AGRICULTURAL SCIENCES

ISSN (Print): 24490954
ISSN (Online): 26364972

PRICE FLUCTUATION AND SPATIAL MARKET INTEGRATION OF RICE IN ADAMAWA STATE RICE MARKET

[1]Dauna Y., [1]Mshelia S. I. and [2]Akinrefon A. A

[1]Department of Agricultural Economics and Extension, School of Agriculture and Agricultural Technology, Modibbo Adama University of Technology, Yola
[2]Department of Statistics and Operations Research, School of Physical Sciences, Modibbo Adama University of Technology, Yola.

Corresponding Email: daunayakubu@gmail.com

Manuscript received: 01/03/2019 Accepted:11/06/2019 Published: June 2019

ABSTRACT
This study investigates spatial price transmission for rice in Adamawa state, Nigeria. Data on weekly basis for the prices of 100kg was collected from ten markets for 52 weeks (September 2015 - August 2016). Data were analyzed with an econometric framework based on the estimation of Autoregressive Distributed lags models, and of the corresponding Error correction specification. Test for Granger causality was also performed. The extent of divergence of the lowest price from the highest price over the period of twelve months was used to examine the dynamics of price behavior of rice marketing. The result of seasonal variation in price revealed that October and November is the period when rice prices are generally low while the highest price month occurred in December. The vector error correction model (VECM) revealed the existence of lung-run equilibrium between Jimeta and the other markets. The Wald test restriction of chi-square result indicated that Jimeta market has short- run relationships with Girei, Song and Dumne market at 5% level with about 61.03% speed of adjustment. Granger Causality showed that a bi-directional and unidirectional flow of price signals existed between the paired markets. The study therefore, recommended Government and other agencies to improve the dilapidated rural roads. This will ameliorate limited access to market and enhance interaction among spatially separated markets and opens up new areas of economic focus in the study area.

Keywords: *Time series, price transmission, rice market*

INTRODUCTION

Rice has become the most important staple food, most common cereal and the fastest growing commodity in Nigeria. It is widely consumed and there is hardly any country in the world where it is not utilized in one form or the other. The consumption of the crop has no cultural, religious ethnic or geographical boundary in Nigeria. The demand for local rice is growing quickly due to population growth and urbanization. Nigeria's estimated annual rice demand is put at 4.8 million metric tonnes while annual production is about 2.8 million metric tonnes of milled product leaving a deficit of 2 million metric tonnes which is bridged by importation (Uchei, 2014).

Prices are important factors in the resource distribution process that takes place via markets. The capability of laissez-fare economy to allocate resources in a way good enough to allow the whole economy to reach an optimal stability is a cardinal result of the economic theory. Spatial price transmission or market integration measures the degree to which markets at geographically separated locations share common long-term price or trade information on a homogeneous commodity (Srofenyoh, 2015). According to Lwesya (2016) spatial market integration spells the timespan for the exogenous shocks to transform and reach the various spatially separated markets. The shorter the time lapse, the better, since longer time lapse leads to the transference of an unreliable price signal that might mutilate producers' marketing decisions. As a consequence, prices of agricultural products like rice diverge from month to month; region to region and even from day to day, due to dilemmas associated with seasonality, poor storage, and consumer preference and marketing cost among others (Akpan and Aya, 2009).

The continuous increase in prices of rice is a big threat to price stability. According to Taru (2014) rice price have experienced unprecedented fluctuations and has continued to increase. This can create pressure on wages, lower real incomes, rising inflation, unemployment and decreasing demand for non-agricultural products. On the other hand, price decline could lead to a misleading allocation of inputs in rice sectors, which could seriously damage production ability and international competitiveness of rice industry. The extent of uncertainty caused by price inefficiency and instability in the Nigerian rice sector has made the industry a risky one. Therefore, this study is designed to analyze the price dynamics and the degree of integration among spatially separated rice markets in Adamawa State, Nigeria.

MATERIALS AND METHODS

Adamawa State is made up of 21 Local Government Areas with four Agricultural Development Project (ADP) zones. According to Adebayo (1999) the State's monthly sunshine distribution pattern shows that the period from January to April has a mean monthly sunshine hour of 220 and increases to 225 for the period between October and December. The temperature and evaporation reach their maximum in April when relative humidity is at its minimum. The State is characterized by mean annual rainfall of less than 1000 mm in the central and northern parts, while the north-eastern strip and southern part record over 1000 mm of rainfall annually. The major food crops grown are cereals such sorghum, maize, rice, and millet and cash crops such as cotton, groundnut and sugarcane (Sajo and Kadams, 1999). According to Ikusemoran and Hajjatu (2009) 34.26% of the land mass of Adamawa State is most suitable for rice production while 44.08% is suitable and that the majour rice producing areas are found in the central part of the State comprising Numan, Demsa, Song, Yola North, Yola South, Girei, Fufore and Jada Local Government Areas as well as the extreme northern part of the State which includes Mubi North, Michika and Maiha Local Government Areas. The average annual rice production in Adamawa State is above 219,500 tonnes (Adedeje *et al.,* 2017).

Agricultural produce/product markets are found almost in every village and in all towns across the State. The markets mainly operate on seven day periodicity except for the Jimeta, Mubi, and Yola markets are operated on daily basis.

Source of Data and Sampling Procedures

Primary data were used in the study. Purposive sampling technique was adopted for the study and is done by selecting ten prominent rice markets across the four agricultural program (ADP) zones in the State. These markets are: Maiha, Konkol, Song, Dumne, Girei, Jimeta, Fufore, Gurin, Tingno and Balaifi markets. Data on weekly basis for the prices of 100kg was collected from ten markets for 52 weeks (September 2015 - August2016).

Divergence of the lowest price from the Highest Price

The extent of divergence of the lowest price from the highest price over the period of twelve months was used to examine the dynamics of price behavior of rice marketing. This was done by getting the difference between two months at a time: September/ October 2014, October/November 2014, November/ December 2014, December 2014 /January 2015, January/February 2015, February/March 2015, March/April 2015, April/May 2015, May/June 2015 and July/August 2015.

Unit root test

When investigating for market integration, the study first examined each price series for evidence of non-stationarity in order to confirm that co-integration approach is the appropriate tool (Fossati *et al.,* 2007; Bonsu *et al.,* 2011).The null hypothesis is generally defined as the presence of a unit root and the alternative hypothesis is either stationary, trend stationary or explosive root depending on the test used. The number of lags in the Augmented Dickey Fuller (ADF) equation is selected to make sure that serial correlation is absent using the Akaike's information criterion. The ADF equation estimated by OLS is rooted in a model with a constant as follows:

$$D(P_t) = \beta + \delta P_{t-1} + \alpha 1 \sum\nolimits^{n}_{(t-1)} D(P_{t-1}) + \varepsilon_t$$

Where D is the differencing operator; P_t is the price variable of interest and ε_t is a white noise process. The unit root test is stated as:

H0: $\delta = 0$ (P_t is non-stationary or has a unit root)

H1: $\delta \neq 0$ (P_t is stationary or has no unit root).

If the null hypothesis which states that the price series is non-stationary is not rejected, then in literature it has been suggested to difference the variable of interest to maintain its mean. If a variable is found to have a unit root, the difference of the variable is included in the model. The procedure requires that the non-stationary variable be differenced sequentially until it reaches stationarity. Since the price series were not stationary at levels (integrated of order zero), they were differenced once to attain stationarity.

Testing for lag length

A test for a suitable lag length included in the co-integration test was performed, because the results of co-integration tests can be quite sensitive to this (Hafer and Sheehan, 1991: Hai *et al*., 2004). The number of lags was selected by applying the Akaike information criterion (AIC). A vector autoregression (VAR) on the differenced series was conducted and lag length of the model with the least AIC was chosen as the appropriate lag length to be included in the co-integration test. The test started with a lag length of 12 and then shortened till the least values of the AIC was obtained.

Granger causality test

Granger causality test was carried out to determine the direction of causality. When two price series are co-integrated and stationary, one can go ahead to carry out the Granger causality test. This is because one granger causal relationship must exist in a group of co-integrated series (Chirwa, 2000). When Granger causality run one way (uni-directional), the market which Granger-causes the other is tagged the exogenous market. Exogeneity can be weak or strong. Hendry (1986) observed that weak exogeneity occurs when the marginal distribution of $P_{i\,(t-1)}$ and $P_{j\,(t-1)}$ was significant, while strong exogeneity occurs when there is no significant Granger-causality from the other variable. It could also be bi-directional which means that both series influence each other (e.g. X causes Y and Y also causes X). The Granger model used in this study can be represented by:

$$\Delta P_{it} = \sum\nolimits^{m}_{i=1} \alpha_i \Delta P_{i(t-1)} + \sum\nolimits^{n}_{j=1} \alpha_j \Delta P_{j(t-1)} + 1_i$$

Where m and n are the numbers of lags determined by a suitable information criteria (Akaike). Rejection of the null hypothesis indicates that prices in market *j* Granger-cause prices in market *i*. The hypotheses under the Granger causality can be stated as follow:

H_o: price of rice in one market does not determine the price in the other market

H_1: price of rice in one market determines the price in the other market.

RESULTS AND DISCUSSION

Dynamics of rice price in Adamawa State

The extent of divergence of the lowest price from the highest price which shows price dynamics of rice in Adamawa State is presented in Table 1. The results revealed that October and November is the period when rice prices are low because these months coincide with the peak marketing season (harvest period). The highest price month occurred in December and this could be attributed to the festive period. After this period in January/February the supply reaches its peak and drops, in the month of March and possibly April when the farmers are left with marketable surplus (differences between total agricultural output and the subsistence needs), the supply start to decline and the prices start to increase and reaches another peak in June/July because these coincided with planting period when seed is demanded. These variations were due to seasonal factors and consequent adjustments that occurred over the months. In general and in a normal year, prices start to decline immediately before December in anticipation of the new harvest and rise as supply dwindles after May and keep on rising to the month of August.

Table 1: Variations in monthly price index of rice in Adamawa State

Month/year	Deviation of lowest price from the Highest	Lowest month	Highest month
Sep/Oct.2014	0.5	October	September
Oct/Nov.2014	1.13	October	November
Nov/Dec.2014	26.27	November	December
Dec2014/Jan.2015	14.68	January	December
Jan/Feb.2015	1.75	February	January
Feb/March.2015	5.46	February	March
March/Apr.2015	3.31	March	April
Apr/May.2015	3.66	April	May
may/Jun.2015	8.00	May	June
Jun/Jul.2015	8.78	July	June
Jul/Aug.2015	7.78	July	August

Source: Field Data, September, 2014 – August, 2015

Degree of integration among rice markets

Unit root test

Unit root test was carried out to check for stationarity of the variables or price series using Augmented Dikey Fuller test (ADF). The test is used to show whether prices are stable or unstable. Unit root test was carried out for prices in all the ten markets under study. The results presented in Table 2 reveals that at levels, the P-value for the coefficients of price of rice in all the markets were insignificant at 5% significance level. The null hypothesis H_0: ᵭ=0 was therefore accepted. The price of rice in all the markets had a unit root in levels. This is interpreted to mean that the prices of rice in all the markets were not stationary and that the price of the previous period influenced the current prices of rice. To make them stationary, their first differences were taken. The P-value for the coefficients of prices in all the markets were significant at 5%. Therefore the null hypothesis of the existence of unit root can be rejected, meaning that the price series is stationary at first difference I(1).

Table 2: Results of unit root test of Rice price in Markets in Levels and First difference at 5% using Augument Dickey Fuller (ADF)

MARKETS	LEVELS	Intercept	intercept & trend				FIRST DIFFERENCE	Intercept		Intercept & trend
	ADF	P-value	ADF	P-value	Remark	ADF	P-value	ADF	P-value	Order of integration
MAIHA	1.580	0.9978	-0.092	0.99932	non stationary	-5.921	0.0000	-7.322	0.0000	I(1)
KONKOL	1.605	0.9979	-0.055	0.9936	non stationary	-5.633	0.0000	-6.770	0.0000	I(1)
SONG	1.337	0.9968	-0.340	0.9885	non stationary	-5.911	0.0000	-7.158	0.0000	I(1)
DUMNE	-0.977	0.6170	-1.823	0.6937	non stationary	-10.366	0.0000	-10.830	0.0000	I(1)
JIMETA	1.465	0.9974	-0.603	0.9788	non stationary	-5.027	0.0000	-6.073	0.0000	I(1)
GIREI	1.514	0.9976	-0.333	0.9887	non stationary	-5.663	0.0000	-7.065	0.0000	I(1)
FUFORE	3.011	1.0000	1.170	1.0000	non stationary	-4.811	0.0001	-6.958	0.0000	I(1)
GURIN	2.902	1.0000	1.004	1.0000	non stationary	-5.475	0.0000	-7.371	0.0000	I(1)
TINGNO	2.429	0.9990	0.689	0.9970	non stationary	-5.319	0.0000	-7.343	0.0000	I(1)
BALAIFI	2.559	0.9991	0.700	1.0000	non stationary	-5.592	0.0000	-7.497	0.0000	I(1)

Output from E-views

Optimal lag selection

The lag selection-order criterion was used to select the appropriate lag length that is included in the co-integration model. Using Akaike's information criterion (AIC) lag 2 was found to be the optimal lag length because it has a lower (AIC) value. The result is presented in (Table 3).

Table 3: optimal lag selection

Number of lag	AIC value
1	127.53
2	125.59

Source: output from E-views

Johansen Multivariate Co-integration Results

To examine the hypothesis that there are r co-integrating vectors, the max-Eigen test was performed. Table 4 reports the results for the Johansen max-Eigen statistic based on the smallest value of the AIC values. Comparing the max-Eigen statistic with the corresponding critical values, it can be seen that the null hypothesis of no co-integrating relationship between the markets can be rejected at 5% level of significance. Therefore, the results suggest that at least a stationarity relationship exist among the ten rice markets under study.

Table: Results of Co-integration analysis for rice prices

Null hypothesis	Alternative hypothesis	Max-Eigen statistic	5%critical value	P-values
r=0	r>0	153.4949*	64.50472	0.0000
r≤1	r>1	104.4327*	58.43354	0.0000
r≤2	r>2	91.56497*	52.36261	0.0000
r≤3	r>3	75.35158*	46.23142	0.0000
r≤4	r>4	56.40642*	40.07757	0.0000
r≤5	r>5	33.13400	33.87687	0.00611
r≤6	r>6	19.88762	27.58434	0.3490
r≤7	r>7	16.00956	21.13162	0.2243
r≤8	r>8	12.01009	14.26460	0.1103
r≤9	r>9	3.173519	3.841466	0.0748

* denotes rejection of null hypothesis at 0.05 level

Long-run market relationship from vector error correction model (VECM)

The vector error correction model was constructed in order to analyze the long-run dynamics of the effects of rice prices in the other selected markets in the study area on the central market (Jimeta). The VECM results of the real prices for all the markets are presented in Table 5. The results reveal that the coefficient of prices in the central market (Jimeta) is negative and significant at 5% level. The implication of this result is that there is the existence of long-run equilibrium between the central market (Jimeta) and the other selected markets in the study area. The explanatory variables in the model jointly explain the variation in central market prices with F-statistic at 5% level. The coefficient of multiple determinations is 71%, suggesting that the variation of the prices in the other markets explained 71% of the changes in the prices of rice in the central market (Jimeta).

Table 5: Long-run estimates from vector error correction model (VECM)

Variable	Coefficient	Std-error	t-statistic	P-value
Jimeta(-1)	-0.610370	0.262223	0.2327670	0.0291
Girei(-1)	1.449832	0.469138	3.090419	0.0052
Girei(-2)	0.817125	0.495256	1.649905	0.1126
Song(-1)	-1.938749	0.785254	2.468945	0.0214
Song(-2)	-0.658525	0.619055	-1.063758	0.2985
Dumne(-1)	0.449795	0.222974	2.017257	0.0555
Dumne(-2)	0.171003	0.156628	1.091775	0.2862
Maiha(-1)	1.040436	0.695027	1.496971	0.1480
Maiha(-2)	-0.331860	0.734688	-0.451702	0.6557
Konkol(-1)	-1.132710	0.694085	-1.631947	0.1163
Konkol(-2)	0.368586	0.695599	0.529882	0.0013
Fufore(-1)	0.799667	0.964443	0.829149	0.4155
Fufore(-2)	-0.441832	0.876850	-0.503886	0.6191
Gurin(-1)	0.034370	0.697766	0.049258	0.9611
Gurin(-2)	0.523238	0.625190	0.836927	0.4112
Tingno(-1)	-1.233339	1.311600	-0.940332	0.3568
Tingno(-2)	0.698396	1.261140	0.553781	0.5851
Balaifi(-1)	1.567701	1.138752	1.376683	0.1819
Balaifi(-2)	-0.366831	0.966008	-0.379739	0.7076
X(resid. term)	0.033729	0.286164	0.117867	0.9072
Constant	-96.64805	68.89437	-1.402844	0.1740
R2	0.712583			
Adjusted R2	0.6900174			
F-stat	2.280928			
Prob(F-stat)	0.022366			

X (resid. term) denotes the error correcting term. Dependent variable: first difference Jimeta real price. Included observations: 49 after adjustments.

Short-run market relationship from Wald test

Wald test restriction of chi-square statistic was applied to test short run relationship between the other markets and the central market (Jimeta). The results revealed that the value of chi-square for Girei, Song and Dumne markets were significant at 5% level (Table 6). This means that the null hypothesis that a price change in the central market immediately transmitted to other markets cannot be rejected. The implication of this is that there is existence of short-run integration between “Jimeta and Girei market”, “Jimeta and Song market” and between “Jimeta and Dumne market”. Short-run integration connotes that a slight change in the price of rice in Jimeta market will result to immediate change in prices of rice in Girei, Song and Dumne markets. Thus, the estimated coefficient for VECM in Table 6 suggests that change in price in any of the markets would cause price in Jimeta market to adjust immediately and the estimated speed of adjustment is about 61.03%. This shows a strong integration/adjustment of the markets to the central market compared to a perfect adjustment of 100% threshold. This implies that real price in Jimeta market adjusts remarkably to its long-run level (high) price shock. It would mean central market consumer real price for rice increases and returns significantly to its expected long-run real price levels.

Table 6: Short-run estimates from Wald test for market integration

Variable	Wald test statistic (chi-square value)	P-value
Girei	9.68067	0.0079*
Song	6.526362	0.0383*
Dumne	6.590706	0.0371*
Maiha	3.235324	0.1984
Konkol	4.815210	0.0900
Fufore	1.581355	0.4535
Gurin	1.0767445	0.5837
Tingno	2.624810	0.2692
Balaifi	3.545475	0.1699
*denotes significant at 5% level		

Granger causality test for selected rice markets in Adamawa State

Pairs of rice markets were investigated for evidence of Granger causality. The Granger causality indicates the direction of price formation between two integrated markets and related arbitrage. The results of the analysis show that there are 20 cases that exhibited bidirectional causality. In these cases Jimeta Granger cause price formation in Girei, Maiha, Konkol, Fufore, Gurin, Tingno and Balaifi markets which in turn provided feedback to Jimeta market. Also Fufore Granger cause price formation in “Song, Dumne and Maiha”, Gurin Granger cause “Girei, Dumne, Tingno, Maiha, and Konkol” and Tingno Grangers price formation in “Song and Dumne”. It could be deduced from the result of the finding that Jimeta is the base market because it dictates price formation in most of the markets investigated.

The results also reveal that unidirectional Granger causality exist between Jimeta→Dumne, Girei→Song, Girei→Dumne, Girei→Maiha, Girei→Kokol, Girei→Tingno, Girei→Balaifi, Song→Dumne, Song→Maiha, Song→Konkol, Song→Balaifi, Maiha→Dumne, Konkol→Dumne, Maiha→Tingno, Maiha→Balaifi, Konkol→Fufore,Konko→Tingno Konkol→Balaifi, Balaifi→Fufore, Tingno→Gurin and Balaifi→Gurin. The case of Unidirectional Granger cause indicates that only one market granger cause price formation in the other market with no feedback. Also there exist cases of no Granger cause between Konkol—Maiha, Gurin—Fufore, Tingno—Fufore and Balaifi—Tingo. This means that these pairs of markets are segmented and current price in one market does not detect price formation in the other market.

CONCLUSION

The market price for rice in Adamawa State experienced an erratic fluctuation within the period of this study. The result also revealed that prices of rice in spatially separated markets were cointegrated, this has led to the rejection of the null hypothesis that rice markets are spatially independent. This confirms the existence of Law of One Price (LOP) as claims by previous studies that cointegration exist between prices of agricultural commodities in spatially separated markets. There were 21cases of the existence of Granger causality (unidirectional), 20 cases of bidirectional relationship and 4 cases of segmented relationship between the markets. Also, the marketing and price information transmission mechanism for rice marketing can be concluded efficient.

REFERENCES

Adebayo, A.A. (1999). *Climate 11*.In Adebayo A.A and Tukur, A.L (eds), *Adamawa in maps*. Paraclate publishers, Yola. Pp23-26

Adedeji, I.A.,Tiku, N.E., P.R.Wazir-Ugwu and Sanusi, S.O.(2017). The Effects of climate change on rice production in Adamawa State, Nigeria. *Agroeconomia Croatia* 7(1):1-13

Akpan, S. B., and A. E. Aya, (2009). Variance in Consumer Prices of selected Food items among Markets in Cross River State. *Global Journal of Social Sciences vol.8 NO. 2* Pp 59-62.

Bonsu, A.M; Akua, A.A and John K.M.K (2011). Efficiency of the plantain marketing in Ghana: A Co-integration Analysis. *Journal of Development and Agricultural Economics,* 3(12):593-601

Chirwa E. W. (2000). Liberalization of Food Marketing and Market Integration in Malawi. Final report of an AERC sponsored Research Work, presented at the Biannual Economic Research Workshop, Nairobi, Kenya. May 27, 2007.

Hendry. D.F. (1986). Econometric modeling with cointegrated variables: An overview.Oxford *bulletin of Economic and statistical research 48(3)*:201-212

Ikusemoran, M. and Hajjatu, T. (2009). Site suitability for yam, rice and cotton production in Adamawa State of Nigeria: A Geographic Information System (GIS) Approach. *FUTY Journal of the Environment 4 (1):*45-58

Lwesya, F, (2016): An Assessment of Spatial Integration for Major Wholesale Rice Markets inTanzania. *Greener Journal of Business and Management Studies 6 (1)*, pp. 035-049

Opeyemi, E; Ayinde, V; Kayode, A and Adewae, F. (2016): Diverse Price variation in Nigeria: A Two-Stage Interactive Ridge Regression Approach. *Journal of Agricultural Science 16(2)*:79-92

Sajo, A. A. and Kadams, A. M. (1999): *Food and Cash Crops* in A.A Adebayo and A.L Tukur (eds) Adamawa State in Maps, Paracelete Publisher, Yola Pp.37-40.

Srofenyoh, F. (2015): Maize Market Integration: A case study of Maize Market in Ghana. *International Journal of Technology and Management Research* 4:1-11

Taru, B. (2014). Price Fluctuation and Market Integration of selected Cereal in North-Eastern Nigeria, 2001-2010. Unpublished Thesis submitted to the School of Postgraduate Studies, University of Nigeria Nsukka