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PRICE INTEGRATION AND TRANSMISSION OF FOOD GRAINS MARKETS IN SOUTHWEST NIGERIA (2004-2013)

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ABSTRACT

The success of market reforms in developing countries depends to a large extent on the strength of price signals transmitted between different level of markets reflecting extent of market integration and extent to which markets function efficiently. Market integration is an indicator that efficiency exists within the flow of information between markets. This study examined price integration and transmission of food grains markets in Southwest, Nigeria. Time series data of rural and urban retail prices of local and imported rice, cowpea and maize between 2004 to 2013 were obtained from the Agricultural Development Programme (ADP) Offices in selected States. The degree of price transmission was analyzed within the framework of Vector Error Correction Model (VECM). The Augmented Dickey Fuller (ADF) unit root test results revealed that the price series were stationary at first difference. Johansen cointegration results showed that even though two Cointegrating Equations (CEs) exist between linear combinations, some stable long run equilibrium relationships exist among the price series. The study concluded that Rural Price of Local Rice in Lagos State (RPLRLS), Rural Price of Cowpea in Oyo State (RPCOYS) and Rural Price of Maize in Lagos State (RPMLS) occupied the leadership position in price formation and transmission. The study therefore, recommended that policy measures aimed at increasing consumption of local rice, cowpea and maize be implemented, in identifying the leader markets.

Keywords*:* **Price transmission, food grains, retail prices, equilibrium relationship**

INTRODUCTION

Market integration refers to the co-movement of prices and more generally to the smooth transmission of price signals and information across spatially separated markets. The dynamics of the exchange of information and its effects on the pricing processes are well understood in Nigeria because prices are the most reliable information source in Nigeria's agricultural marketing system (Oladapo and Momoh, 2007).

According to Amikuzomo (2010), spatial price transmission or market integration (MI) measures the degree to which markets, at geographically separated locations, share common long run price or trade information on a homogenous commodity. Studies on price transmission measure the degree to which commodity prices at geographically separated markets or at different levels of the value chain share common long run price information. Spatial price analyses began over 60 years ago, with the seminal article being the Enke-Samuelson-Takayama-Judge (ESTJ) equilibrium model for spatial price equilibrium relationships ((Enke (1951), Samuelson (1952) and Takayama and Judge (1964)).

Price transmission and integration analysis has received considerable attention in the past 50 years (Amikuzomo and Ogundari, 2012). This is because price transmission studies have both practical and theoretical usefulness. On the theoretical level, price transmission plays a key role in neo-classical economics by postulating that price drive resource allocation. Thus, the absence of price transmission between markets trading with each other may imply gaps in economic theory (Peltzman, 2000) and result in less than Pareto efficiency in resource allocation in economic welfare theory. Minot (2010) stated that the study of price transmission helps to understand causes of changes in prices and also to forecast prices based on trends in related prices and diagnose poorly functioning markets.

According to Akintunde *et al., (*2012) rice, maize, garri and cowpea are among staple food items whose prices are highly unstable between seasons in Southwest Nigeria. Consumers pay different amounts for the same product in different markets separated by few kilometers. Price instability of agricultural commodities would be considered a normal phenomenon if it does not significantly differ from one market to another. On the contrary, if product prices are significantly different among markets, it may distort resources flow.

According to Ingwe *et al.,* (2008), crops grown in Southwest Nigeria include timber, rubber, cocoa, palm produce, citrus, cashew, kolanut, plantain, banana, maize, rice, cowpea, yam and cassava. Among these, cowpea, rice and maize are the staple food widely consumed by households. Fafchamps *et al.,* (2003) noted that the major food grains (maize, cowpea and polished rice) constitute 80 to 90 per cent of the calorie consumption of Nigerians. Poor storage facilities, low level of domestic production and inconsistent trade policies have been found to be largely responsible for insufficient supply of these commodities (Onu and Illiyasu, 2008).

Although, literature exists on the relationship between urban and rural markets of staple foods in Nigeria but not much is known on food grain price integration and transmission in Southwest, Nigeria. Moreover, in spite of the observed spatial price linkages of staple foods in Nigeria, there is a scarcity of studies on the links between intra and inter-state spatial price linkages of food grains in Southwest, Nigeria. It is the need to fill the existing gaps in this area that gave impetus to this study.

In order to broaden the scope of research and deepen understanding of the spatial foodgrains market taking into consideration the importance of the rice, cowpea and maize to food security, this study seeks to analyse price integration and transmission in selected foodgrains markets. The specific objectives are 1) investigate the order of integration of the foodgrains prices 2) determine the extent of price integration between the markets 3) examine the direction of causality between urban and rural market prices and 4) analyse the price transmission process using the Vector Error Correction Model. The rest of the paper is organised as follows: materials and methods, results and discussion and conclusion.

MATERIALS AND METHODS

2.1 Data and sources

Secondary data were used for this study. The data were of time series nature. Monthly retail prices in rural and urban markets for local and imported rice, cowpea and maize between 2004 and 2013 were obtained from Agricultural Development Programme offices in Lagos, Ogun and Oyo States, Southwest, Nigeria. Lagos State is set as reference. This is because the State is the most commercialize among the selected States.

2.2 Analytical Techniques

The study used co-integration model to analyse the data. The degree and speed of price transmission was examined within the framework of Vector Error Correction Model (VECM). In addition the model includes unit root test that determines the time series properties of the data, while co-integration analysis is a prerequisite for applying the VECM (Engel and Granger, 1987) and Granger causality.

2.2.1 Model Specification

It is assumed for this study that urban prices of selected food grains in Lagos State is determined principally by its rural price, the rural price in the neighboring States and urban price of imported rice in Lagos State. The economic model for this study is specified in double logarithmic form as follows:

$$InP_{it}^{u} = \beta_0 + \beta_1 InP_{it}^{r} + \beta_2 InP_{it}^{n} + \beta_3 InP_{it}^{F} + \varepsilon_i \quad (1)$$

P_{it}^{u} = log of urban price of rice, cowpea and maize in N/kg

P_{it}^{r} = log of rural price of rice, cowpea and maize in N/kg

P_{it}^{n} = log of rural price of rice, cowpea and maize in N/kg in neighbouring State

P_{it}^{f} = log of urban price of imported Rice in the case of local rice in N/kg,

β_0 is a constant term, β_1 to β_3 are estimated parameters in the model

2.2.2 Test for Unit Roots

The price series in this study was firstly tested for stationarity with the purpose of overcoming the problem of spurious regression. A variable that is non-stationary is said to be integrated of order *d*, written *I (d)*, if it must be differenced *d* times to become stationary. In the same way, a variable that has to be differenced once to become stationary is said to be *I (1)* i.e., integrated of order 1. The Augmented Dickey Fuller (ADF) was adopted to test for stationarity following Adeoye *et al.,* (2011). This involves running a regression of the form:

$$\Delta P_{it} = \partial P_{it-1} + \sum \beta_1 \Delta P_{it-1} + \ell_{it} \quad \textbf{(2)}$$

Where

Δ = first difference operator (Difference term)

P_{it} = food grains price series investigated for stationarity

t = time or trend variable

2.2.3 Cointegration Test

After the stationarity test, the study proceeded by testing for cointegration between the price series that exhibited stationarity of the same order. The maximum likelihood procedure for cointegration as propounded by Johansen (1988) was used for this study. The model is specified below following the adaptation of Johansen's model by Onanuga and Shittu (2010):

$$\Delta P_{it} = \alpha + \sum \Gamma_k \Delta P_{t-k} + \Pi P_{t-1} + \varepsilon_t \quad (3)$$

Where:

P_{it} = nx1 vector of n- price variables (rice, cowpea and maize price)

Δ = difference operator, so $\Delta P_t = P_t - P_{t-1}$,

ε_t = n x 1 vector of error term assumed to be white noise.

α = n x 1 vector of estimated parameters that describe the trend component

Π = n x n matrix of estimated parameters that describe the long term relation ship and the error correction adjustment, and

Γk = set of n x n matrices of estimated parameters that describe the short run relationship between prices, one for each of 'q' lags included in the model.

K = number of lags which should be adequately large enough to capture the short run dynamics of the underlying Vector Autoregressive (VAR) equation and produce normally distributed white noise residuals.

2.2.3 Vector Error Correction Model

VECM was used to determine the degree and speed of price transmission between urban markets and rural markets within and across states. Each estimated model consists of a rural price for one commodity in one market and the urban market price for the same commodity. The VECM representation of price transmission is specified by stating the changes in each of the contemporaneous prices P_t^u and P_t^r as a function of the lagged short term reactions of both prices and their deviations from equilibrium at period *t* +1. A simple VECM that captures the interactions between urban price and rural price takes the form below as stated by Minot (2010).

$$\Delta P_t^u = \alpha + \theta\left(P_{(t-1)}^r - \beta P_{(t-1)}^u\right) + \delta \Delta P_{(t-1)}^u + \rho\delta\Delta P_{(t-1)}^r + \varepsilon_t \quad (6)$$

Where:

P_t^r = log of rural prices

P_t^u = log of urban price

Δ = difference operator, so $\Delta P_t = P_t - P_{t-1}$

θ, β and δ = estimated parameters, and

εt = error term

From the perspective of empirical price transmission analysis, the main advantage of the VECM over the VAR is that it separates the long run equilibrium (cointegrating) relationship between P_t^u and P_t^r which is captured by the error correction term $\left(P_{(t-1)}^r - \beta P_{(t-1)}^u\right)$ from the short run dynamics that ensure that any deviations from the long run equilibrium are corrected.

The critical issues in VECM are the cointegrating vector and speed of adjustment parameters, which are key for characterizing the extent of price transmissions and the disequilibrium behavior of prices. Two forms of the speed of price transmission (adjustment) parameters are estimated in the VECM; α^u which measures the response to price shocks by the urban prices to correct disequilibrium and α^r measuring the corresponding price adjustment by the hypothesized determinants to correct disequilibrium following price shocks in the rice, cowpea and maize markets in the numeraire States and neighbouring States. The parameters represent the dynamic interactions between urban and rural prices of local rice, cowpea and maize within a State and between States. The speed of adjustment to long-run equilibrium following a shock in the markets, is another indicator of the degree of market integration (Phylaktis, 1999, Acquah and Owusu, 2012). According to Phylaktis (1999), the greater the speed of adjustment, the greater the market integration.

2.2.4 *Granger Causality*

When two series are stationary of the same order and co-integrated, one can proceed to investigate for causality within a Vector Autoregressive (VAR) framework. This is because at least, one Granger causal relationship exists in a group of co-integrated series (Alexander and Wyeth, 1994; Onanuga and Shittu 2010). Testing for Granger causality plays an important part in many vector error correction models, but it is important when examining price transmission between urban and rural markets. This is because causality from rural to urban prices is plausible. The granger causality model is specified below:

$$P_t^u = \sum_{k=1}^{n} \propto_k P_{t-1}^u + \sum_{k=1}^{n} b_k P_{t-1}^r + \varepsilon_t \quad (7)$$

Where ***n*** is the numbers of lag determined by a suitable information criterion.

εi = random error term

$\propto_k$ = coefficient of the lagged $\Delta P_{(t-1)}^u$ **(**urban food grains**)** values.

b_k = coefficient of the lagged $\Delta P_{(t-1)}^r$ **(**rural food grains**)** values.

RESULTS AND DISCUSSIONS

3.1 Results of ADF Unit Root and Co-integration Tests

Co-integration analysis begins with the test of stationarity of time series data. Table 1 indicates that the price series were stationary at first difference. This showed that the price series were integrated of order one I(1). This agrees with the findings of Adeoye *et al.,* (2010) and Onanuga and Shittu (2010). This confirmed that they were all generated by the same stochastic processes and thus, capable of exhibiting long run spatial equilibrium.

3.2 Results of Co-integration Test

3.2.1. Deterministic specification and Co-integration test

The choice of how deterministic terms/ variables to be accommodated in the Vector Error Correction (VEC) model was made by application of the Pantula Principle (Johansen, 1992). This entailed selection of the least restrictive specification among those specifications having the lowest number of cointegrating equations (CEs), if more than one. The summary statistics of the number of CEs in the five possible specifications are presented in Table 3. It was revealed that the co-integration test for models 1 and 2 should be conducted under both specifications (option C and D) suggested by both trace and maximum eigen value tests. Model 3 was dictated to be conducted under option D. Considering however, that it is very much uncommon for economic series not to be characterised by some deterministic trend (Arize *et al.,* 2000). However, a linear trend exists in the study data, trend (constant) deterministic specification, as implied by trace test and maximum eigen value tests were adopted in this study. The detailed co-integration result is presented in Table 3.

Table 1: Results of Augmented Dickey Fuller Unit Root Test

Series	Test at level 1(0)			Test at First Difference 1(1)		
Series / States	**Lagos**	**Ogun**	**Oyo**	**Lagos**	**Ogun**	**Oyo**
Local Rice						
Rural	-1.96	-2.45	-1.45	-14.60**	-9.91**	-13.29**
Urban	-1.64	-0.43	-1.76	-15.92**	-9.66**	-11.20**
Imported Rice						
Rural	-1.72	-0.51	-0.73	-14.24**	-10.62**	-14.27**
Urban	-1.99	-0.37	-2.43	-10.04**	-9.99**	-10.53**
Cowpea						
Rural	-0.83	-0.81	-1.14	-10.62**	-10.41**	-9.43**
Urban	-0.62	-0.50	-0.87	-10.76**	-10.35**	-14.75**
Maize						
Rural	-2.46	-1.44	-1.63	-13.09**	-10.69**	-8.86**
Urban	-2.33	-1.72	-2.39	-12.57**	-10.67**	-9.93**

Critical values at $p<0.01=3.49$, $p<0.05=2.89$, $p<0.1=2.58$.
** implies significance at $p<0.01$ level.
Source: Data analysis

Table 2: Summary of Co-integration results by Deterministic Specifications

Series	Model	Data Trend	None Deterministic	None Deterministic	Linear Deterministic	linear Deterministic	Quadratic Deterministic
		Test Type	No Intercept No Trend	Intercept No Trend	Intercept No Trend	Intercept Trend	Intercept Trend
Rice	1	Trace	1	1	1	1	1
		Max- Eigen	0	0	1	1	1
Cowpea	2	Trace	0	0	1	1	1
		Max- Eigen	0	0	1	1	1
Maize	3	Trace	1	1	2	1	2
		Max- Eigen	1	1	2	1	2

Source: Data analysis

3.2.4. Results of co-integration tests

Table 3 summarises the Johansen based co-integration test applied on the variables in the three economic models. In the estimated models, the Johansen test indicated that there was a statistically significant long run relationship. i.e. null hypotheses of no co-integration in the three models were rejected by both the trace and maximum eigen value tests. This showed that Urban Price of Local Rice in Lagos State (UPLRLS), Urban Price of Cowpea in Lagos State (UPCLS), and Urban Price of Maize in Lagos State (UPMLS) and their hypothesized determinant price variables rejected their respective null hypotheses of no co-integration at $p<0.05$. Both the trace and maximum Eigen value tests revealed that two co-integrated equations existed among the linear combinations for tests at $p<0.05$ for models 1 and 3. This implies that even though the urban local rice, cowpea and maize price series in Lagos State and their hypothesized determinants were generally I (1) series, some stable long run equilibrium relationship exist among the series. The strong evidence that urban and rural prices within these major markets are integrated indicates the possibility of exchange of price information between markets in the long run and causality at least in one direction, most probably from the urban price to the rural price.

Table 3: Results of co-integration tests

Model	Hypothesized No. of Co-integrating Equations (CEs)	Trace Test Statistics	Trace Test Critical value P(<0.05)	Hypothesized No. of co-integrating equations (CEs)	Maximum Eigen Test Statistics	Maximum Eigen Test Critical value (p<0.05)
1	None**	92.782	88.803	None**	47.674	38.331
	At most 1**	65.107	63.876	At most 1**	33.844	32.118
	At most 2	23.263	42.915	At most 2	13.537	25.823
	At most 3	9.725	25.872	At most 3	6.2496	19.387
2	None**	64.873	63.876	None**	33.737	32.118
	At most 1	31.135	42.915	At most 1	15.151	25.823
	At most 2	15.984	25.872	At most 2	11.660	19.387
	At most 3	4.324	12.517	At most 3	4.3240	12.517
3	None**	123.154		None**	47.721	38.331
	At most 1**	75.432		At most 1**	35.353	25.823
	At most 2	13.966		At most 2	9.461	19.387
	At most 3	4.504	88.803	At most 3	4.504	12.517
			63.876			
			25.872			
			12.517			

** implies statistic is significant at $p<0.05$.
Source: Data analysis

3.3 Vector Error Correction Results

The existence of cointegration between the dependent variables and their hypothesized determinants necessitated the specification of VECM for this study. VECM has a way of reconciling the long run and short run components (Onanuga and Shittu, 2010). The coefficients in the cointegrating variables in each of the model give the estimated long run relationship among the price variables. Considering the changes in the prices of rice, cowpea and maize over a period of time, an attempt was made to understand transmission of price signals from one market to another and their degree of association. The estimated long run relationship (t-ratio in parentheses), based on normalization in respect of the urban prices of the selected food grains and their hypothesized determinants, are written below:

$$\ln UPLRLS_t = 114.42 + \underset{(3.58)}{1.63} \ln RPLRLS_{t-1} - \underset{(2.92)}{0.98} \ln RPLROGS_{t-1} + \underset{(3.12)}{0.29} \ln RPLROYS_{t-1} + \underset{(3.29)}{1.66} \ln UPIRLS_{t-1} \quad (7)$$

$$\ln UPCLS = 5.97 + \underset{(3.04)}{2.92} \ln RPCLS_{t-1} - \underset{(-2.21)}{0.08} \ln RPCOGS_{t-1} + \underset{(4.10)}{0.24} \ln RPCOYS_{t-1} \quad (8)$$

$$\ln UPMLS = 9.08 + \underset{(2.88)}{1.09} \ln RPMLS_{t-1} - \underset{(-0.77)}{0.05} \ln RPMOGS_{t-1} - \underset{(-0.39)}{0.01} \ln RPMOYS_{t-1} \quad (9)$$

The estimated cointegrating equation in equation 7 revealed that RPLRLS, RPLROYS and UPIRLS exerted a significant ($p<0.01$) and positive influence while RPLROGS exerted a significant ($p<0.05$) but negative influence on UPLRLS. This implied that one per cent increase in RPLRLS, RPLROYS and UPIRLS were revealed as causing UPLRLS to increase by 1.63%, 0.29% and 1.66% respectively in the long run.

Cointegrating equation in equation 8 revealed that RPCLS and RPCOYS exerted a significant ($p<0.01$) and positive influence on UPCLS while RPCOGS exerted a negative influence on UPCLS at $p<0.05$. This implied that 1% increase in RPCLS and RPCOYS result to an increase in UPCLS by 2.92% and 0.24% while 1% increase in RPCLOGS resulted to a decrease in UPCLS by 0.08% in the long run.

Cointegrating equation in equation 9 revealed that RPMLS is the only determinant of UPMLS in the long run. A 1% increase in RPMLS caused an increase in UPMLS by 1.09% in the long run. A complete proportional change in RPMLS was transmitted to UPMLS in the long run. RPMOGS and RPMOYS appeared to receive no price signals from UPMLS, despite the presence of spatial integration between them.

The results revealed the existence of long run equilibrium relationships between urban prices of local rice, cowpea and maize and their rural prices (complete transmission of price shocks from rural to urban market was also shown). Urban markets did not dominate prices of rural markets for selected food grains in the referenced States.

Also, there was existence of long run equilibrium relationship and complete transmission of price shocks from urban price of local rice to urban price of imported rice. The imported rice market dominated prices in the local rice market. This is because more than 100% of the proportional change in urban price of imported rice was transmitted to the urban price of local rice in the long run. Hence, banning rice imports or reducing imports with high tariffs in line with public opinion in Nigeria is a policy option to consider.

The long run results revealed the existence of long run equilibrium relationship between urban prices of local rice, cowpea and maize and rural prices of these commodities in the neighbouring states. Also revealed is partial transmission of price shocks from rural to urban market. The latter did dominate prices of local rice, cowpea and maize in rural markets in the reference states.

Having determined the cointegration relationships and long run elasticity coefficients, estimates of the short run dynamics between urban prices of food grains and hypothesized determinants within the southwest markets (spatial price transmission) was carried out. Table 5 depicts the short run components of the VECM results.

The results of the short run components of the VECM are presented in table 4. Based on examination of the F-statistics and the adjusted R^2 in equation 7, variables in the VECM significantly explained short run changes in only the UPLRLS and the RPLRLS at $p<0.05$, accounting for 52% and 59% of the short run variation in the two series, respectively. This means that a greater percentage (52% and 59%) of its price was explained by current and previous prices in RPLRLS but not those of RPLROGS, RPLROYS and UPIRLS.

The error correction (adjustment) coefficients in UPLRLS and RPLRLS were significant at $p<0.05$ and associated with the desirable negative signs indicating any disequilibrium in the long run would be corrected in the short run. Thus, the short run price movements along the long run equilibrium path is stable. The significant value implied that there is a tendency to bring the price back into equilibrium whenever it deviate from it. This showed that UPLRLS in Southwest, Nigeria, adjusts significantly to shocks to its equilibrium relationship with its hypothesized determinants, that are caused by exogenous changes in past values of UPLRLS and RPLRLS.

The effects on UPLRLS of market forces that destabilize the equilibrium relationship between UPLRLS and its determinants were corrected within 1.2 months (36 days). UPLRLS adjusted so as to eliminate about 82% of a unit negative change in the deviation from the equilibrium relationships created by changes in hypothesized determinants. This depicts that about 82% of the disequilibrium corrected for each month in UPLRLS was attributed to its own prices and the remaining influenced by other internal and external market forces. Accordingly, 66% of disequilibrium corrected for each month in RPLRLS was attributed to its own price and the remaining influenced by other internal and external market forces.

The speed of adjustment of 82% and 66% from the short run to the long run equilibrium is relatively high compared to a perfect adjustment of 100% threshold. This indicated that there is strong integration among the markets. Price transmission between UPLRLS and RPLRLS implied a strong transmission relating to the reference market and this could be attributed to the good communication among the two markets.

Evidence from the F-statistics and the adjusted R^2 in equation 8, suggested that the variables in the VECM significantly explained short run changes in UPCLS, RPCLS and RPCOGS at $p<0.05$, accounting for 55%, 63% and 87% of the short run variations in the series, respectively. The error correction coefficients in the UPCLS, RPCLS and RPCOGS equations were significant ($p<0.01$) and associated with negative signs. This showed that UPCLS in Southwest, Nigeria, adjusted significantly to market forces to its equilibrium relationship with its hypothesized determinants, that are caused by exogenous changes in past values of UPCLS, RPCLS and RPCOGS. The effects on UPCLS of market forces that destabilized the equilibrium relationship between UPCLS and its determinants were corrected within 1.9 months (58 days). The speed of adjustment of 51%, 87% and 60% from the short run to the long run equilibrium is relatively high compared to a perfect adjustment of 100% threshold. This indicated that there is strong integration among the three cowpea markets.

Examination of the F-statistics and the adjusted R^2 in equation 9, suggested that the variables in the VECM significantly explained short run changes in UPMLS, RPMLS, RPMOGS, and RPMOYS at $p<0.05$, accounted for 60.7%, 54.2%, 52.5% and 71.2% of the short run variations in the series respectively. The error correction coefficients in the UPMLS equation were significant at $p<0.01$ and associated with negative signs. This showed that UPMLS in Southwest, Nigeria, adjusted significantly to market forces to its equilibrium relationship with its hypothesized determinants, that are caused by exogenous changes in past values of UPMLS, RPMLS, RPMOGS and RPMOYS. The effects on UPMLS of market forces that destabilized the equilibrium relationship between UPMLS and its determinants were corrected within 2.3 months (70 days). The speed of adjustment of 42%, 12%, 2% and 33% of UPMLS, RPMLS, RPMOGS and RPMOYS from the short run to the long run equilibrium is relatively low compared to a perfect adjustment of 100% threshold. This indicated that there is weak integration and price transmission relating to the reference urban market and this could be attributed to the poor price communication among the various maize markets in Southwest Nigeria.

3.4 Pairwise Granger Causality Results

Granger causality means the direction of price formation between two markets in which there is spatial arbitrage, i.e., physical movement of the commodity to adjust for these prices differences. This analysis was necessitated by the observation of Gujarati (2004) that although regression deals with the dependence of one variable on other variables, it does not necessarily imply causation. Table 4 presents the results of pairwise Granger causality model. Significant probability values denote rejection of null hypothesis of no Granger causality. Twenty (20) market links each of rice, cowpea and maize were investigated for evidence of Granger causality. Of this, 13 rice, 15 cowpea and 10 maize markets links rejected their respective null hypotheses of no Granger causality.

It can be observed that RPLRLS, RPCOYS and RPMOYS had strong influence on rural and urban market prices of other States. Therefore, there is high market integration between the rural and urban markets in rice and cowpea markets. This is attributed to the high consumption volume of rice and cowpea compared to maize. However, the result also implied that price changes in one market were manifested to an identical price response in the other markets (Goletti *et al.,* 1995, Barrett 1996, Adeoye *et al.,* 2010). Therefore, RPLRLS, RPCOYS and RPMLS occupied the leadership position in price formation in the study area.

Table 4: Results of Pairwise Granger causality

Null hypotheses (Rice)	Probability	Null hypotheses (Cowpea)	Probability	Null hypotheses (Maize)	Probability
RPLROYS → UPLROGS	0.7828	RPCLS → UPCLS	0.8064	RPMLS ← UPMLS	0.2911
UPLROGS ← RPLROYS	0.0549**	UPCLS ← RPCLS	0.2014	UPMLS ← RPMLS	0.0391**
RPLRLS → UPLRLS	0.0225**	RPCOGS ← UPCLS	7.7834	RPMOGS ← UPMLS	0.2011
UPLRLS ← RPLRLS	0.6246	UPCLS → RPCOGS	0.0418**	UPMLS ← RPMOGS	0.1254
RPLROYS → UPLRLS	0.4998	RPCOYS → UPCLS	0.0009***	RPMLS → UPMOYS	0.0177**
UPLRLS → RPLROYS	0.0319**	UPCLS ← RPCOYS	0.0013***	UPMOYS ← RPMLS	0.2554
RPIRLS → UPLRLS	0.0002***	RPCOGS ← RPCLS	7.5280	RPMOGS → RPMLS	0.0535*
UPLRLS ← RPIRLS	0.3659	RPCLS ← RPCOGS	0.0550**	RPMLS ← RPMOGS	0.1312
UPIRLS → RPLRLS	0.0009***	RPCOYS → RPCLS	0.0129**	RPMOYS → RPMLS	0.1998
RPLRLS ← UPIRLS	0.0824*	RPCLS ← RPCOYS	0.0001***	RPMLS ← RPMOYS	0.0371**
RPLROYS → RPLROGS	0.7135	RPCOYS → RPCOGS	0.0280**	RPMOYS → UPMOGS	0.5422
RPLROGS → RPLROYS	0.0346**	RPCOGS ← RPCOYS	0.0002***	UPMOGS ← RPMOYS	0.0303**
UPIROGS ← RPLROGS	0.5969	RPCLS → UPCOGS	0.2211	RPMOGS → RPMOYS	0.8523
RPLROGS ← UPIROGS	0.0278**	UPCOGS ← RPCLS	0.0004***	RPMOYS ← RPMOGS	0.0148**
UPIROGS → RPLROYS	0.0213**	RPCOYS → UPCOGS	0.0549*	RPMLS → UPMOYS	0.0126**
RPLROYS ← UPIROGS	0.0085***	UPCOGS ← RPCOYS	0.0002***	UPMOYS ← RPMLS	0.0237**
RPLRLS → UPLROYS	0.0337**	RPCLS → UPCOYS	0.0177**	RPMOYS → UPMOYS	0.0009***
UPLROYS ← RPLRLS	0.2884	UPCOYS ← RPCLS	0.0179**	UPMOYS ← RPMOYS	0.3291
RPLROGS → UPLROYS	0.0970*	RPCOGS → UPCOYS	0.0055***	RPMOGS → UPMOGS	0.0057***
UPLROYS ← RPLROYS	0.0353**	UPCOYS ← RPCOGS	0.0215**	UPMOGS ← RPMOGS	0.7255

*****,** ** and * implies statistic is significant at p<0.01, 0.05 and p<0.1
Source: Data analysis

Table 5: Estimated Vector Error Correction Model

Error Correction (model 1)	D(UPLRLS)	D(RPLRLS)	D(RPLROGS)	D(RPLROYS)	D(UPIRLS)
ecm1(-1)	-0.828710 (-2.39951)	-0.665154 (-2.32443)	0.048324 (0.81055)	0.182415 (3.21733)	0.026556 (0.45128)
Adj. R-Square	0.517412	0.592010	0.293939	0.100797	0.041276
F-Statistics	4.480042	3.003321	3.022068	1.544468	1.209117
Log Likehood	-72.26681	-53.76319	-20.5968	-25.77101	-21.92811
Error correction (model 2)	**D(UPCLS)**	**D(RPCLS)**	**D(RPCOGS)**	**D(RPCOYS)**	
ecm(-1)	-0.518219 (-2.72738)	-0.875604 (-3.02283)	-60.16763 (-2.59706)	0.011993 (0.06349)	
Adj. R-squared	0.549932	0.627562	0.875343	-0.015466	
F-statistic	2.362885	3.327517	0.899729	0.824007	
Log-Likelihood	66.3477	-56.9942	-127.54986	-116.9646	
Error correction (model 3)	**D(UPCLS)**	**D(RPCLS)**	**D(RPCOGS)**	**D(RPCOYS)**	
ecm(-1)	-0.518219 (-2.72738)	-0.875604 (-3.02283)	-60.16763 (-2.59706)	0.011993 (0.06349)	
Adj. R-squared	0.549932	0.627562	0.875343	-0.015466	
F-statistic	2.362885	3.327517	0.899729	0.824007	
Log-Likelihood	66.3477	-56.9942	-127.54986	-116.9646	

** implies statistic is significant at $p<0.05$.
Source: Data analysis

CONCLUSION AND RECOMMENDATIONS

Based on recent developments in time series modeling that points to a need to review previous research efforts aimed at explaining price behaviour in Southwest Nigeria, this study adopted Vector Error Correction Modeling framework in analysing price integration and transmission of food grains markets in Southwest Nigeria. The study used a sample of monthly retail prices of rice, cowpea and maize from January 2004 to December 2013 obtained from Agricultural Development Programmes (ADPs) offices in the selected States.

It was concluded that positive relationship existed between urban prices of selected food grains in the reference State and their rural prices as well as the urban prices of imported rice in the long run. A negative relationship existed between urban prices of the selected food grains in the reference State and rural prices in neighboring States. It is a case of partial transmission of market shocks whereby changes in urban prices of rice, cowpea and maize were transmitted to rural prices, but not the other way round. In this case, local rice, cowpea and maize producers may not benefit price increases sooner than observed in the rural markets of the neighbouring States.

Short run dynamics of VECM revealed that any exogenously induced changes to the long run relations is corrected between one or three months but a higher changes were corrected within a month. Thus, short run response of urban prices of food grains to changes in their rural prices tend to be eroded as urban prices return to their long run equilibrium relations with the rural prices in a few months. Evidence from these speeds of adjustment showed a strong market integration in rice and cowpea markets. However, there was existence of poor price integration and transmission in the maize markets in Southwest Nigeria.

RECOMMENDATIONS

The policy that ensued from this study include the following:

When it is desired that a national pricing policy for increased consumption of local rice, cowpea and maize be implemented, the identified leader markets (RPLRLS, RPCOYS and RPMLS) should be the target. This is because prices formed in them will be efficiently transmitted to the other markets with very small distortions during the transmission process.

The banning of rice imports or reducing imports with high tariffs might is an option to consider and also encouraging quality improvement of local rice through modern processing techniques and enhancing competition between local and imported rice. This should be a key concern of government.

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