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Analysis of Market Integration and Price Variation in Rice Marketing in Osun State, Nigeria

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Authors' contributions

This work was carried out in collaboration between both authors. Author COE designed the study, managed the analysis, wrote the protocol and first draft of the manuscript, read and approved the final manuscript. Author AAA performed the statistical analyses of the study and carried out the field work. Both authors managed the literature searches.

Original Research Article

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ABSTRACT

Aims: The aim of the study was to examine market integration and price variation in local rice 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 rice.
Study Design: Secondary data were used in this study. The data were sourced from Osun State Agricultural Development Programme. The average monthly retail price (/Kg) of local rice covering the period, January, 2000 to December, 2010 (11years) for Osogbo (urban market), Telemu (rural market) and Erin Ijesa (rural market) were used.
Place and Duration of Study: Osun State, South-West Nigeria, between March and July 2011.
Methodology: Coefficient of variation and price correlation coefficient were used to examine the behavior of local rice 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.
Results: Augmented Dicker Fuller procedure (ADF) indicated that all the variables (the individual price series for rice) were not stationary at their respective levels, but stationary

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at their first difference. Both the trace and maximum eigen value statistics indicated the existence of co-integration relation at 5% significant level for the pairs of product prices, implying that rice markets during the study period were linked together and therefore the long-run equilibrium was stable. The results also indicated that urban rice markets did not granger-cause rural rice markets while rural rice markets granger caused urban rice 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 local rice in Nigeria.

Conclusion: The study concluded that rice markets in both urban and rural areas of Osun were co-integrated and had short-run and long-run relationships, with rural rice markets occupying the leadership position in price formation and transmission. The design of appropriate agricultural price policies aimed at efficient and cost effective government market interventions such as price stabilization and food distribution policies must henceforth, take into cognizance, the high degree of co-integration among rice markets in the study area, as established in this study. It was therefore recommended that rice farmers (who are located in these rural areas) be placed at the center of marketing policies so they can determine the direction of price movements.

Keywords: Co-integration; granger-caused; food security; sustainability; mono-product; rice.

ABBREVIATIONS

Central Bank of Nigeria (CBN); Food and Agriculture Organization (FAO); National Agricultural Extension Research and Liaison Services (NAERLS); National Population Commission (NPC).

1. INTRODUCTION

Agriculture, the article of sustainability, in clear recognition of its crucial role in the sustainable development of a mono-product economy like that of Nigeria, is presently receiving its deserved attention from the government. The fact that the nation's first commercial oil well at Oloibiri, is already dried up, after only 50 years of continuous production, is a clear attestation to the non-renewable nature of crude oil. World Bank [1] records show that the Nigerian government is diversifying the nation's economy by measures aimed at ensuring food security. To achieve this, the presidential initiative was embarked upon by the government, with rice identified as one of the crops earmarked for special priority in resource allocation [2]. This initiative has translated to the current Agricultural Transformation Agenda (ATA), aimed at maximizing the full potentials of the agricultural sector for the overall economic growth and development of Nigeria.

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 percent of the total land area devoted to cereal production in Nigeria [3]. National Agricultural Extension Research and Liaison Station, 1996). Rice accounts for about 12 percent of the cereals produced in Nigeria [4]. The government of Nigeria, realizing the importance of the grain subsector has continued to intervene in stabilizing the grain subsector through agricultural policy reformation. Agricultural production problems can be overcome through introducing new technology and efficient marketing systems [5]. 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 [6]. This study therefore sought to know the trend in price of rice in rural and urban markets as well as the level of integration between the markets for rice in Osun State. The research questions include (a) how do prices relate between rice markets? (b) Are there linkages between rice markets in urban and rural areas? (c) What is the degree of market integration among these rural and urban markets for rice in the study area?

2. 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 rice markets. The specific objectives were to:

1. Examine the price behavior between rural and urban markets for rice.
2. Determine if co-integration (long run equilibrium) relationship exist between local rice prices in rural and urban markets.
3. Determine the leading markets between urban and rural markets.
4. Determine the degree of market integration.

Hypothesis of the study:

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

Justification for the study: there are many reasons that justify the need to assess the transmission of the market price for rice across spatially linked markets, where rice takes a substantial share of indigent farmers' income. Undertaking such analyses would help in assessing the nature of price relationships, the direction of causal relationships and the major determinants of rice prices. Moreover, examining the degree of market integration may be helpful in contributing towards the appropriate design of agricultural price policies. These issues would help in designing and guiding efficient and cost effective government market interventions such as price stabilization and food distribution policies [7]. Without spatial price analysis of the markets, price signals will not be transmitted from food deficit to food surplus areas, prices would be more volatile, agricultural producers would fail to specialize according to long term comparative advantage and the gain from trade would not be realized [8]. The uniqueness of this study is that it focused on the specific co-movement of rice prices in the rural and urban markets of Osun State, south-west Nigeria.

3. METHODOLOGY

3.1 Study Area

This study was carried out in Osun State, Nigeria. Osun state has an estimated population of 3,423,535 [9]. Osun State is made up of 30 local government councils. Its coordinates are: 7º30′n 4º30′e7.500ºn 4.500ºe, with a land mass of 9,251 km^2 (3,572 sq mi) [10]. 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 people of Osun State. 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 and kola, while food crops include yam, maize, cassava, millet, rice and plantain. The vegetation consists of high forest and derived savannah towards the north. The climate is tropical with two distinct seasons. Usually the wet season last between March and October, while the dry season comes between November and February. Mean annual rainfall is between 2,000 and 22,000 mm. Maximum temperature is 32.5ºc while the relative humidity is 79.90 percent [10]. The choice of Osun State for the study was deemed to be appropriate because of its antecedent in agriculture and food marketing. In the study, effort was made to analyze price trends of local rice 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.

3.2 Sources of Data

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

3.3 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 (₦/kg) and series of prices were all deflated by using Consumer Price Index (CPI). The real prices obtained were then used for the analyses.

$$\text{real price} = \frac{\text{nominal price} \times 100}{\text{CPI}}$$

Data collected were analyzed using the following:

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

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

Where,

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

$\bar{P}_{it}$ and $\bar{P}_{jt}$ = mean of the variables

Price correlation coefficients were used to examine the strength of price linkages across markets. Given price series from two markets at time t, p_{it} and p_{jt}, the degree of linear association between the markets can be measured by the sign and magnitude of the correlation coefficient, *r*. The t - statistic was used to ascertain if the coefficient between prices in the markets was statistically different from zero.

Co-efficient of Variation (CV)

$$CV = \frac{\text{Standard Deviation}}{\text{Mean}} \times 100\% \qquad (2)$$

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 [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 local rice prices in the rural and urban markets of the study area as follows:

3.4 Testing for Stationarity

Stationary time series data happen 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 [17].

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

$$\delta XT = \alpha + \delta X_{T-1} + \sum_{k=1}^{p} \beta \delta X_{T-K} + \varepsilon_t \qquad (3)$$

Where:

XT	=	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. I (0). If the null hypothesis of non stationary cannot be rejected, that is, the absolute value of the adf statistic is smaller than the critical Augmented Dickey Fuller (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 becomes stationary and order noted. The process is considered stationary if /δ/<1, thus testing for stationary 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 is greater than the critical value.

3.5 Selection of Lag Length

For the determination of the lag length to be included in var (vector auto regression) model. Akaike's [17-19], Information Criterion (AIC), schwarz's bayesian information criterion (SBIC), and Hannan-Quinn Criterion (HQIC) are used for var models. When using AIC, SBC or HQIC based on the estimated standard errors in respective equations, the model with the lowest value from the AIC, SBC or HQIC 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:

$$AIC = LN(\Sigma^2) + 2K/T \quad (4)$$

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 AIC, HQIC and sic 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 [20,21] AS:

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

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:

$$\text{Max } (r/r+1) = -\, t \ln (1 - \lambda_{r+1}) \quad (7)$$

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

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 nonexistence 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 auto regression (var) as in the following equation [22-24]:

$$X_T = \mu + \sum_{i-1}^{p} \Gamma_I \, \Delta X_{T-1} + \Pi X_{T-K} + E_T + \mathrm{B}_T \quad (8)$$

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 π = αβ′ 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 [22-25]:

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

Where :

Δ = The difference operator
Xt = (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} 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 δx_{t-k} is i(0). So, it is the ∏ matrix that conveys information about the long-run relationship among the variables in x_t. The rank of ∏, 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 xt is stationary.

IF 0 < RANK (∏) = R < N, AND THERE ARE N X R MATRICES A AND B SUCH THAT ∏ = AB' then it can be said that there are r co-integrating relations among the elements of xt. The co-integrating vector β has the property that β'xt 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.

3.6 Empirical Model

For this study, it was hypothesized that rural and urban market prices for local rice are jointly determined or endogenous, given an implicit representation of the model with two endogenous variables without exogenous variables as [23,24].

$$X_T = (LN\_RP_T, LN\_UP_T) \quad (10)$$

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;

$$LN\_RP_T = \acute{\omega}_0 + \acute{\omega}_1 LN\_UP_T + y_t \quad (11)$$

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 [22-24]:

$$\Delta \mathrm{RP_T} = \Psi_{10} + \sum_{i=1}^{p} \Psi_{11i} \Delta RP_{T-i} + \sum_{i=1}^{p} \psi_{12i} \Delta UP_{T-i} - \rho\,(RP_{T-1} - UP_{T-1}) + Y_{1t} \quad (12)$$

$$\Delta \mathrm{UP_T} = \Psi_{20} + \sum_{i=1}^{p} \Psi_{21i} \Delta UP_{T-i} + \sum_{i=1}^{p} \psi_{22i} \Delta UP_{T-i} - \rho\,(RP_{T-1} - UP_{T-1}) + Y_{2t} \quad (13)$$

Where:

Δ = the difference operator
RP and UP = rural and urban markets prices
ψ_{11} and ψ_{12} = short run coefficients
ρ = error correction instrument measuring the speed of adjustment from the short-run state of is equilibrium 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.

3.7 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 [8]. When granger causality run one way (uni-directional), the market which granger-causes the other is tagged the exogenous market. Erogeneity can be weak or strong. Weak erogeneity 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 local rice in one market does not determine (granger cause) the price in the other market
H_a: price of local rice 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 [8,23,24]:

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

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: local rice market prices are integrated in the long-run.
h_a: local rice 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.

4. RESULTS AND DISCUSSION

4.1 Price Behavior of Rice in the Study Area

Average annual retail prices of local rice: The behavior of the average monthly retail price of local rice from 2000 to 2010 are presented in Table 1. It could be seen that in Osogbo market, prices ranged from an average of about 40.2/kg in 2000 to a peak of 99 /kg in 2010. In Erin Ijesa market, prices ranged from 36.6/kg in 2000 to 94/kg in 2010.

Table 1. Average annual retail price of local rice (2000 - 2010) in /kg

Year	Osogbo (Urban)	Erin Ijesa (Rural)	Telemu (Rural)
2000	48.4	47.2	49.5
2001	58.5	53.4	60.5
2002	62.6	58.9	63.5
2003	72.5	67.2	73.5
2004	85.8	82.5	88.0
2005	95.6	90.0	98.5
2006	115	110.9	117.3
2007	125.4	120	126.5
2008	137.0	132.8	136.2
2009	145.4	139	143.2
2010	160	146.5	162.0
Average	100.5	95.3	101.7
Overall average		99.1	

Source: Computed, employing Price data series from OSSADEP (2012)

The average annual retail price of rice was higher in Telemu market (which is a rural market, dominated by retailers) than in Erin Ijesa (which is also a rural market, but dominated by wholesalers of grain products). Among other things, the difference in mean could represent the extra cost, including transportation and transactions, incurred by the marketing agents, as well as marketing margins. It has been argued [26,6], 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 collaborate with the findings of [24] 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.

4.2 Variability in Average Retail Prices of Local Rice

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. This indicates that the retail price for rice 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 high price of produce in the rural area, as suggested by [6,23].

Table 2. Variability in average annual retail prices of local rice (2000 - 2010)

Markets	Average Price (/kg)	Coefficient of Variation (%)
Osogbo	100.5	38.2
Erin	95.3	36.0
Telemu	101.7	40.3

Source: Rice price series from January, 2000 to December, 2010 collected from OSSADEP (2012).

Price correlation co-efficient for rice in Osun State: Pearson price correlation analysis was used to determine the behaviour of market price between local rice in rural and urban markets. The results (Table 3) were calculated as 0.90 between Erin and Osogbo, 0.85 between Osogbo and Telemu and 0.35 between Erin and Telemu. Results were significant at 1 percent level except for 0.35 which was significant only at 5 percent level. The results of the analysis of the correlation between market prices of local rice in urban and rural area, is shown in Table 5. The results showed a correlation coefficient of 0.86 between Erin Ijesa and Osogbo market prices, 0.90 between Osogbo and Telemu and 0.087 between Erin and Telemu. The coefficients were significant at 1 percent level.

Table 3. Pearson correlation between retail prices of local rice in the selected markets

	Osogbo	Erin Ijesa	Telemu
Osogbo	1.00	0.86	0.90
Erin Ijesa	0.86	1.00	0.87
Telemu	0.90	0.87	1.00

Source: Rice price series from January, 2000 to December, 2010 collected from OSSADEP (2012).

The high and significant correlation of the price series calculated as 0.90 and 0.86 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. 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 [23], which noted high correlation coefficients of pineapple prices in Edo, Oyo and Lagos States' rural and urban markets.

4.3 Johansen Multivariate Co-integration Test Result

4.3.1 Testing for stationarity

Stationarity test for rice in Osun State: As presented in (Table 4), the ADF test statistics calculated at price levels for the local rice price series were-1.82,-1.88 and -1.81 for Osogbo, Erin Ijesa and Telemu respectively. The results indicate that all the variables were not stationary at their level. The null hypothesis which states that prices of rice in the rural markets do not determine prices in the urban market could not be accepted at the probability of 5 percent level of significance. However, the null hypothesis was accepted for all the variables at their respective levels. The values in first differences were -7.66, -6.22 and -8.39 in Osogbo, Erin Ijesa and Telemu respectively. When first-differenced, however, the null hypothesis of non-stationarity was rejected in favour of the alternative as the values of the ADF t-statistics were greater in absolute term than the critical value. This result is necessary and sufficient for a test of co-integration of the price series.

Table 4. Unit Root Test on rice price series

Market	Price Levels I(0)	First differences I(1)
Osogbo	-1.85	-7.66
Erin Ijesa	-1.81	-6.22
Telemu	-1.88	-8.39
ADF Test Critical values at 5%	-3.89	-3.46
ADF Test Critical Values at 1%	-3.64	-3.64

Source: Rice price series from January, 2000 to December, 2010 collected from OSSADEP (2012).

The results of stationarity test for the local rice, 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 ADF 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 percent and 1 percent levels. The findings corroborate earlier findings that food commodity price series are mostly stationary of order 1 i.e. I (1) [8,23,27,28]. The result was explained by the fact that most food price series had trends in them because of inflation and therefore exhibited non-stationarity.
Selection of lag length.

Akaike Information Criterion (AIC) test [17,18], suggested that the value K=1 is the appropriate specification for the order of 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 interrelated in the period before the year 2000. These results are in line with the findings of [28] which showed that the use of lag 1 is suitable in the co-integration procedure.

4.3.2 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 percent significant level for rice. The result of the Johansen's Maximum Likelihood co-integration test is shown in Table 5. The result, based on the 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 percent significance level for the local rice market prices.

Table 5. Testing for number of co-integration relations (rice)

$H_{o:}$ λ Trace tests	$H_{A:}$	λ Trace value	5% Critical value	Prob**	Hypothesized No. of CE(s)
r = 0	r > 0	70.27	29.80	0.00	None*
r ≤ 1	r >1	35.37	15.50	0.00	At most 1*
r ≤ 2	r >2	2.07	3.84	0.15	At most 2
λmax tests		**λ max value**			
r =0	r =1	34.90	29.80	0.00	None*
r =1	r =2	33.29	15.50	0.00	At most 1*
r =2	r =3	2.07	3.84	0.15	At most 2

Source: Price series from January, 2000 to December, 2010; collected from OSSADEP (2012).

Market integration lends itself to co-integration interpretation with its presence being evaluated by means of co-integration tests [22]. Thus, the result indicates that rice 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 [23], who concluded that grain market prices within Oyo State are highly co-integrated and the findings of [24], that long-run equilibrium existed within the spatial integration of cassava products market in Nigeria.

The result of the Johansen's Maximum Likelihood Co-Integration test is presented in Table 6. Comparing the trace and Eigen statistics with the corresponding critical values, it can be seen that the null hypothesis of no co-integrating relationship can be rejected at the 5 percent significance level for the local rice market prices. The results from the trace and Eigen test indicate that there are co-integrating vectors. This implies that there existed a long-run relationship between the variables.

Table 6. Estimation of the dynamics in the short–run by using VECM for rice

Error correction	ΔOSO	ΔERIN	ΔTEL
Rice			
CointEq1	0.04	-0.18	0.06
	(0.18)	(0.18)	(0.18)
	[-2.12]	[1.76]	[0.31]

Source: Price series from January, 2000 to December, 2010; collected from OSSADEP (2012).
Note: All figures in brackets (…) are standard errors and all figures in parenthesis […] are t–values.

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

The result of the Vector Error Correction Model shows 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 price appears to respond faster than the rural price. The adjustment coefficient is statistically significant at 1 percent for urban market price for local rice 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 local rice after an exogenous shock, is restored primarily by corrections made by the urban market prices

4.3.4 Granger causality test

The result of the Granger causality analysis (Table 7) indicated that, Osogbo (urban) local rice market price did not determine the Erin Ijesa (rural) market price. Although, Erin Ijesa market price determined the urban market price, while Osogbo local rice market price determined Telemu market price. This result is consistent with the findings of [24] in the study of spatial integration and price transmission in selected cassava products' markets in Nigeria, that Granger causality runs from rural to the urban markets and not the other way round.

Table 7. Pair-wise Granger Causality Test for Local Rice Market

Null hypothesis	F – statistics	Probability Value
MERIN does not Granger Cause MOSO	6.31	0.00***
MOSO does not Granger Cause MERIN	0.37	0.67
MTEL does not Granger Cause MOSO	0.33	0.77
MOSO does not Granger Cause MTEL	10.19	0.00***
MTEL does not Granger Cause MERIN	0.58	0.78
MERIN does not granger cause MTEL	6.14	0.00***

****Significant at 1% probability level*

Source: Rice price series from January, 2000 to December, 2010; collected from OSSADEP (2012).

4.3.5 Wald test for market integration

The Wald test restriction of the F-statistic was applied to determine market integration in the local rice markets. The F statistical values were of 0.20 and 0.19 with probability values of 0.85 and 0.75 respectively, for local rice which shows in Table 8, that they are not significant even at 1 percent. The long-run and short-run null hypotheses that local rice market prices are integrated and a price change in a market is immediately transmitted to other markets, respectively, therefore cannot be rejected. The results mean that there existed both long-run and short-run market integrations between Osogbo and the other selected markets. Thus, changes in the price of rice in rural markets would cause the price of rice in urban markets to adjust immediately.

Table 8. Wald Test for local rice market

Null hypothesis	F-statistics	*P*- value
Long-run market integration	0.20	0.85
Short-run market integration	0.19	0.75

5. CONCLUSION

This study is an evaluation of market integration and price variation in marketing of local rice in Osun State, Nigeria. The trend analysis showed that the prices of food grain rice 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. The study further established that extra costs were incurred by the marketing agents in transportation and transactions, as well as marketing margins. This implies high cost of transactions and risk to invested capital. Results of Pearson correlation coefficient indicated that the rural and urban market price series for rice were positively and significantly correlated. Thus, suggesting co-movement in the prices, attributable to the transmission of market information by marketers through various means. Such free flow of market information has implications in strengthening the interaction of the forces of demand and supply, thereby encouraging competitiveness and its attendant benefits. 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 rice markets were co-integrated and had short-run and long-run relationships. The result of the Granger causality test confirmed that rural rice markets were occupying the leadership position in price formation and transmission. The main policy implications is thus hinged on the fact that relevant stakeholders in the business of rice marketing must take into consideration the leadership position of rural rice markets in price formation and transmission. The important role played by the marketing of rice in the Nigerian economy has been well canvassed in this paper. Effort must be put in place to strengthen this positive trend of free flow of market information in rice marketing in the study area. Such effort would ultimately ensure the sustainability of rice marketing and improved living conditions for all the rice marketers and other groups of businesses that depend on this sector of the economy for their livelihood. The design of appropriate agricultural price policies aimed at efficient and cost effective government market interventions such as price stabilization and food distribution policies must henceforth; take into cognizance, the high degree of co-integration among rice markets in the study area, as established in this study.

6. BASED ON THE RESULTS OF THE STUDY, THE FOLLOWING ARE RECOMMENDED

- 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.

- Accurate and timely information on food grain the conditions of rice will enable quicker response to market shocks, and market channel members could then be empowered to efficiently and effectively distribute food grain rice from surplus to deficit markets.

- Rural areas which have been shown in this study to be the market leaders should be the target of government developmental reforms. Incomes of rural people can be greatly enhanced with such incentives by government to intensify their production and marketing of grain rice which will create greater opportunities for economic growth and development and eventually leads to market efficiency and increased technical and allocative efficiency of rice producers.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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