Long and short-run price integration analysis of rice marketing in Kwara State, Nigeria

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ABSTRACT

This study examined the long and short-run analysis of rice marketing in Kwara State, Nigeria. Time series data on the retail prices of rice were collected for a period of 60 months (2006-2010) to test for the long linear equilibrium relationship as well as the speed of price transmission between selected markets in the State. The test procedures involved the Augumented Dickey Fuller test to detect the presence of unit root in the series; Johansen co-integration test for the long run equilibrium relationship among the variables; vector error correction model test (VECM) to capture short-run and long-run changes in the price movements; and Granger casualty test to reflect the direction of influence between prices. The results revealed that stationarity in the price series was eliminated after the first differencing and that there was a stable long-run equilibrium relationship among the markets. The vector error correction estimates shows that most of the markets were not well integrated in the short –run, and finally, the causality test revealed that no single market dominated the price formation either in the rural or urban markets in the study area.

Key words: Integration, vector error correction and rice markets

INTRODUCTION

Rice is an important stable and annual food crop in Nigeria economy (Bamidele et al.2010). The importance of research into the interaction among markets and rice prices cannot be over emphasized due to the incessant population increases coupled with ever increasing demand in virtually every household in the country and particularly, in the study area. Hence, for the teeming populace to enjoy self sufficiency in rice production and marketing, there should be transmission of marketing information from areas where there are surpluses to areas of acute shortage so as to lessen the aftermath effect of shocks arising from changes in demand and supply due to climate change, disease and pests, and other vagaries of nature since agriculture in the country is rain-fed. One of the ways of achieving this millennial goal is effective transmission of market information as well as co-movement in prices within the study area. Price transmission studies are presumably an empirical exercise testing the predictions of economic theory and providing important insights as to how changes in one market are transmitted to another, thus reflecting the extent of market integration, as well as the extent to which markets function efficiently (George et al, 2006). Therefore, the essence of this paper was to test for the existence of long-run linear equilibrium relationship among the selected markets as well as the direction of influence between rice prices among the markets in the study area.

CONCEPTUAL FRAMEWORK

Market integration is the extent to which shocks arising in one location are passed on to other locations (Ojo et al, 2013). A series is said to be stationary if the mean and autocovariances of the series do not depend on time, that is, they are time invariant. The model of spatial integration predicts that, under competitive conditions, price differences between two regions in the same economic market for a homogeneous commodity will approximately equal the inter-regional transportation costs. Market integration thus involves a test of price efficiency by examining how food markets in different regions respond jointly to supply and demand forces. If price movements in different parts of the country tend to behave similarly, reflecting the cost of transferring the product between two regions, then markets are said to be integrated. Several studies on market liberalization have tested for food market integration (Ravallion, 1986; Alexander and Wyeth, 1994 and Dercon, 1995). Early empirical studies of market integration used static price correlations to test for spatial market integration in agricultural markets (Jones, 1968; Harriss, 1979 and Blauch, 1997). This involves the estimation of bivariate correlation or regression coefficients between the time series of spot prices for an identical good at different market places. In these analyses, a statistically significant coefficient implies that the two markets are integrated. This kind of modeling of spatial market integration has been criticized for masking other**.** Some other past research work on market integration on various combinations of foodstuffs markets are Akwasi et al., (2011); Amikuzuno (2010); Mohammad and Verbeke, (2010); Okoroafor et al., (2010); Rahji and Adewunmi (2008); Daan, (2008); Mafimisebi, 2008; Tahir and Javed, 2007; Aminu (2006); Huang and Rozelle, (2006); Christine et al., (2005); Akande and Akpokodje (2003); and Takamatsu (2002). These studies suggest that the major sources of poor integration and inefficiency include the poor price information transmission channel, too many intermediaries and the high cost of transportation, as well as the sources and validity of price data. The price series used for the various studies were collected weekly or fortnightly by the researchers.

METHODOLOGY

Study area: Kwara State, with a population of 2,591,555 (which is projected to reach 3,080,544 in 2013 at an annual growth rate of 2.5%) (World Bank, 2012), covers a total land area of 332,500 square kilometers. It lies within latitude $7^0 45'$ N - $9^0 30'$ N and longitudes $2^0 30'$ E - $6^0 23'$ E (Fakayode, Babatunde and Ajao, 2008). It is bordered in the north by Niger State; Kogi State in the east; Oyo, Osun and Ekiti States in the south and the Republic of Benin along its north-western part. The climatic conditions of the State divides it into wet and dry seasons with the temperature ranging from 33^0C to 37^0C. According to Abidoye (2012), agriculture is the predominant economic activity in the State. The crops mainly grown are maize, yam, cassava, rice and tomatoes.

Sampling techniques: This involved random selection of five major rice markets from the State. The markets selected were Patigi (Patigi market), Offa (Owode market), Oke-oyi (Oke-oyi market), Oke-ero (Odo-owa market) and Malete (Malete market). Some of the markets are rural while others are urban. The urban markets were Patigi and Owode markets while the rural markets were Malete, Oke-oyi and Odo-owa markets. Rural markets are those located within the area of production while urban markets are considered as those located outside the area of production.

Data collection: Data for the study were obtained from secondary sources. The data were on the retail monthly rice prices for 60 months (2006-2010) were obtained from Agricultural Development Programme Office in the State.

Data analytical techniques: Analysis of relationships between prices is a common tool in market integration analysis (Okoh and Egbon, 2005). The market integration model (showing the basic relationship to be investigated) is expressed as follows:

$$\ln P_{Bt} = \alpha + \beta \ln P_{At} + \gamma \ln P_{Bt-1} + \varepsilon_{it} \quad (1)$$

Where,

P_{Bt} = the price of rice in B^{th} market in t^{th} month
P_{At} = the price of rice in A^{th} market in t^{th} month
P_{Bt-1}= the price of rice in B^{th} market in the previous month
α = a constant term
β gives the relationship between the prices
γ = the error correction term
Ɛ = white noise term.
A prori conditions specify that if:

β = 1, the law of one price holds and the relative price is constant. This implies that the two markets are perfectly spatially integrated, that is, a price change in the supplying market is fully reflected in the consuming market.

0 < β < 1, there is a relationship between the prices, but the relative price is not constant. The degree of integration is evaluated by investigating how far the deviation of β is from unity.

Any term or parameter that has been defined at the point of first mention is used subsequently without redefining.

Test and estimation procedure: The study employed Error Correction Models as suggested by Engle and Granger (1987). There are four steps in the application of the above technique. The first involves carrying out a unit root test on univariate time series to determine the order of integration through successive differencing. Secondly, Johansen co-integration method was estimated using variables of the same order of integration. The residuals of the co-integration were tested for stationarity in the third step. Lastly, the Error Correction Model (ECM) was estimated.

Step I: Using the Augmented Dickey-Fuller (ADF) test (Dickey and Fuller, 1976) the order of integration of each time series variable was tested to find out if the data are trend stationary or not. The ADF test for this study was formulated by these equations:

$$\Delta P_{Bt} = \beta_0 + \beta_t P_{Bt-i} + \sum c_i \Delta P_{Bt-1} + \varepsilon_t \quad (2)$$

$$\Delta P_{At} = \gamma_0 + \gamma_t P_{At-i} + \sum d_i \Delta P_{At-1} + \varepsilon_t \quad (3)$$

Where,

Δ = the first difference operator
ε_t = the stochastic error term that follows the classical assumptions.

The other variables in equations (2) and (3) are as defined in equation (1). The null hypothesis in equations (2) and (3) is that unit root exists, that is, $\beta = \gamma = 1$ against the alternative hypothesis, that $\beta \neq \gamma < 1$

The decision rule here is that, if the value of the ADF statistic is less than the critical value at the conventional significance level (usually the five per cent significance level) then the series (P_t) is said to be non-stationary and vice versa. Once the series are found to be stationary, then there should exist a linear combination of these variables, which is integrated of order one. The general representation for equations (1) and (2) is:

$$\Delta P_{it} = \beta + \beta_i T + \delta_i P_{t-1} + \sum_{j=1}^{k} b_i \Delta P_{t-1} + \varepsilon_t \qquad (4)$$

Where,

Δ = the difference operator
P_{it} = the price of rice in market i, at time, t (Dickey and Fuller, 1979),
β = drift parameter
T = time trend
P_{t-1}= the price of rice in the previous month
β_i, δ_i and b_i = coefficients
ε_t = white noise error term with zero mean and constant variance
ΔP_{t-1}= (P_{t-1} + P_{t-2}), ΔP_{t-2} = (P_{t-2} + P_{t-3}) that is, using lagged difference terms.
The number of lagged difference term to include is often determined empirically, the idea being to include enough terms so that the error term is serially independent (Gujarati, 1995).

Step 2: The next logical step is to test for cointegration using Johansen co-integration techniques (Trace and Eigenvalue Test).

If two series are individually stationary at same order, the Johansen and Juselius (1990) and Juselius (2006) can be used to estimate the long run co-integrating vector from a Vector Auto Regression (VAR) model of the form:

$$\Delta_{pt} = \alpha + \sum_{i=1}^{k-1} \Gamma_i \Delta p_{t-1} + \Pi p_{t-1} + \mu_t \qquad (5)$$

Where:

p_t is a n x 1vector containing the rice price series at time (t), Δ is the first difference operator. Γ_i and Π are m x n matrix of parameters on the i^th and k^th lag of p_t, $\Gamma_i = \left(\sum_{i=1}^{k} A\right) - I_g$, $\Pi = \left(\sum_{i=1}^{k} A_i\right) - I_g$, I_g is the identity matrix of dimension g, Î ± is constant term, μ_t is n x 1 white noise vector. Throughout, p is restricted to be (at most) integrated of order one, denoted 1(1), where 1(j) variable requires j^{th} differencing to make it stationary. Equation (10) tests the co-integrating relationship between stationary series. Johansen and Juselius (1990) and Juselius (2006) derived two maximum likelihood statistics for testing the rank of Π, and for identifying possible co-integration as follows:

$$\lambda_{trace}(r) = -T \sum_{i=r+1}^{m} In(1-\lambda_i) \qquad (6)$$

$$\lambda_{\max}(r, r+1) = -TIn(1-\lambda_{r+1}) \qquad (7)$$

Where,

r = the co-integration number of pair-wise vector,

λ_i = i^{th} eigenvalue's value of matrix $\prod$.

T = the number of observations.

λ_{trace} is not a dependent test, but a series of tests corresponding to different r-value. λ_{max} tests each eigenvalue separately. The null hypothesis of the two statistical tests is that there is existence of r co-integration relations while the alternative hypothesis is that there is existence of more than r co-integration relations.

Step III: This involves estimating the Error Correction Model (ECM). ECM captures the short-run disequilibrium situations as well as the long-run equilibrium adjustments between prices. Even if one demonstrates market integration through co-integration, there could be disequilibrium in the short-run i.e. price adjustment across markets may not happen instantaneously. It may take some time for the spatial price adjustments to take place. ECM can incorporate such short-run and long-run changes in the price movements.

An ECM formulation, which describes both the short-run and the long-run behaviours of prices, is expressed as follows:

$$\Delta P_{Bt} = \gamma_1 + \gamma_2 \Delta P_{At} - \pi \hat{\upsilon}_{Bt-I} + V_{it} \qquad (8)$$

In this model,

γ_2 = the impact multiplier (the short-run effect) that measures the immediate impact that a change in P_{At} will have on a change in P_{Bt}.
π = the feedback effect or the adjustment effect that shows how much of the disequilibrium is being corrected, that is the extent to which any disequilibrium in the previous period affects any adjustment in the P_{Bt} period. Note that, $\hat{\upsilon}_{t-1} = P_{Bt-1} - \hat{\rho}_1 - \hat{\rho}_2 P_{At-1}$ therefore from this equation we also have ρ_2 being the long-run response.

Step IV: This involves carrying out Granger casualty test. If a pair of series is co-integrated then there must be Granger-causality in at least one direction, which reflects the direction of influence between series (in this case, price). Theoretically, if the current or lagged terms of a time-series variable, say P_{At}, determine another time-series variable, say P_{Bt}, then there exists a Granger-causality relationship between P_{At} and P_{Bt}, in which P_{Bt} is Granger caused by P_{At}.

$$\Delta P_{Bt} = \theta_{11}\Delta P_{Bt-1} + ... + \theta_{1n}\Delta P_{Bt-n} + \theta_{21}\Delta P_{At-1} + ... + \theta_{2n}\Delta P_{At-n} - \gamma_1(P_{Bt-1} - \alpha P_{At-1} - \delta) + \varepsilon_{1t} \qquad (9)$$
$$\Delta P_{Bt} = \theta_{31}\Delta P_{Bt-1} + ... + \theta_{3n}\Delta P_{Bt-n} + \theta_{41}\Delta P_{At-1} + ... + \theta_{4n}\Delta P_{At-n} - \gamma_2(P_{Bt-1} - \alpha P_{At-1} - \delta) + \varepsilon_{2t} \qquad (10)$$

The following two assumptions were tested using the above two models to determine the Granger causality relationship between prices.

$\theta_{21} = \Lambda = \theta_{2n} = \Lambda = \gamma_1 = 0$ (No causality from P_{Bt} to P_{At})
$\theta_{41} = \Lambda = \theta_{4n} = \Lambda = \gamma_2 = 0$ (No causality from P_{At} to P_{Bt})

The above test (I – IV) procedures offer a framework for the assessment of price transmission and market integration in the study area.

RESULTS AND DISCUSSIONS

Augumented Dickey-Fuller Unit Root Test on Retail Price Data Series

The first step in testing market integration between the selected markets in the study area using the augmented Dickey-Fuller (ADF) test at level shows that all rice price series in the model were non-stationary at level both at 1% and 5% levels of significance (Table 1). This is because the absolute values of critical statistics were greater than the absolute values of the t-statistics and hence, contains unit root and are non-stationary i.e, I(0). This prompted the test of stationarity of the first difference.

After the differencing, the price series attained stationarity because the absolute values of the t-statistics were greater than the critical values and hence, all the variables were integrated of order one, I(1). Therefore, the null hypothesis of unit root was accepted at levels but rejected at first difference for all the price series both at 1% and 5% levels of significance. The reason for this process according to Okoroafor et al. (2010), is to avoid the consequences of regressing non-stationary time series with the attendant problem of spurious results due to inflation and seasonality. This finding concur with earlier findings and conclusion that food commodity price series are mostly stationary of order one i.e. 1(1) (Agunbiade, 2013; Okoroafor et al., 2010; Okoh and Egbon, 2003; and Mafimisebi, 2008).

Co-integration Test Results: The presence of co-integration between two series is an indication of their inter-dependence and its absence reflects market segmentation. Co-integration was tested with the aid of Johansen's maximum likelihood procedure using two test statistics, namely the trace (λ- trace) and eigenvalue (λ_i-max.). Table 2 shows the co-integration test results for the sampled market pairs in Kwara State. It was revealed that the two tests statistics - the maximal eigenvalue and trace tests, were absolutely harmonized during the period as to the number of co-integrating vectors, despite differences in the value of the tabulated test statistics for seven (7) market pairs at the conventional 0.05 probability level. Since the two test statistics were greater than the critical values, the null hypothesis was rejected in favour of the alternative which is an evidence of long-run linear relationship in the price series. In other words, retail prices of rice in one market do not significantly differ from that of the corresponding market within the State. This discovery, according to Akande and Akpokodje (2003), may be attributed to free flow of information on prices within and across the States. However, we fail to reject the null hypothesis for thirty percent of the pairs thus implying the absence of long-run linear relationship between them. The implication of this is that Owode market in relation to Patigi, Malete and Odo-owa markets acted independently as separate entities within the study period.

Multiple Co-integration of Rural Markets in Kwara State: Table 3 shows the result of the two test statistics for rural markets in Kwara State. Both the λ-trace and eigenvalue statistics exceeded the critical value at 5% level for null hypotheses of r = 0 and r = 1, therefore we reject the null hypothesis of no cointegrating vectors in favour of alternate hypothesis of r = 2. This implies that there were two co-integrating relationships at the 0.05 level (The values and deviations can be inferred from Table 3) which is an indication of strong inter-dependence between the markets. Therefore, the long-run equilibrium is stable.

Vector Error Correction (VEC) estimates for rural markets in Kwara State: The Vector Error Correction (VEC) estimates for rural markets were presented in Table 4. It measured the short-run dynamics among rural rice markets and the result shows that with the exception of two, all the estimated short-run coefficients are statistically insignificant at the 5% level. This shows that the transmission of price changes from one market to another during the same month was weak. Adjustment to long-run equilibrium in the short-run revealed that price changes in Malete and Odo-owa during the period of study transmitted to other markets at a rate of 76% and 21%, respectively, per month which suggests that the adjustment process was very fast and slow for the former and latter, respectively. Odo-owa market still showed faster adjustment process than the remaining markets in equation 2 (i.e 58% for Odo-owa, 36% for Oke-oyi and 21% for Malete). This implies that in the short-run, the rural markets were not well integrated.

Vector Error Correction Estimates for Urban Rice Markets in Kwara: Vector Error Correction estimates for urban rice markets are as depicted in Table 5. It was discovered that none of the estimated short-run coefficients was statistically significant at the 5% level. This suggests that the transmission of price changes from one market to another during the same month was also weak. Adjustment towards the long-run equilibrium in the short-run was slow. This was because, within a month, price changes in Patigi and Owode were transmitted to other markets at a rate of 19% and 16% respectively. Based on the results, it can be concluded that urban rice markets in the study area are not well integrated in the short run as well.

Pairwise Granger-causality test for rice markets in Kwara State: The result is depicted in Table 6. For nine (9) out of fourteen (14) market pairs tested, the null hypothesis of no causality was rejected. From the nine pairs, five (5) had one-way causal relationships while the remaining four (4) were bi-directional. In the first market pair, Patigi Granger-caused Malete at 1% significance level which is an indication of a strong uni-directional causality i.e, Patigi dominated price formation with Malete market. Despite the fact that Oke-oyi revealed a two- way causation with Patigi at 5% level, it also showed a strong one-way causality with Malete and Odo-owa (5% respectively) as well as Owode (1%). This implies that price changes in Oke-oyi market affects price formation in each of these markets. In addition, Patigi prices manifested a two-way causation with oke-oyi and Odo-owa at 5% level whilst Odo-owa manifested a bi- and uni-directional causation with Patigi as well as malete, respectively. The results showed that no market was exclusively given the leadership position in the study area.

Table 1: Augmented Dickey Fuller (ADF) Unit Root Tests of Price Series in the Study Area

Market price series	Price level 1(0)	First difference 1(1)
Patigi	-2.5753*	-9.1384**
Malete	-1.8382*	-15.4622**
Oke-oyi	-1.3362*	-8.6151**
Odo-owa	-2.0918*	-12.1396**
Owode	-2.4575*	-10.2403**

Source: Field survey, 2012

Note: Critical values are -3.561 and -3.5482 at the 99%, and -2.9117 and -2.9126 at the 95% confidence levels for price levels and first difference series, respectively.

*Non-stationary; **Stationary

Table 2: Pair-wise Co-integration Test on Rice Markets in Kwara State

Market Pairs (P_i-P_j)	Trace Test Statistics	Maximal Eigenvalue Test Statistics
Patigi/Owode	11.5947	9.2606
Patigi /Malete	21.6126**	18.4805**
Patigi /Oke oyi	20.9976**	18.7451**
Patigi /Odo-owa	23.3094**	20.6630**
Owode /Malete	11.9511	9.3928
Owode /Oke-oyi	17.3838**	14.4191**
Owode / Odo-owa	15.4581	12.2375
Malete/Oke-oyi	21.9355**	19.3014**
Malete/ Odo-owa	27.7085**	25.0999**
Okeoyi/ Odo-owa	25.6896**	22.9138**

Source: Field survey, 2012 **Significant at 0.05 level

The critical values for trace test and maximal eigenvalue tests are 15.4947 and 14.2646 at 0.05% respectively.

Table 3: Multiple Johansen Co-integration Test for Rural Markets in Kwara State

Null hypothesis	Trace Statistics	95% critical value	Maximum eigenvalue	95% critical value
r=0	47.32**	29.8	25.77**	21.14
r=1	21.55**	15.49	19.16**	14.26
r=2	2.39	3.84	2.39	3.84

Source: Field survey, 2012 **significant at 0.05 level

Table 4: Vector Error Correction Estimates for Rural Markets

Error Correction	D(Malete)	D(Oke-Oyi)	D(Odo-Owa)
CointEq1	-0.756813	-0.001277	0.212129
	(0.25102)	(0.28720)	(0.33544)
	[-3.01496]	[-0.00445]	[0.63239]
CointEq2	0.206002	-0.357302	0.583286
	(0.20887)	(0.23897)	(0.27911)
	[0.98629]	[-1.49518]	[2.08980]

Source: Field survey, 2012 ( ) standard errors [ ] t-statistics

Table 5: Vector Error Correction Estimates for Urban Markets in Kwara State

Error Correction:	D(Patigi)	D(Owode)
CointEq1	-0.189181	0.160393
	(0.09696)	(0.10765)
	[-1.95107]	[1.48997]

Source: Field survey, 2012 ( ) Standard errors [ ] t-statistics

Table 6: Pairwise Granger-causality Test on Rice Markets in Kwara

Null hypothesis	F-Statistics	Probability

Patigi→ Malete	5.2187***	0.0085
Okeoyi→ Patigi	3.3855**	0.0452
Patigi→Oke-oyi	3.2951**	0.0448
Odo-owa→ Patigi	3.3536**	0.0425
Patigi→Odo-owa	4.4924**	0.0158
Oke-oyi→Malete	4.5424**	0.0151
Odo-owa→Malete	6.1455***	0.0040
Oke-oyi→Odo-owa	3.7453**	0.0301
Oke-oyi→Owode	5.3808***	0.0075

Source: Field survey, 2012 → indicates direction of causality

** means significant at 5% level; *** means significant at 1% level

CONCLUSION AND RECOMMENDATIONS

This study examined the long and short run integration of rice markets in Kwara State, Nigeria. The results of the analysis revealed that in the long-run, the rice markets were well integrated, that is, there was strong inter-dependence between them. Whereas in the short run, the result of the speed of price adjustment showed that price adjustment across markets did not happen instantaneously. It took some time for the spatial price adjustments to take place and hence, were not integrated. The causality test results indicated that no market was exclusively given the leadership position in the State. Therefore, there is the need to improve marketers' timely access to accurate marketing information as well as rehabilitation of deplorable road infrastructure that link the rural markets with urban markets. According to Ojo (2013), the implication of this is that marketers will be able to adjust faster to changing price situations either in the rural or urban markets thereby reducing the risks and uncertainties embedded in ignorance of the happenings in the target/end markets.

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