that there exists a long run equilibrium relationship between variables stated in the model.

2.3 Specification of the Multiple Regression model

Here, multiple regression model is used to determine factors affecting spatial markets integration. The empirical model is as follows:

$$TS_{ij} = \beta_0 + \beta_1 \text{Dist} + \beta_2 \text{Infr} + \beta_3 \text{Output}PC_i + \beta_4 \text{Output}PC_j + e_i \quad \text{.......} (8)$$

Whereas: following Gonzalo *et al*. (2013),

TS_{ij}= test statistic of the cointegration test between a pair of markets *i and j* (Johansen's trace statistic). A high value of that test statistic provides evidence of strong co-movement of prices and, therefore, spatial integration; a low value points to the opposite. *Dist*= It measures the distance between the integrated markets.

Infra = measures the quality of roads as the proportion of asphalted roads in total roads. *OutputPC* = is the annual average output of the commodity (kg) divided by the state's population.

3.0 RESULTS AND DISCUSSION

3.1 Unit Root Test

Table 1 shows that all state price series were not stationary at level. However, after first differencing, all of the variables became stationary at either 1% or 5% levels. Meaning that they were generated from the same stochastic process and capable of exhibiting long-run relationships between them.

Table 1: Unit Root Test for State Price Series

	At Level		At First Difference	
State	ADF	p-value	ADF	p-value
Adamawa	0.9058	0.9932	-3.1338**	0.0419
Bauchi	0.6273	0.9865	-3.2416**	0.0341
Borno	1.7681	0.9992	-3.5191**	0.0197
Gombe	0.2550	0.9688	-3.3763**	0.0262
Jigawa	1.4584	0.9980	-3.8693*	0.0104
Kaduna	2.5584	0.9999	-3.1405**	0.0413
Kano	2.0261	0.9996	-4.2169*	0.0048
Katsina	1.2950	0.9974	-5.0613*	0.0009
Kebbi	2.4403	0.9999	-5.2253*	0.0006
Sokoto	1.6677	0.9990	-5.0153*	0.0010
Taraba	-0.9214	0.7570	-3.0742**	0.0469
Yobe	0.4978	0.9777	-3.3392**	0.0282
Zamfara	0.9363	0.9937	-4.0900*	0.0062

*Source: Eview's estimate using data from NAERLS. *and ** denotes significance at 1% and 5%. MacKinnon critical values of ADF statistics are -3.8574 (1%) and 3.0404 (5%). H_0 = there is a unit root. If the ADF value is greater in absolute value than the critical value, the H_0 is rejected.*

3.2 Johansen Cointegration Test on Pairs of State Price Series

Table 2 shows that the degree of integration between Kano and Jigawa states (22.25), is higher than between Kano and Gombe states (15.69). The reason for this difference could be attributed to the distance between the states. Jigawa is closer to Kano than Gombe state. However, distance is not the only factor that determines integration between spatially separated markets, other factors such as production per capita also plays a vital role in facilitating markets cointegration.

On the other hand, the result on Table 2 shows no cointegration between Yobe and Kano state as the trace value (6.39) is less than the critical value. Likewise, there is no cointegration between

Jigawa and Adamawa state (12.34). Clearly it shows that existence of bilateral trade between spatially separated markets does not necessarily warrant cointegration. Therefore, two markets can trade same commodity but its price in each market may move independently.

In consideration of all the paired markets in Table 2, about 58% of them are found to be spatially cointegrated. Thus, majority of the rice markets in the study area are cointegrated, with Kano market being "a hub" where most of the markets in the North East and the North West have either direct or indirect link with it.

Table 2: Trace Statistics for Rice

State	Sokoto	Bauchi	Kaduna	Kebbi	Borno	Yobe	kano	Katsina	Gombe	Jigawa	Taraba	Adamawa	Zamfara
Sokoto													
Bauchi													
kaduna	**17.23**	-											
Kebbi	7.060	-	**15.333**										
Borno	-	-	-	-									
Yobe	-	7.443	-	-	**18.783**								
Kano	**18.34**	5.425	**18.02**	5.184	5.069	6.393							
Katsina	10.772	-	-	**19.98**	-	-	**15.305**						
Gombe	-	**25.601**	-	-	**29.398**	**22.569**	**15.688**	-					
Jigawa	-	7.571	**20.62**	5.899	-	-	**22.254**	13.390	**23.827**				
Taraba	-	-	-	-	8.51	-	**17.086**	-	**31.599**	**16.099**			
Adamawa	-	-	-	-	3.534	-	**18.527**	-	**27.905**	12.344	6.502		
Zamfara	**16.225**	-	-	4.634	-	-	-	**24.132**	-	-	-	-	

Source: Eviews 7.1 output. (1) The Critical value at 5% is 15.50. (2) Significant coefficient in bold (3) Trace statistics is the market integration proxy

This is evident from the number of significant traces between Kano and other states. Moreover, Kano is the most developed state in the entire North in terms of commercial activities. Particularly, it has large number of rice processing industries which allows marketers to supply paddy rice from various states for processing and milling.

Generally, the implication of the significance of the traces is that a price change in one market induces change in price in another market, all things being equal. In other words, smooth price transmission do take place between cointegrated markets. This could allow efficient implementation of government policy measures such as price control. In cointegrated markets, if government imposes regulations on one strategic market, the effect would be transferred automatically to other markets without effort dublication because all cointegrated markets act as a single market.

The result obtained from this study is similar to other studies such as Emokaro and Ayantoyinbo (2014) who found that rice markets in Osun state were cointegrated; Ikudayisi and Rahji (2015) who reported a strong and stable price linkages across some states in the North and some in the South which engaged in Onion marketing; and Makama and Amruthat (2016) who reported the existence of a long-run relationship between India and Nigeria with regards to rice trading.

3.4 Error Correction Model

Having established the cointegration relationship between series of state prices, it is equally important to estimate short- and long-run coefficients so as to determine the speed of price adjustment. This is done by the use of ECM and the result is presented in Table 4. Here, not all the cointegrated series are considered for EC analysis, rather only pairs that have significant relationship were used. This is to minimize the number of equations that might be used for ECM, considering the fact that selecting few states that have significant relationship would generally give the desired result.

3.5 Price Transmission between States

The Error Correction Term (ECT), which measures the speed of price adjustment to long-run equilibrium for most of the pair states, was very low (Table 4). Taking Adamawa and Gombe states as an example, the ECT is -0.3677 which means that the rate of price transmission between the two states is about 37 percent per annum.

Table 4: ECM of interstate pairs in the North East and the North West

Variable Y	X	Coeff	Std.Err	t-stat	Prob.	R^2
	C	0.0235	0.0171	1.3730	0.1887	
D(LADA)	D(LGOM)	0.6500***	0.1196	5.4371	0.0001	0.6632
	UL(-1)	-0.3677**	0.1626	-2.2617	0.0380	
	C	0.0539	0.0110	4.8883	0.0002	
D(LBOR)	D(LGOM)	0.1942**	0.0814	2.3871	0.0297	0.0758
	UL(-1)	-0.0581	0.0460	-1.2632	0.2246	
	C	0.0612	0.0302	2.0307	0.0592	
D(LJIG)	D(LGOM)	-0.1177	0.2308	-0.5100	0.6170	0.0209
	UL(-1)	-0.0847	0.1236	-0.6848	0.5033	
	C	0.0500	0.0263	1.9046	0.0750	
D(LKAN)	D(LGOM)	-0.0211	0.1967	-0.1072	0.9159	0.0418
	UL(-1)	-0.0981	0.1380	-0.7111	0.4872	
	C	0.0111	0.0148	0.7508	0.4637	
D(LTAR)	D(LGOM)	0.8783***	0.1000	8.7824	0.0000	0.8333
	UL(-1)	-0.6432	0.1905	-3.3772	0.0038	
	C	0.0494	0.0158	3.1267	0.0065	
D(LKAD)	D(LKAN)	0.0657	0.1540	0.4269	0.6751	0.4706
	LU(-1)	-0.5557***	0.1602	-3.4683	0.0032	
	C	0.0463	0.0264	1.7545	0.0985	
D(LKAN)	D(LTAR)	0.0887	0.2144	0.4140	0.6844	0.0402
	UL(-1)	-0.1142	0.1406	-0.8123	0.4285	

*Source: Eviews 7.1 output using data from NEARLS (1999-2018); Significance level at 1%, 5% and 10% is indicated by ***, ** and * respectively.*

The only pair of states with a relatively higher percentage of price transmission is Taraba - Gombe having an ECT of -0.6432. The rate at which price is adjusted to long-run equilibrium between the two states is about 64 percent per annum.

Factors that could lead to low price transmission between most of the states are: poor infrastructure, high level of insecurity, inadequate storage facilities, fluctuation of rice supply due to variation in weather conditions, and flood disaster. The findings are in line with the results obtained by Ojo *et al*. (2013), who established a weak price transmission between rice markets in Kwara and Niger states; and Ani (2015), who reported a very weak adjustment speed of price of soybeans between Enugu and Benue States. The relatively high ECT recorded for Taraba Gombe states might be because Gombe state is one of the leading purchasers of rice in Taraba state. When demand for rice is high in Gombe state, marketers from Gombe would troop into various Taraba markets and clear off all the surpluses, inducing prices in Taraba state to rise. This finding goes with the result obtained by Mokumako and Baliyan (2016), who reported high elasticity of maize price transmission from South Africa to Botswana.

3.5 RESULTS OF THE MULTIPLE REGRESSION MODEL

Regression analysis was used to examine the determinants of spatial market integration. Following Gonzalo et al. (2013), trace statistics from cointegration analysis was used as a response variable, while factors such as distance, per capita production, and infrastructure were used as explanatory variables. The Eviews 7.1 software was used in estimating the regression coefficie

nts. The result is presented in Table 5 below.

Another significant variable captured in Table 5 is the per capita production (pcp_i), which has a positive sign (6.504) and statistically significant at the 1% level. This result is expected because unless you produce more than your essential requirement, you hardly sell out your produce, all things being equal. If no trade occurs, then the issue of

Table 5: Determinants of Rice Market Integration

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-27.10092	7.001037	-3.870986	0.0002
LOG(DIST)	-2.001798***	0.504614	-3.966989	0.0002
LOG(INFR)	0.134131	0.736854	0.182032	0.8561
LOG(PCPJ)	1.122418	2.347823	0.478068	0.6340
LOG(PCPI)	6.503521***	2.414412	2.693625	0.0088
R-Squared	0.506759	D-W stat	1.552704	
Adj R-squared	0.479732			
F-statistic	18.75019			
Prob(F-stat)	0.000000			

Source: Eview's 7.1 output

The result in Table 5 reveals that the R^2 value which is a measure of goodness of fit, is 0.51, which means that the explanatory variables explain about 51% variation in the dependent variable. Similar studies on market integration determinants reported a value of R^2 as 0.68 (Tsiboe *et al*., 2016) and 0.31 (Ismet *et al*., 1998).

Table 5 shows that the distance variable has a negative sign (-2.0) and statistically significant at the 1% level, which means that there is evidence to establish the opposite relationship between distance and cointegration of spatially separated markets. That is to say, when markets are close to each other and trade exists between them, their prices may tend to move together. In a similar studies, Tsiboe *et al.* (2016) found that distance has negatively influenced market integration in Liberia rice markets and Gonzalo *et al*. (2013) also reported that remote provinces seem to be less integrated as a result of higher weighted distance which seem to increase transport costs and, therefore, reduce the degree of spatial integration in Indonesia rice markets.

cointegration will not even arise in the first place. Therefore, the larger the quantity produced, the more the accumulation of surpluses. Consequently, buyers would clear off the excess and thus, establish trade and pave the way for building a strong cointegration between the markets.

Furthermore, the infrastructure (infr) variable has a positive sign, signifying that qualitative and excellent network roads lead to a higher degree of market integration. Even if the distance between markets is significantly prolonged, once the road is asphalted, transport costs will be low and, consequently, the degree of cointegration will be high. However, the variable is, in this study, not significant even at the 10% level. Due to the part that most of the road networks in the North East and the North West can neither be described as completely bad nor good, on a single road, part of it may be outstanding while another part may be terrible.

4.0 CONCLUSION AND RECOMMENDATIONS

This study concludes that market integration exists between some states in the North East and the North West. Some states in the North East also cointegrate with some in the North West. Speed of price adjustment to long-run equilibrium for most states is sluggish due to insufficient arbitrage between rice markets, poor infrastructure, high level of insecurity, inadequate storage facilities, and rice supply fluctuation due to weather variation conditions and flood disaster. The most critical factors determining rice markets' cointegration are the distance between markets and per capita production in the supplying market. Also, good road infrastructure leads to higher degree of market integration.

Overall, the study recommends that in addition to implementing viable pricing policies, the government should rehabilitate the existing road networks linking various states to reduce transportation costs. Also, more feeder roads should be constructed to minimize the distance between some markets virtually. Again, multifaceted measures to increase rice production should be adopted. Such measures may include an enhanced security system, adequate input supply, enhanced storage facilities, and flood disaster mitigation.

All these will go a long way in increasing per capita rice production, positively affecting the degree of market integration among rice markets in the Northeast and the North West regions and the whole country at large.

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