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Co-integration Analysis of Maize Marketing in Osun State, Nigeria

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Abstract
The aim of the study was to examine market integration and price variation in white maize marketing in Osun State, Nigeria. Specific issues addressed in the study were the determination of existence of co-integration between the rural and urban markets and the leading market between the rural and urban markets for maize. Secondary data were used in this study. The data were sourced from Osun State Agricultural Development Programme. The average monthly retail price (₦/Kg) of white maize covering the period, January, 2000 to December, 2010 (11 years) for Osogbo (urban market), Telemu (rural market) and Erin Ijesa (rural market) were used. Coefficient of variation and price correlation coefficient were used to examine the behavior of white maize market price in urban and rural areas of Osun State. The Augmented Dickey-Fuller (ADF) test was used to investigate stationarity in the pairs of prices while the Johansen co-integration technique was used to determine the existence of co-integration between the markets. Augmented Dickey Fuller procedure (ADF) indicated that all the variables and the individual price series for maize were not stationary at their respective levels, but stationary at their first difference. Both the trace and maximum eigen value statistics indicated the existence of co-integration relationship at 5% significant level for the pairs of product prices, implying that maize markets during the study period were linked with each other and therefore the long-run equilibrium was stable. The results also indicated that urban maize markets did not granger-cause rural maize markets~~)~~, while rural maize markets granger caused urban maize markets at 5% level of significance respectively. The error correction model showed significant causality link between the rural and urban markets, suggesting a clear trend in price leadership. It follows that there could be efficiency in transmission of price information among operators if relative stability is attained in the rural markets of white maize in Nigeria. The study concluded that maize markets in both urban and rural areas of Osun were co-integrated and had short-run and long-run relationships, with rural maize markets occupying the leadership position in price formation and transmission.

Keyword: Keywords: Causality effect, Co-integration, Granger-caused, Price series, Maize.

Introduction
The place of agriculture in enhancing the wellbeing of the people cannot be overemphasized. This is true because, it is the only sector providing staple food for the increasing population.[1] The Nigerian government's main focus at present is on raising agricultural productivity, both in staples for local and regional consumption, and for a wide range of products. With the current fall in oil prices, the Nigerian government is increasingly giving agriculture a higher priority in its effort to reduce poverty, diversify the national economy away from oil and to ensure food security in order to improve the per capita income in Nigeria.[2]
The major food grains in Nigeria are rice, maize, sorghum, wheat, pearl, millet, and cowpea with rice ranking as the sixth major crop in terms of the land area while sorghum accounts for 50 percent of the total grain production and occupies about 45 % of the total land area devoted to cereal production in Nigeria[3]

Statement of the Problem
The government of Nigeria, realizing the importance of the grain subsector has continued to intervene in stabilizing the grain subsector through agricultural policy reformation. Adetunji and Adesiyan[4] stated that agricultural production problems can be overcome through introducing new technology and efficient marketing systems, it is however obvious that increased production without corresponding well-developed and efficient marketing system may amount to wastage of resources. A good and efficient marketing system promotes the pace of economic development by encouraging specialization, which leads to more output[5] and the role of price movement in the assessment of the marketing system is of great concern to economists. This study therefore sought to know the trend in the price of maize in rural and urban markets as well as the level of integration between the markets for maize in Osun State. The choice of maize is, among other things, hinged on the fact that maize is produced by small and large scale farmers throughout the country and is widely consumed as a staple in both rural and urban households. A large percentage of Nigeria's maize production is utilized by the industrial sector for production of confectioneries, drugs and animal feeds.

Research Questions
The research questions include:
(i) How do prices relate between markets?
(ii) Are there linkages between markets in urban and rural areas?

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(iii) What is the degree of market integration among these rural and urban markets?

Objectives of the Study

The overall objective of the study was to examine the extent and degree of market integration and price variations in the Osun State maize markets. The specific objectives were to:

(i). Examine the price behaviour between rural and urban markets for maize

(ii). Determine if co-integration (long run equilibrium) relationship exists between white maize prices in rural and urban markets

(iii). Determine the leading markets between urban and rural markets

(iv). Determine the degree of market integration.

Hypothesis of the study:

H_0: prices of maize in rural markets do not determine prices of maize in urban markets.

Literature Review and Conceptual Framework

Food grain marketing warrants special attention because food grains play an important role in Nigeria as staples in many homes. Secondly, the structure and the conduct of the food grain market can affect the economy of the people in the communities and the nation's economy in significant ways[6]

The concept of co-integration has been applied by researchers to examine the existence of long run correlation which determines a long run equilibrium between series of prices especially among urban and rural food markets as noted by Oladapo and Mommoh[7],Ojiaka *et al*[8], and Okoh and Egbon[9]. This same concept is applied in this study to examine the long run relationship between the movement of urban and rural prices of white maize in Osun State.

Methodology

The Study Area

This study was carried out in Osun State, Nigeria. Osun State has an estimated population of 3,423,535[25] and is made up of 30 Local Government Councils. Its coordinates are: 7°30′n 4°30′e7.500°n 4.500°e, with a land mass of 9,251 km^2. This means that the State lies entirely in the tropics. The State is bounded in the west by Oyo State, in the north by Kwara State, in the east by Ondo and Ekiti States and in the south by Ogun State. Agriculture is the traditional occupation of the inhabitants and the tropical nature of the climate favours the growth of a variety of food and cash crops. The main cash crops include cocoa, palm produce, kola, while food crops include yam, maize, cassava, millet, rice and plantain. The vegetation consists of high forest and derived savannah towards the north with a mean annual rainfall between 2,000 and 22,000 mm. Maximum temperature is 32.5^{0}C while the relative humidity is 79.90 %. The choice of Osun State for the study was deemed to be appropriate because of its antecedent in agriculture and food marketing. Osun and Oyo States produce 50% of the total quantity of maize produced in Southwestern Nigeria and due to the influx of food produced from neighboring States of Oyo, Kwara, Ekiti, and Ondo [10]

In the study, effort was made to analyze price trends of white maize in the rural supply market and urban demand market in Osun State, Nigeria with the view to determining if linkages existed between them and ascertaining the nature of their interrelatedness.

Method of Data Collection

The secondary data used in the study were sourced from Osun State Agricultural Development Programme. The average monthly retail price (N/kg) of white maize covering January, 2000 to December, 2010 (11years) for Osogbo (urban market), Telemu (rural market) and Erin-Ijesa (rural market) were used.

Method of Data Analysis

Data were analyzed using e views software and statistical processes were employed in order to achieve an appropriate analysis. To deal with national currency fluctuations, which may cause price to look as though they are integrated; all prices were quoted in naira per kilogram (N/kg) and series of prices were all deflated by using consumer price index (cpi). The consumer price index (cpi) simply measures the change in prices for a mixed market basket of goods and services. The real prices obtained were then used for the analyses.

$$\text{Real price} = \frac{\text{nominal price}}{\text{Cpi}} \times 100$$

Coefficient of variation and pearson correlation coefficient were used to examine the price behavior of rural and urban markets of white maize in study area. This was adapted from Mohammad[11] and Enders[12] and computed as shown below:

Price Correlation Coefficient (r)

$$r = \frac{\sum_{t=1}^{T} (P_{it}-\bar{P}_{it})(P_{jt}-\bar{P}_{jt})}{\sqrt{\sum_{t=1}^{T} (P_{it}-\bar{P}_{it})^2 \sum_{t=1}^{T} (P_{jt}-\bar{P}_{jt})^2}} \qquad \ldots\ldots\ldots\ldots(1)$$

Where,

P_{it} and P_{jt} = price variables at time t

$\overline{P}_{it}$ and $\overline{P}_{jt}$ = means of the variables

Price correlation coefficients were used to examine the strength of price linkages across markets. The t - statistic was used to ascertain if the coefficient between prices in the markets was statistically significant.

Coefficient of Variation (CV)

$$CV = \frac{\text{standard deviation}}{\text{mean}} \times 100\% \quad \ldots\ldots (2)$$

Johansen Multivariate Co-Integration Procedure

Johansen developed a multivariate co-integration method in 1988, which is still the most suitable approach to test prices of food markets that are usually endogenous and simultaneously determined[13].

The four important points to be considered before performing co-integration tests, according to Chirwa[14], are: First, co-integration refers to one or more linear combinations of non-stationary variables. Second, all variables must be integrated of the same order. However, this condition is not necessarily required in all cases. It is possible that variables are integrated of different orders. Third, there may be as many as *n*-1 linearly independent co-integrating vectors if a linear combination of non-stationary variables has *n* variables. The number of co-integrating vectors is called the co-integrating rank (*r*). If more than two time series are considered, it is possible to have more than one co-integrating rank. Finally, consider the case in which each variable contains a single unit root. Before conducting the co-integration tests, the lag lengths are determined by using the minimum value of the Akaike information criterion.

Johansen co-integration procedure was used to determine the existence of co-integration (long run equilibrium) relationship between white maize prices in the rural and urban markets of the study area as follows:

Testing for Stationarity:

Time series data are stationary if the average variance and covariance at any lag are still constant at any time[15]. The individual price series are tested for the order of integration to determine whether or not they are stationary. A number of tests for stationarity are available in the literature; these include the Dickey-Fuller (DF) test[16], the Augmented Dickey-Fuller (ADF) test[17] and the Philips-Perron (PP) test. A standard test for non-stationarity is the Augmented Dickey Fuller (ADF) test.

For each price series X_t the test statistic was measured by the following regression.

$$\Delta X_t = \alpha + \delta X_{t-1} + \sum_{k=1}^{p} \beta\delta X_{t-k} + \varepsilon_t \quad \ldots\ldots (3)$$

Where

X_t	=	price at time t
δ	=	first difference operator.
t	=	time indicator.
ε_t	=	the error term.
δ, α and β	=	parameters to be estimated.
K	=	number of lag of the price variables to be included.

The first stage is to test whether each series is stationary i.e. 1(0). If the null hypothesis of non stationarity cannot be rejected, that is, the absolute value of the ADF statistic is smaller than the critical ADF value, then the next stage is to test whether the first differences are stationary. If the null hypothesis of non-stationarity cannot be rejected, then the series is still not stationary. Therefore, differencing continues until the series become stationary and order noted. The process is considered stationary if / $\bar{\delta}$ /<1, thus testing for stationarity is equivalent with testing for unit roots (δ <1) under the following hypotheses:

H_o : $\delta = 0$ the price series is non-stationary or there is existence of unit root.

H_1 : $\delta \neq 0$ the price series is stationary or there is white noise in the series.

The hypothesis of non-stationarity will be accepted at 0.01 or 0.05 levels if ADF value is greater than the critical value.

Selection of Lag Length:

For the determination of the lag length to be included in Vector Auto Regression (VAR) model Akaike's Information Criterion (AIC), Schwarz's Bayesian Information Criterion (SBIC), and Hannan-Quinn Information Criterion (HQIC) are used (Said and Dickey[17]; Greene[18], and Engle and Granger[19]. When using AIC, SBC or HQIC based on the estimated standard errors in respective equations, the model with the lowest value will be chosen.

SBIC = $\ln(\sigma^2) + k/t \ln t$

HQIC = $\ln(\sigma^2) + 2k/t \ln t$

AIC = $\ln(\sigma^2) + 2k/t$

In this paper, the AIC was used because it has the lowest estimated standard error when compared with others. AIC can be described by the following equation:

$$AIC = \ln(\sigma^2) + 2k/t \quad \ldots\ldots (4)$$

Where;

σ^2 = the variance of the estimated residuals.

t = the number of parameters

k = the sample size.

The maximum lag length begins with 3 lags and proceeds down to the appropriate lag by examining the information criteria.

The number of lagged difference terms to be included can be chosen based on t-test, f-test or the Akaike's Information Criterion (AIC)[19].

Testing the Number of Co-integrating Relationships:

Johansen also, proposed two likelihood ratio tests namely, Eigen value and Trace statistic for the determination of r. It is a maximum likelihood ratio test involving a reduced rank regression between two variables, say i(1) and i(0) .λ trace has a null hypothesis of number of co-integrating vectors being less than or equal to r, while alternative hypothesis is that there are more than r co-integrating vectors. Additionally, λ max has a null of r co-integrating vectors against r+1 co-integrating vectors. For both tests, if the test statistics is more than the critical value, we reject the null hypothesis. Testing is conducted as a sequence and under the null, r = 0, 1,..n-1. When r = 0, failing to reject h_0 will complete the test. But if this is not the case meaning when h_0: r = 0 is not rejected, the test continues until the null is no longer rejected.

(a) The trace statistic is computed according to (Johansen and Juselius[20] and Rapsomanikis[21]) as:

$$\lambda trace = T \sum_{i=r+1}^{n} \ln(1 - \hat{\lambda}_i) \quad (6)$$

Where;

Λi = estimated eigen value (characteristic roots) obtained from π matrix

T = the sample size.

R = number of co-integrating vectors

N = number of variables under considerations.

(b) the maximum eigen value statistic computed as:

$$\max(r/r+1) = -t \ln(1-\lambda_{r+1}) \quad \ldots\ldots (7)$$

T = the sample size

(λ_{r+1}) = estimated eigen values (characteristic roots) obtained from the ∏ matrix

H_0 : there is no co-integrating vector between the- estimated prices for maize.

H_a : there is co-integrating vector between the- estimated prices for maize.

If the value of λ trace and λ max exceed the critical value, reject the null hypothesis and accept the alternative hypothesis of more co–integration vectors at 0.05 or 0.01 level.

Absence of a co-integrating relationship spots non-existence of long-run relationship.

***Vector Error Correction Model (VECM)**:*

If prices are integrated of the same order and prices of each model are co-integrated, a vector error correction model (VECM) is appropriate to determine the multivariate relationships among prices. Johansen defined two matrices α and β, such that π = αβ′, where both α and β are (n x r) matrices. The procedure is based on maximum likelihood estimation of the error correction model and each two-variable system is modeled as a vector autoregression (VAR) as in the following equation (Oladapo and Momoh[7]; Ojiako *et al*[8] and Hopcraft[22]:

$$X_T = \mu + \sum_{i-1}^{p} \Gamma_I \Delta X_{T-I} + \Pi X_{T-K} + E_T + B_T \quad \ldots\ldots (8)$$

Where;

X = the vector of endogenous variables

Γi = the matrix of short run coefficients

Π = the matrix of long–run coefficients

E_T = the vector of independent and normally distributed errors.

K = number of lags, and should be adequately large enough both to capture the short-run dynamics of the underlying VAR and to produce normally distributed white noise residuals.

If the coefficient matrix π has reduced rank $r < n$, then there exist n xr matrices α and β each with rank r such that $\pi = \alpha\beta'$ and $\beta' X_t$ is stationary, r is the number of co-integrating relationships, the elements of α are known as the adjustment parameters in the vector error correction model and each column of β is a co-integrating vector. It can be shown that for a given r, the maximum likelihood estimator of β defines the combination of X_{t-1} that yields the r largest canonical correlations of δX_t with X_{t-1} after correcting for lagged differences and deterministic variables when present. Johansen proposed two different likelihood ratio tests of the significance of these canonical correlations and thereby the reduced rank of the π matrix.

The procedure for testing co-integration is based on the error correction model (ECM) representation of xt given by (Ahmed and Rustagi[23], Oladapo and Momoh[7], Ojiako *et al.*[8], and Hopcraft[22]):

$$\Delta X_T = \mu + \sum_{i-1}^{p-1} \Gamma_I \Delta X_{T-1} + \Pi X_{T-K} + E_T + B_T \qquad \text{.. (9)}$$

where;

Δ	=	the difference operator
$\mathbf{X_T}$	=	(nx1) vector of i (1) (i.e integrated of order one) prices
Γ_i	=	- (i – π_1 - ………,k -1)
I	=	1,2,………, k - 1
π	=	- (i - π - π_k)each of π_1 is an (n x) matrix of parameters
k	=	number of lags
ε_t	=	an identical and independently distributed n-dimensional vector of residuals with zero mean and variance matrix
B	=	co-integrating vector (containing the long-run)
μ	=	constant term
T	=	time trend.

Since X_{t-k} is i(1), but δx_t and δX_{t-i} variables are i(0) (i.e., integrated of order zero), equation (9) will be balanced if $\delta x_t - {}_k$ is i(0). So, it is the $\prod$ matrix that conveys information about the long-run relationship among the variables in X_t. The rank of $\prod$, r, determines the number of co-integrating vectors, as it determines how many linear combinations of Xt are stationary. If r = n, the variables are stationary in levels. If r = 0, no linear combination of X_t is stationary.

if 0 < rank ($\prod$) = r < n, and there are n x r matrices α and β such that $\prod = \alpha\beta'$ then it can be said that there are r co-integrating relations among the elements of X_t. The co-integrating vector β has the property that $\beta' X_t$ is stationary even though xt itself is non-stationary. The matrix α measures the strength of the co-integrating vectors in the ECM, as it represents the speed of adjustment parameter.

Empirical model:

For this study, it was hypothesized that rural and urban market prices for white maize are jointly determined or endogenous, given an implicit representation of the model with two endogenous variables without exogenous variables as (Ojiako *et al.*[8] and Hopcraft[22]).

$$X_t = (\ln\_rp_t, \ln\_up_t) \qquad \text{………………………………………….. (10)}$$

where;

X_t

Ln_rp_t = natural log of rural market price

Ln_up_t = natural log of urban market price

From equation (10) above, the long-run co-integrating equation can be specified explicitly for rural market price as;

$$\ln\_rpt = \acute{\omega}_0 + \acute{\omega}_1 \text{lnup}_t + y_t \qquad \text{……………………………………….. (11)}$$

Where;

$\acute{\omega}_0$	=	the log of a proportionality coefficient, a constant term capturing the transportation and other forms of cost
$\acute{\omega}_1$	=	long run coefficient deprecating the relationship between rural and urban market prices
y_t	=	random error term

If	$\acute{\omega}_1 = 0$	then there is no relationship
If	$0 < \acute{\omega}_1 < 1$	there is a relationship but the relative price is not constant, meaning that the goods will be imperfect substitutes.
If	$_1 = 1$	there is relationship with constant relative price, meaning that the law of one price holds and goods are perfect substitutes.

Equation (11), describes a case where prices adjust immediately. If however, a dynamic adjustment pattern is expected in prices, it will be accounted for by introduction of lags of the two prices, but even at that, the long-run relationship between prices will take the same form depicted in equation (11) above.
Vecm model in this study was estimated as (Oladapo and Momoh[7], Ojiako *et al.*[8], and Hopcraft[22]):

$$\Delta RP_t = \psi_{10} + \sum_{i=1}^{p} \psi_{11i}\,\Delta RP_{t-i} + \sum_{i=1}^{p} \psi_{12i}\,\Delta UP_{t-i} - \rho\,(RP_{t-1} - UP_{t-1}) + Y_{1t} \qquad (12)$$

$$\Delta UP_t = \psi_{20} + \sum_{i=1}^{p} \psi_{21i}\,\Delta UP_{t-i} + \sum_{i=1}^{p} \psi_{22i}\,\Delta UP_{t-i} - \rho\,(RP_{t-1} - UP_{t-1}) + Y_{2t} \qquad (13)$$

where;

Δ	=	the difference operator
Rp and up	=	rural and urban markets prices
Ψ_{11} and ψ_{12}	=	short run coefficients
P	=	error correction instrument measuring the speed of Adjustment from the short-run state of disequilibrium to the Long-run steady-state equilibrium
Y_t	=	an error term assumed to be distributed as white noise
Ψ_{10} and ψ_{20}	=	constants.

Granger causality test:

The granger causality test was used to determine the leading markets between urban and rural markets. Granger causality provides additional evidence as to whether, and in which direction, price integration and transmission is occurring between two price series or market levels. This is because one granger causal relationship must exist in a group of co-integrated series[19]. When granger causality runs one way (uni-directional), the market which granger-causes the other is tagged the exogenous market. Exogeneity can be weak or strong. Weak exogeneity occurs when the marginal distribution of $X_{i\,(t-1)}$ and $X_{j\,(t-1)}$ are significant, while strong exogeneity occurs when there is no significant granger-causality from the other variable. It could also be bi-directional which indicates that both series influence each other (e.g. X causes y and y also causes x).
The granger model used in this study is represented by:

$$RP_t = \alpha_0 + \sum_{i=1}^{m} \alpha_i UP_{t-i} + \sum_{j=1}^{n} \beta_j RP_{t-j} + \varepsilon_t \qquad 14$$

Where;

n	=	number of observation
M	=	number of lag
Rp_t	=	rural market price
Up_t	=	urban market price
α and β	=	parameters to be estimated.

H_0: price of white maize in one market does not determine (granger cause) the price in the other market
H_a: price of white maize in one market does determine the price in the other market (not granger cause)

Wald test for market integration:
The type and degree of market integration was determined by the statistical significance of the estimated parameters based on the results of the set of hypothesis using the f-statistic of the wald tests restrictions. The restrictions were tested on the OLS (Ordinary Least Square) estimation of the following equation

$$X_t = \eta + \sum_{k=1}^{k} A_i X_{t-i} + \varepsilon_t$$

where;

t	=	1, 2,... Refers to the months from January 2000 to December, 2010
x_t	=	n × 1 vector of the logarithmic prices at time t ($x_t = x_{1t}, x_{2t},\ldots,x_{nt}$)
ai	=	n × n matrices of parameters;
Ŋ	=	n × 1 vector of intercept terms
εt	=	n×1 vector of error terms,
K	=	the lag length
Et	=	the vector of error term

(a) long-run market integration:
H_0-white maize market prices are integrated in the long-run.
h_a: white maize market prices are not integrated in the long-run.
(b) short –run market integration:

H_0: a price change in a market is immediately transmitted to the other market.
H_a: a price change in a market is not immediately transmitted to the other market.

Results and Discussion

Price Behavior of Maize in the Study Area

Average annual retail prices of white maize: The behavior of the average monthly retail price of maize from 2000 to 2010 is presented in Table 1. It could be seen that retail prices of white maize in Telemu market ranged from #37/kg in 2000 to #95/kg in 2010. It was observed, that Erin Ijesa market had the lowest period average price (#36.6 /kg) while Osogbo market had the highest (#99/kg).

The average annual retail price of white maize in urban area was higher than the price in rural area–the difference in mean is expected and in this case statistically significant ($p < 0.01$). Among other things, they could represent the extra cost, including transportation and transactions, incurred by the marketing agents, as well as marketing margins. It has been argued by Olukosi *et al.*[5], that given the high cost of transactions and the risk to invested capital, the margins of the marketing agents could be considered reasonable. These findings agree with the findings of Ojiako *et al*.[8] in their analysis of the spatial integration of cassava product market price in Nigeria, where it was reported that the mean price value of *lafun* in the urban market was higher than prices in the rural markets.

Table 1: Average annual retail price of white maize 2000 – 2010 in-/kg.

Year	Osogbo	Erin Ijesa	Telemu
2000	40.2	36.6	37.0
2001	45.2	42.8	42.5
2002	53.5	49.8	48.5
2003	56.4	54.3	55.2
2004	64.1	62.1	62.9
2005	72.7	69.2	68.3
2006	79.5	73.4	74.0
2007	86.2	82.0	81.5
2008	92.3	88.0	85.2
2009	95.6	90.0	90.5
2010	99.0	94.0	95.0
Average	71.3	67.4	67.3
Overall Average	68.7		

Source: Computed employing Price data series from OSSADEP (2012

Variability in Average Retail Prices of White Maize:

Variability in average monthly retail price of white maize is presented in Table 2. Telemu market (a rural market dominated by retailers) had the highest coefficient of variation. The rural markets had a higher coefficient of variation than the urban market. This indicates that the retail price for white maize in the urban market was more stable than what obtained in the rural markets (producer areas). This is because most marketers preferred to sell their produce in the urban area and this could eventually lead to scarcity in the rural area and eventual rise in price that will encourage increase in production that would force the price down again thus giving rise to a high coefficient of variation. This is in agreement with Olukosi *et al*[5] and Oladapo and Momoh[7].

Table 2: Variability in Average Annual Retail Prices of White Maize (2000 - 2010)

Markets	Average Price (₦ /kg)	Coefficient of Variation (%)
Osogbo	71.3	27.9
Erin	67.4	28.1
Telemu	67.4	28.0

Source: Rice price series from January, 2000 to December, 2010

Price correlation co-efficient for maize in Osun State:

Pearson price correlation analysis was used to determine the behaviour of market price between white maize in rural and urban markets.

The high and significant correlation of the price series is an indication of co-movement in the prices. The positive correlation showed that an increase in the retail price in one market would follow the price increase in the other market (Table 3). This could be possible due to the transmission of market information by marketers through various means, particularly via the use of mobile phones, coupled with the short distance between markets. This could also suggest the possible existence of relative price elasticities in these markets. This corroborates the findings of Oladapo and Momoh[7], which noted high correlation coefficients of pineapple prices in Edo, Oyo and Lagos States' rural and urban markets.

Table 3: Pearson Correlation between Retail Prices of White Maize in Selected Markets

	Osogbo	Erin Ijesa	Telemu

Osogbo	1	0.92	0.85
Erin	0.92	1	0.35
Telemu	0.85	0.35	1

Source: Maize price series from January, 2000 to December, 2010

Johansen Multivariate Co-Integration Test Results

Testing For Stationarity

As presented in Table 4, the ADF test statistics calculated at price levels for the rural markets were - 1.42 for Erin and -1.36 for Telemu, while it was -1.7 3 at Osogbo (urban market). In the first difference, the statistics calculated were -5.3 4 and -5.9 2 for rural and -6.76 for urban markets. When compared with the critical value, the results showed that all the series were non-stationary and integrated of order one, that is, they were also 1(1) series.

The results of stationarity test for the white maize, using Augmented Dickey-Fuller (ADF) unit roots tests indicated that all the variables were not stationary at their levels. The calculated ADF statistic was less than the critical values at both 5 percent and 1 percent levels of significance. Therefore, the null hypothesis of non-stationary was accepted for all the variables at their levels. When first-differenced, however, the null hypothesis of non-stationarity was rejected in favour of the alternative as the calculated ADF values became higher than the critical values at both 5% and 1% levels. The findings corroborate earlier findings that food commodity price series are mostly stationary of order 1 i.e. 1(1). The result was explained by the fact that most food price series had trends in them because of inflation and therefore exhibited non-stationarity.

Table 4: Unit -Root Test on Maize Price Series

Market	Test as Level I(0)	Test at First differences I(1)
Osogbo	-1.17	-6.76
Telemu (Rural)	-1.42	-5.34
Erin Ijesa (Rural)	-1.37	-5.93
ADF Test Critical values at 5%	-3.89	-3.46
ADF Test Critical Values at 1%	-4.06	-4.06

Source: Maize price series from January, 2000 to December, 2010

Selection of Lag Length

Akaike Information Criterion (AIC) test (Dickey and Fuller[16]; Said and Dickey[17]), suggested that the value k = 1 is the appropriate specification for the order of a VAR model. The use of one lag on the model of the economy implies that all variables in the model influenced each other not only in the present period (from the year 2000 to 2010) but these variables were also inter-related in the period before the year 2000. These results are in line with the findings of Desi and Yulius[24], which showed that the use of lag 1 is suitable in the co-integration procedure.

Testing for co-integration between urban and rural market prices

Both trace and maximum Eigen value statistics indicate the existence of co-integrating relationship at 5% level of significance. The result of the Johansen's maximum likelihood co-integration test is shown in Table 5. The result, based on both the Trace test and maximum Eigen value test, showed the existence of two co-integrating vectors and the rejection of the null hypothesis of r = 0. Comparing the Trace and Eigen statistic with the corresponding critical values, it can be seen that the null hypothesis of no co-integrating relationship can be rejected at the 5 % level of significance.

Market integration lends itself to co-integration interpretation with its presence being evaluated by means of co-integration tests[21]. Thus, the result indicates that maize markets in Osun State during the study period were co-integrated, and there existed long-run equilibrium. This finding is supported by the earlier studies carried out by Oladapo and Momoh[7] who concluded that grain market prices within Oyo State are highly co-integrated and the findings of Ojiako *et al.*[8] that long-run equilibrium existed within the spatial integration of cassava products market in Nigeria.

Table 5: Testing for number of Co-integration Relations

$H_{o:}$	$H_{A:}$		5%	Prob**	Hypothesized
λ Trace tests		λ Trace value	Critical value		No. of CE(s)
r =0	r >0	52.59	29.80	0.00	None*
r ≤1	r >1	20.30	15.50	0.01	At most 1*
r ≤2	r >2	4.80	3.84	0.03	At most 2
λmax tests		λ max value			
r = 0	r =1	32.29	29.80	0.00	None*
r =1	r =2	15.49	15.19	0.01	At most 1*

r =2	r =3	4.80	3.84	0.03	At most 2

Source: Price series from January, 2000 to December, 2010.

Testing for short-run market integration with a vector error correction model

The results of the Vector Error Correction Model presented in Table 6 indicate that if there is a positive deviation for the long-run equilibrium, the market tends to respond with a decrease in the rural price or an increase in the urban price. The urban (OSO) price appears to respond faster than the rural price. The adjustment coefficient is statistically significant at 1% for urban market price for white maize suggesting that the rural price is weakly exogenous. This implies that movement in the rural price was less affected by price in the urban market while movement in the urban price was dictated by events in the rural markets. This means that the long-run equilibrium in the white maize market, after an exogenous shock, is restored primarily by corrections made by the urban market prices.

Table 6: Estimation of the Dynamics in the short–run by using VECM for Maize

	ΔOSO	ΔERIN	ΔTEL
	0.04	-0.13	-0.15
	(0.21)	(0.19)	(0.20)
	[-1.90]	[-1.68]	[1.76]

Source: Price series from January, 2000 to December, 2010
Note: All figures in brackets (…) are standard errors and all figures in parenthesis […] are t–values.

Granger Causality Test

The results of granger causality test at 5% level of significance in Table 8 indicate that Osogbo white maize market price did not determine Erin Ijesa and Telemu market prices but Erin Ijesa and Telemu market prices determined the Osogbo market price. This implies that the direction of the granger causality was from rural to urban.

Table 7: Pair-Wise Granger Causality Test for White Maize Market Price

null hypothesis	f-statistics	*p*-value
Perin does not granger cause Poso	4.27	0.02
Poso does not granger cause Perin	0.18	0.22
Ptele does not granger cause Poso	5.83	0.00
Poso does not granger cause Ptele	0.04	0.02
Ptele does not granger cause Perin	0.18	2.12
Perin does not granger cause Ptele	0.22	0.54

Source: Maize price series from January, 2000 to December, 2010

Wald Test for Market Integration

The Wald test shows that there existed both long-run and short-run market integrations between Osogbo and the other selected markets. Thus, changes in food grain price in rural markets would cause food grain price in urban markets to adjust immediately.

The Wald test restriction of the F-statistic was applied to determine market integration in the white maize markets as shown in Table 8. The F values of 0.25 and 0.57 with probability values of 0.96 and 0.62 were not significant even at 1%. The long-run and short-run null hypotheses that white maize market prices are integrated and a price change in a market is immediately transmitted to other markets, respectively, therefore cannot be rejected.

Table 8: Wald test for White Maize Market

Null hypothesis	F-statistics	*Pp* –value
Long-run market integration	0.25	0.96
Short-run market integration	0.57	0.62

Conclusion and Recommendations

The trend analysis showed that the prices of maize in the markets studied, moved in an upward trend every year. This is due to the fact that prices were higher in one year compared to other years. Results of Pearson correlation coefficient indicated that the rural and urban market price series for maize were positively and significantly correlated. The stationary test indicated that the prices were not stationary at level form. The results of the maximum likelihood test showed that there were co-integrating vectors, which suggested that maize markets were co-integrated and had short-run and long-run relationships. The result of the Granger causality test confirmed that rural maize markets were occupying the leadership position in price formation and transmission**.** White maize marketers are therefore advised to follow the trend of the co integration and take advantage of it to improve the marketing of white maize in the area.

Efforts need to be made to furnish maize farmers and marketers with spatial price variations for marketed grains so they could easily know the price of differences for food products and make profitable adjustments accordingly, in other to ensure sustainability and food security. There is the need for efficient transmission of price information among the operators in the urban and rural markets through the establishment of market information centers to facilitate adequate communication and flow of information between markets. Rural areas which have been shown in this study to be the market leaders should be the target of government developmental reforms.

References

1.Obayagbona J, Eboiyehi O (2013). Impact of Agricultural Output on Per Capita Income in Nigeria: 1980-2011. *Nigerian Journal of Agricultural and Development Economics* 3(1):141-150.
2. World Bank (2005). Development Report, Washington D.C.
3. NAERLS (1996). Prospects and Problems of the 1996 Cropping Season. A report of a study conducted by the National Agricultural Extension Research and Liaison Services.
4. Adetunji M.O. and Adesiyan, I.O. (2008). Economic Analysis of Plantain Marketing in Akinyele Local Government Area of Oyo State, Nigeria. *International Journal of Agricultural Economics and Rural Development. 1(1):15-21*
5. Olukosi J.O., Isitor S.U. and Ode M.O. (2007). *Introduction to Agricultural Marketing and Prices: Principles and Applications.* Third Edition, GU Abuja, Nigeria. Pp. 47 – 57.
6. Onu J.I. and Iliyasu, H.A. (2008). An Economic Analysis of the Food Grain Market in Adamawa State, Nigeria. *World Journal of Agricultural Sciences*. 4(5):617-622,

7. Oladapo, M.O. and Momoh, S. (2007). Food Price Differences and Market Integration in Oyo State, Nigeria. *International Journal of Agricultural Research.* 2(1):69-74.
8. Ojiako, I.A., Ezedinma. C., Asumugha, G.N. and Nkang, N.M. (2012). Spatial Integration and Price Transmission in Selected Cassava Products' Markets in Nigeria: A Case of Lafun *World Applied Sciences Journal.* 18(9):1209-1219.
9. Okoh, R.N. and Egbon, P.C. (2005). The Integration of Nigeria's Rural and Urban Foodstuff Markets. AERC Research Paper 151, African Economic Research Consortium, Nairobi.
10. Ogunbodede, B.A. and Olakojo S.A. (2001). "Development of Striga Ash Tolerant Hybrid Maize (*Zea mays* L.) Varieties". Tropical Agric Research and Extension. 4(1):42-54.
11. Mohammad, S. (2005). Supply Response Analysis of Major Crops in Different Agro-Ecological Zones in Punjab. *Pakistan Journal of Agricultural Research.*124(54):144-156.
12. Enders, W. (2010). *Applied Econometric Time Series, 3rd edition,* New York: Wiley.
13. Widarjono, A. (2007). *Econometrics: Theory and applications to economics and business.* Ekinosia Faculty of Economics, UII, Yogyakarta.
14. Chirwa, E.W. (2000). Food Marketing Reforms and Integration of Maize and Rice Markets in Malawi. Working Paper, School of Economics, University of East Anglia.
15. Dickey, D.A. and Fuller, W.A. (1971). Distribution of the Estimators for Autoregressive Time Series with Unit Roots. *Journal of the American Statistical Association.* 74(366): 427-431.
16. Dickey, D.A. and Fuller, W.A. (1981). Likelihood Ratio Statistics for Autoregressive Time Series with a Unit Root. *Econometrica*. 49(4):1057-1072.
17. Said, S.E. and Dickey, D.A. (1984). Testing for Unit Roots in Autoregressive-Moving Average Models of Unknown Order. *Biometrika.* 71:599-607.
18. Greene, W.H. (1993). Econometric Analysis. Second Edition. NewYork: Macmillan.
19. Engle, R.F. and Granger, C.W.J. (1987). "Co-integration and Error Correction: Representation, Estimation and Testing, *Econometrica.* 55(2):251-276.
20. Johansen, S. and Juselius, K. (1990). Maximum Likelihood Estimation and Inference on Cointegration with Application to the Demand for Money, *Oxford Bulletin of Economics and Statistics.* 52(2):169-210.
21. Rapsomanikis, G., Hallam, D. and Conforti, P. (2005). Market Integration and Price Transmission in Selected Food and Cash Crop Markets of Developing Countries: *Review and Applications*. 33: 225-229.

22. Hopcraft, P. (1987). Grain Marketing Policies and Institutions in Africa. *Finance and Development.* 24(1):37-43.
23. Ahmed, R. and Rustagi, N. (1987). Marketing and Price Incentives in African and Asian Countries. In: Elz, D. (Ed): *Agricultural Marketing Strategy and Pricing Policy. International Bank for Reconstruction and Development,* Washington, USA
24. Desi, A. and Yulius, J. (2012). Integration of Rice Market Inter-Provinces of Rice Production
Center in Indonesia. Proceedings of an International Conference on Environment, Energy and Biotechnology IPCBEE .33:42-51.
25. National Population Commission (2006). Population Census, 2006. Federal Republic of Nigeria. http://www.nigerianstat.gov.ng/national bureau of statistics/official gazatte (fgp 71/52007/2,500(l24):pdf. Retrieved June, 2012.