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Spatial Integration and Price Transmission in Selected Cassava Products' Markets in Nigeria: A Case of Lafun

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Abstract: An advanced time series econometric technique was used to study the interaction between the prices of fermented flour, a popular cassava-based food product also called lafun, in typical urban-demand and rural-supply markets in Nigeria. The price data cover 95 weeks from week 37 of 2004 to week 28 of 2006. The Augmented Dickey-Fuller (ADF) test was used to investigate stationarity in the pairs of prices while the Johansen cointegration technique, with its associated vector error correction model (VECM), was used to measure the speed of adjustment coefficients characterizing the long run dynamics of the system. Individual unit roots tests revealed non-stationarity in the price series - rural and urban prices were integrated of order one. The ADF-test statistics for the rural and urban prices were -1.42 and -2.46 in levels and -9.67 and -10.75 in first differences. The pair of prices was cointegrated with highly significant trace-statistics (16.41; $p<0.5$). The VECM reveals that the long-run equilibrium after exogenous shocks in the markets were restored primarily by corrections made by the urban market prices. The Granger causality runs one-way from the rural to the urban market, without a feedback loop. Also, the impulse response analysis revealed that the rural price was more responsive to shocks emanating from the rural market, the effect of which was computed as 95.6% using the forecast error variance decompositions. Results revealed further that the effects of rural prices' shock on urban price was very negligible at 3.2% after 10 weeks. The implication is that the rural market was the dominant market for determining the price of lafun in the short-run. The error correction model revealed significant causality link between the peripheral and central 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 lafun in Nigeria. The study recommends that farmers should be placed at the centre of the marketing policy to enable them determine the direction of price movements.

Key words: Lafun · Cassava-based · Price transmission · Rural-supply · Urban-demand · Markets · Nigeria

INTRODUCTION

Cassava (*Manihot esculenta Crantz*) is an important food security crop in Nigeria. It was confirmed as far back as 1985 that the dietary calorie equivalent of per capita consumption of cassava in Nigeria amounted to about 238 kcal [1]. This was derived mainly from the consumption of the principal cassava food forms, like *gari* (toasted granules), cassava chips/flour, fermented pastes and/or fresh roots. This viewpoint has been corroborated when it was remarked that cassava provided some 70 percent of total calorie intake for over one-half of the Nigerian population [2, 3]. Aside, the cassava industry has been credited for contributing immensely to household income in Nigeria and Africa [3] while engaging over 80 percent of the rural population in various aspects of production, processing, marketing and utilization enterprises. It has been succinctly argued that cassava production in Nigeria is a commercial enterprise with 62 percent of output from rural households' fields being marketed [4].

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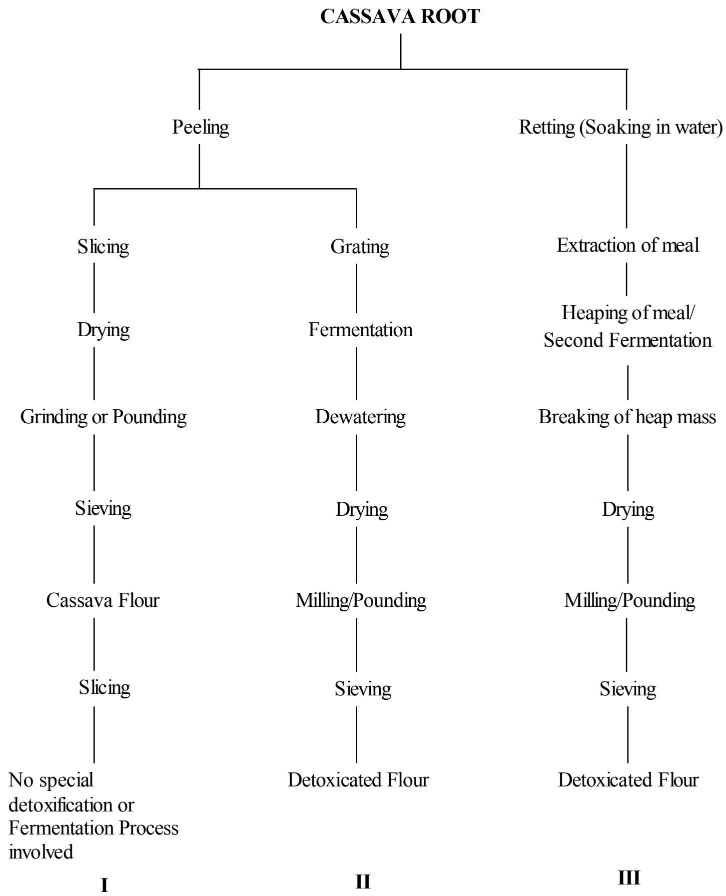

Fig. 1: Flow diagram of village production of cassava flours; Source: Ayernor, G.S., 1995 [6]

Recent studies have also found an increasing trend in the proportion of total cassava production that is being marketed in Nigeria [5].

To serve its function as a provider of household food, income and employment, cassava is processed into various wet and dry product forms, which are eaten by both the rural and urban populace [5]. A market survey conducted in 2005 [5] identified four common wet cassava-based products as cassava fresh roots, edible starch, fermented paste and cooked *fufu* (sometimes called *santana* or six-to-six in some parts of Nigeria). Also identified are four common dry cassava-based products, including *gari*, which can come either in white or yellow form, fermented cassava flour (locally called *lafun* or *elubo*), cassava chips and *abacha*. Among the dry products, fermented flour (*lafun*) is unique because it does not only serve as food but also possesses latent import substitution opportunities. With respect to food, it is used to prepare *amala,* a very popular food recipe in the south-west area of Nigeria. *Amala* is usually served hot, like semolina, with local soup (like *ewedu*, *ifo* and *egusi*). Regarding to the latter, cassava flour can be used as a partial replacement for wheat flour for bakery and pasta products. The process of processing *lafun* locally could involve three main variants as illustrated in Figure 1 [6]. Improved technology has caused the mechanization of the different processes to increase efficiency, productivity and profitability. Included among the steps in commercial processing of cassava flour are roots sorting, weighing, peeling, washing, grating, fermentation, dewatering, granulating, dehydration, milling, sieving and packaging.

This study is conducted in *lafun*. However, our interest is not on its production or processing methodologies, but on the price variable in its marketing. The general objective is to determine the existence, or otherwise, of linkage between market prices in a typical rural-supply market and urban-demand market of the product. Price is no doubt an important variable in the food demand and supply chain [7]. Among the functions performed by prices are that they help to express value of products, provide information on products' level of supply in the market, provide information on the marketing agent's perception of the products' future supply and demand and act either as an incentive or a disincentive for trade and production [8]. It is expected, *ceteris paribus*, that if the market of a product is efficient, variations in the product's prices in a typical rural source market will be followed by similar variations in price in urban destination market. By implication, prices that move together are expected to share a long-run equilibrium relationship [9].

Methodology

Study Area: The study was conducted based on price information documented for two markets that sell *lafun*: rural supplying Wannune market, located at latitude N07.57072° and longitude E08.88206° in Tarka Local Government Area of Benue State, Nigeria and an urban demand market for the product, the popular Mile 12 market, located at latitude N06.60886° and longitude E03.35056° in Isheri-Ikosi LGA of Lagos State, Nigeria. An appraisal of cassava-based products' markets in Nigeria revealed that traders from Lagos markets, including the popular Mile 12 market, Lagos get their supply of various wet and dry products of cassava, including *lafun*, from Benue State. The Wannune market is one of the rural markets supplying *lafun* to traders from Mile 12.

Study Data: The data used for this study were obtained from the records of the market information services (MIS) unit of the Integrated Cassava Project (ICP), International Institute of Tropical Agriculture, Ibadan, Nigeria. The unit has documented the weekly market prices for over twenty agricultural commodities, including those of the major cassava products, from over 50 urban and rural markets across Nigeria. These have been made available on the official website http://www.cassavabiz.org since 2004. The price series for *lafun*, a popular dry cassava product was investigated. Price data for *lafun*, which covered 95 weeks, from week 37 of (September) 2004 to week 28 of (July) 2006 were used for the study. In this study, the effort is made to analyze prevailing price trends of *lafun* in the rural supply market in Benue State alongside that of urban demand market in Lagos State with a view to determining if linkages existed between them and ascertaining the nature of their interrelatedness.

Analytical Technique

Cointegration and Error Correction Representation: The study used the technique of cointegration and error correction representation. Cointegration describes the existence of long-run or equilibrium relationships [10, 11]. A long-term relationship implies that concerned variables move together overtime so that any short-term disturbances from the long-run trend can be corrected [12]. Absence of cointegration implies in principle that variables of interest can wander arbitrarily far away from other [13]. The technique sidesteps the spurious regressions caused by non-stationarity of time series data and also provides information on both short-run dynamics and long-run relationships between variables within the same model. Cointegration analysis only makes sense for nonstationary price series.

A series is said to be integrated of order 'd', denoted by *I(d)*, if it can be differenced *d* times to produce a stationary series. A "white noise" is an example of a *I(0)* series. A "random walk process" is an example of a *I(1)* series while accumulating a random walk would give rise to a *I(2)* series.

A set of nonstationary variables is cointegrated if some linear combinations of the prices are stationary [14]. Suppose two variables, X_{1t} and X_{2t}, are *I(d)* then any linear combination of the variables will also be *I(d)* by definition. Most economic variables, including prices, are *I(1)* and cointegration is defined for *I(1)* variables [10]. It follows that the necessary condition for testing for cointegration is that the individual time series has similar statistical properties, meaning that they should be integrated of the same order [11].

Appropriate tests for stationarity were provided by Engle and Granger [15] as the Dickey-Fuller (DF) and the augmented Dickey-Fuller (ADF) statistics, based on the t-statistics obtained for parameter *b* from estimating the following ordinary least square (OLS) regressions:

$$\Delta X_t = a + bX_{t-1} + u_t \tag{1}$$

$$\Delta X_t = a + bX_{t-1} + \sum_{i=1}^{k} c_i \Delta X_{t-i} + u_t \tag{2}$$

where X_t is the price variable of interest; $\Delta X_t = (X_{t-1} - X_t)$; a, b and c are unknown parameters, u_t is error term and k is the lag length chosen for ADF to ensure that u_t is empirical white noise. The hypothesis of nonstationarity, or unit root (b =1) will be accepted at 0.01 or 0.05 levels if the DF or ADF statistic is greater than the critical value of -3.50 or -2.89 for a model with only intercept and -4.06 or -3.46 for a model with intercept and trend.

For cointegration, two series are cointegrated of order one, *CI(1,1)*, if the individual series are *I(1)* and their linear combination, called the cointegrating regression is *I(0)*. If two *I(1)* series are cointegrated, the models can then be given an error correction representation and if an error correction model (ECM) provides an adequate representation of the two variables, then they must be cointegrated [15, 16]. Given the price series from the two markets being investigated, if the series have long-run equilibrium relationship even though they may have significant short-run divergences, then the markets must be considered to be cointegrated in the long-run.

In this study, the Johansen cointegration procedure was used because of its obvious advantages over the Engle and Granger two-step procedure. The first advantage is that the Johansen's procedure enables the testing for and estimation of, more than one cointegrating relationships and also permits testing for the validity of any restrictions on cointegrating relationships implied by economic theory [10]. The second advantage is that where there are, say *n* series and *n-1* potential cointegrating relationships, the Johansen's method starts by testing the null hypothesis of zero cointegrating relationship and, if rejected, proceeds in step-wise fashion to test the null of one, two and higher orders of such relationships up to *n-1*.

Conceptual Model Specification: The general form of the Johansen's model to be estimated for the rural and urban markets' prices of *lafun* can now be presented as follows:

If X_t denotes an $nx1$ unrestricted vector autoregression (VAR) in the levels of the non-stationary *I(1)* prices being considered, then:

$$X_t = \mu + a_1 X_{t-1} + a_2 X_{t-2} + \cdots + a_p X_{t-p} + E_t = \mu + \sum_{i=1}^{p} a_i X_{t-i} + E_t \qquad (3)$$

where X_t is a *px1* vector of prices; X_{t-1} is a *px1* vector of the ith lagged values of x_t; μ is a *px1* vector of constants; α_i is a *pxp* matrix of unknown coefficients to be estimated; P is the lag length; and E_t is a *px1* vector of identically and independently distributed error terms with zero mean and contemporaneous covariance matrix, $E(E_t E_t)=\Omega$.

By subtracting X_{t-1} from both sides of equation (3) and using I to represent a *pxp* identity matrix, we obtain

$$\Delta X_t = \mu + (a_1 - 1)\Delta X_{t-1} + (a_2 + a_1 - 1)X_{t-2} + \cdots + a_p X_{t-p} + E_t \qquad (4)$$

Also adding and subtracting ($\alpha_2 + \alpha_1$ - 1) X_{t-3} to and from the right hand side of equation (4) results to the relation in equation (5) as follows

$$\Delta X_t = \mu + (a_1 - 1)\Delta X_{t-1} + (a_2 + a_1 - 1)X_{t-2} + (a_3 + a_2 + a_1 - 1)X_{t-3} + \cdots + a_p X_{t-p} + E_t \qquad (5)$$

If the process is continued in this way, we arrive at

$$\Delta X_t = \mu + \zeta_1 \Delta X_{t-1} + \cdots + \zeta_{p-1}\Delta X_{t-(p-1)} + \Pi X_{t-p} + E_t = \mu + \sum_{i=1}^{p-1} \zeta_i \Delta X_{t-i} + \Pi X_{t-p} + E_t \qquad (6)$$

where $\zeta_1 = -(1 - \sum_{j=1}^{i} a_j)$, for j=1,2, …, p-1; $\Pi = -(1 - \sum_{i=1}^{p} a_i)$; and $\Delta X_{t-1} = (p\,x\,p)$ vector of X_{t-1} in first differences, for i = 1,2, …, p-1; all other variables are as previously defined. It follows that the VAR (p) has been transformed into an ECM (p) with an error correction component, ΠX_{t-p}. The matrix Π is of primary interest in equation (6) for two main reasons:

- Rank of $\prod$, *rank* $\prod$, serves as the basis for determining whether or not cointegration or long-run relationships exist among the variables - if the *rank*$\prod$ = 0, the variables are not cointegrated and the model is equivalent to a VAR in first difference; if 0< *rank*$\prod$ <*n*, the variables are cointegrated; and if *rank*$\prod$ = *n*, the variables are stationary and the model is equivalent to a VAR in levels [17];
- $\prod$ can be decomposed into the product of two matrices α and β or $\prod = a\beta'$, where β is the matrix that reflects the cointegrating relationship. If $\beta' X_t = 0$, the system is in equilibrium; otherwise, $\beta' X_t$ is the deviation from the long-run equilibrium, or the equilibrium error, which is stationary in a cointegrated system [18]. α is the matrix of speed of adjustment coefficients that characterizes the long run dynamics of the system. If α has a large value, the system will respond to a deviation from the long-run equilibrium with rapid adjustment. Contrarily, if it has a small value the system will respond with slow adjustment to a deviation from the long-run equilibrium. At times the value of α = 0 for some system equations imply that the corresponding variable is weakly exogenous and does not respond to equilibrium error. At least one α must have a non-zero value in a cointegrated system [17].

In view of the aforementioned concept, Johansen's Maximum Likelihoods procedure for testing for cointegration was proposed [18]. The procedure involves pre-testing the order of cointegration in individual series, determining the lag length for the ECM; and estimating the ECM and determining the rank of $\prod$. The presence of a cointegrating relation would form the basis of the VEC specification.

Empirical Model: For this study we hypothesize that both the rural and urban markets prices of *lafun* are jointly determined or endogenous to the system. Following Sims [19], we can give an implicit representation of the model with two endogenous variables without an exogenous variable as

$$X_t = (\ln\_RP_t,\ \ln\_UP_t) \tag{7}$$

where X_t is as earlier defined, ln_RP_t and ln_UP_t are natural logarithm values of the rural and urban market prices of *lafun*. Given the VECM of equation (7), the long-run cointegrating equation can be specified explicitly for the rural market as

$$\ln\_RP_t = \varphi_0 + \varphi_1 \ln\_UP_t + v_t \tag{8}$$

where φ_0, the log of a proportionality coefficient, is a constant term capturing the transportation and other forms of cost; φ_1 is a long run static coefficient depicting the relationship between the urban and rural market prices; and v_t is the random error term with the standard assumptions. If φ_1=0 there is no relationship between the urban and rural market prices; if 0<φ_1<1 there is a relationship but the relative price is not constant, meaning that the goods will be imperfect substitutes; if φ_1=1 there is relationship with constant relative price, meaning that the Law of One Price holds and goods are perfect substitutes. Equation (8) 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 (8) above [20].

Upon the establishment of the existence of cointegration between the price series, the VECM will be estimated. The form of the model for this study is

$$\Delta RP_t = \psi_{10} + \sum_{i=1}^{p} \psi_{11i} \Delta RP_{t-i} + \sum_{i=1}^{p} \psi_{12i} \Delta UP_{t-i} - \rho (RP_{t-1} - UP_{t-1}) + v_{1t} \tag{9}$$

$$\Delta UP_t = \psi_{20} + \sum_{i=1}^{p} \psi_{21i} \Delta RP_{t-i} + \sum_{t=1}^{p} \psi_{22i} \Delta UP_{t-i} - \rho (RP_{t-1} - UP_{t-i}) + v_{2t} \tag{10}$$

where RP_t *and* UP_t are rural and urban markets prices of *lafun* earlier defined, Δ is the difference operator, Ψ_{10} and Ψ_{20} are constants, Ψ_{11} and Ψ_{12} are the short-run coefficients, ρ is the error-correction instrument measuring the speed of adjustment from the short-run state of disequilibrium to the long-run steady-state equilibrium; and v_t is an error term assumed to be distributed as white noise.

Causality Tests: The Granger causality tests are useful in measuring the predictive ability of time series models [21]. A time series, Y_t, "Granger causes" another series, X_t, if present values of X_t can be better predicted by including, among other variables, the past values of Y_t rather than not doing so [21]. In our case, this can be formally stated as saying that urban market price (UP_t) Granger causes the rural market price (RP_t) of flour if the value of v_t in the following equation in different from zero.

$$RP_t = \alpha_0 + \sum_{i=1}^{m} \alpha_i UP_{t-i} + \sum_{j=1}^{m} \beta_j RP_{t-j} + e_t \tag{11}$$

The variables are as previously defined. To prove the existence of causality, an F-test, which is equivalent to the Wald Test, is used. It is expressed as

$$F_{UP_t \to RP_t} = \frac{(SSE_r - SSE_u)/m}{SSE_u/(n-2m-1)} \sim F_{[m,(n-2m+1)]}(\alpha) \tag{12}$$

where SSE_r is the sum of squared errors of equation (11) with restricted coefficients of lagged UP_t (that is to say that coefficients are set to zero); SSE_u is the sum of squared errors of the unrestricted form of the equation, α is the critical value; n is the number of observations; and m is the number of lags. The number of lags used in our test is two. If $F_{(UPt \to RPt)}$ is less than $F_{[(m,n-2m+1)]}(\alpha)$, UP_t does not Granger cause RP_t; otherwise it does. If it holds true from the tests that the UP_t Granger causes the RP_t and also RP_t Granger causes the UP_t, it reflects a feedback relationship between the urban and rural prices of *lafun*.

Impulse Response and Error Variance Decomposition Analyses: The VECM estimation is used to calculate the elements of the impulse response function (IRF) and the error variance decomposition. The functions are used to conduct simulations in which one of the variables is shocked and the response of each of the other variable(s) is traced over a given number of time periods [22]. An impulse response function traces the effect of a one-time shock to one of the innovations on current and future values of the endogenous variables. A shock associated with a particular variable, does not only directly affect it but also transmits to all other endogenous variables through the dynamic or lag structure of the VAR [21]. To interpret the response as a percentage change, one has to multiply the impulse responses by one hundred [23]. By tracing the effect and persistence of one market price shock to another market the IRF shows how fast information is transmitted across markets.

The IRF is used to trace the impact of the shock in a variable unto the VECM system in a time period, making it possible to measure how rapidly information is transmitted across the markets. In particular, an impulse response function traces the effect of one unit standard deviation shock to one of the innovations (error terms) and its impact on the current and future values of the endogenous variables [21]. The impulse responses are the dynamic equivalents of the elasticity coefficients [21, 24]. On its part, the forecast error variance decomposition provides information on the relative importance of each random innovation in affecting the variables in the VECM [21]. It helps to separate the variation in an endogenous variable into the component shocks of the model.

All estimates were obtained using the Standard Version of Eviews econometric software. EViews implements VAR-based cointegration tests using the methodology developed in Johansen [25, 26].

RESULTS AND DISCUSSION

Trends in Prices of Lafun: The trends in the observed weekly prices of *lafun* in the rural source and urban destination markets are presented in Figure 2. As expected higher prices were recorded for the urban market compared with the rural market. Also, the trends in both price series tend to be increasing and upward over time, suggesting that they could have certain features in common. The Pearson correlation coefficient was calculated to be $r = 0.703$ and highly significant ($p<0.01$).

The trends in the quarterly averages are presented in Figure 3. The fact that higher prices were recorded for urban as against the prices for the rural market is further corroborated. Also corroborated is the upward trend in the quarterly prices. The time trend equations reveal slope coefficients as 5.66 for rural price and 7.17 for the urban price. The simple regression coefficients are calculated as 0.88 and 0.69 respectively.

Descriptive Statistics of Products' Prices: The descriptive statistics of cassava products' prices are presented in Table 1. As expected the mean price value is higher for the urban market. The difference in mean is expected and in this case statistically significant ($p<0.01$). Among other things, they could represent the extra cost, including transportation and transactions, incurred by the marketing agents, as well as marketing margins. It has been argued that given the high cost of transactions and the risk to invested capital, the margins of the marketing agents could be considered reasonable [8].

Times Series Properties of Rural and Urban Prices -Tests for Unit Roots: The results of Augmented Dickey-Fuller unit roots tests are presented in Table 2. It shows that the null hypothesis of the presence of unit roots could not be rejected for rural and urban markets' prices. At levels, the calculated ADF statistic was less than the critical ADF values at both 5% and 1% levels of significance. When evaluated in their first differences the calculated ADF values became higher than the critical values at both 5% and 1% levels. Two specifications were used for the tests with respect to the exogenous variables: one considered intercept only and the other considered intercept and linear trend. Both specifications, which were based on the Schwartz Information Criterion (SIC) led to similar conclusion: urban and rural prices were nonstationary in levels but stationary in first differences. This is an indication that the prices were integrated of order one, I(1). Being integrated of the same order makes them are ideal for cointegration test.

Test for Cointegration: The Johansen's test was applied. The estimated long-run equilibrium relationship normalized with the rural price is as presented in Table 3. Both the Trace and Maximum eigenvalue statistics indicate the existence of one cointegrationg relation at 5% significant level for the pair of product prices. Cointegrating relationships were obtained within lag-intervals 1 to 2. The cointegrating graph is presented in Figures 4.

Vector Error Correction Model: Because the prices are cointegrated it is expected that the system can respond to exogenous shocks and return to equilibrium in the long-run. Consequently, we estimated the error correction modeling (VECM) for the pair of prices and the result is reported in Table 4. The speed of adjustment is determined by the long-run parameter estimates or estimated adjustment coefficients given as -0.0316 and

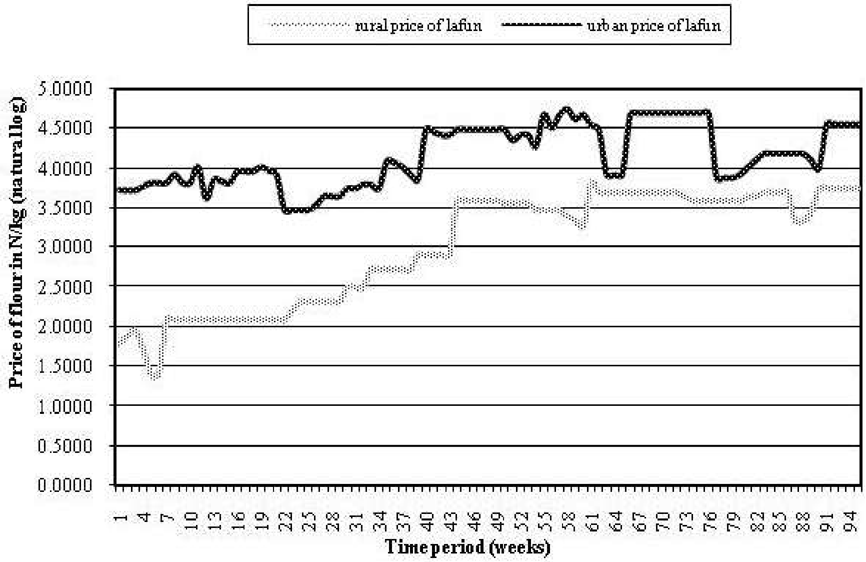

Fig. 2: Trends in urban and rural markets' prices of *lafun*

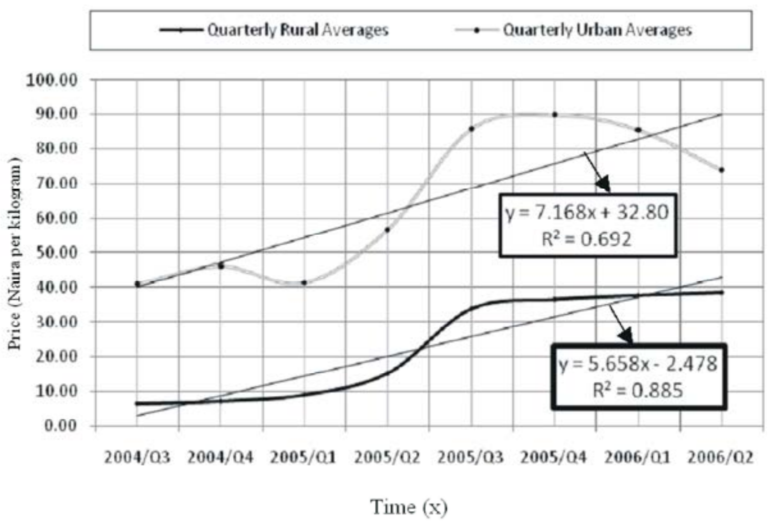

Fig. 3: Trends in rural and urban prices of *lafun*, Quarter 3, 2004 - Quarter 2, 2006

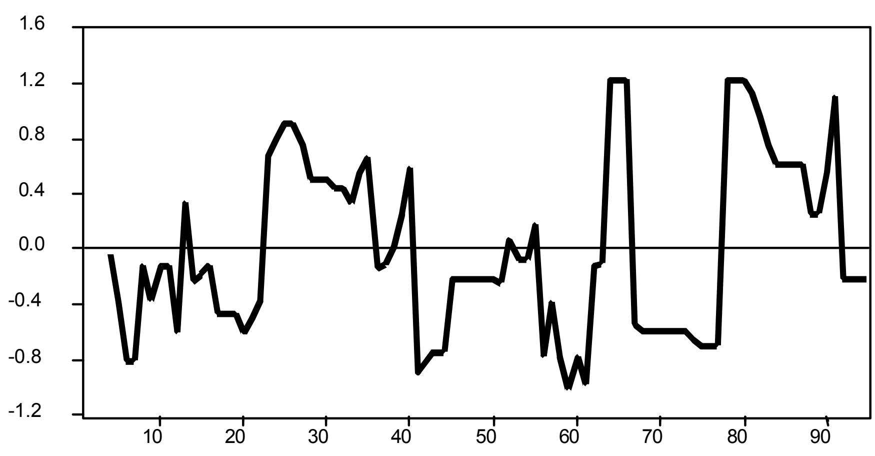

Fig. 4: Cointegrating relation for urban and rural prices of *lafun*

Table 1: Descriptive statistics of rural and urban prices of *lafun* in levels

	Rural price (n=95)		Urban price (n=95)			
Commodity	Mean (Naira/kg)+	Std Dev.	Mean (Naira/kg)+	Std. Dev.	Difference (Naira/kg)+	t-value
Lafun	24.88	13.893	67.69	25.349	42.81***	14.43

***=Significant at 1%; **=Significant at 5%

+ Exchange rate of the Nigerian Naira (N) to the United States Dollars ($) at the period of study was N140.00/US$1.00

Table 2: The Stationarity - Augmented Dickey-Fuller unit roots - tests

			ADF[a] statistic Tests at levels		Test at first differences	
Commodity	Market type	Market location	Intercept only	Intercept & trend+	Intercept only	Intercept and trend+
Lafun	Rural	Benue State	-1.415	-2.157	-9.674***	-9.651***
	Urban	Lagos State	-2.459	-3.098	-10.755***	-10.696***
ADF Test Critical values at 5%			-2.893	-3.459	-2.893	-3.459
ADF Test Critical values at 1%			-3.501	-4.059	-3.502	-4.059

***=Significant at 1%; **=Significant at 5%.

+The null hypothesis of unit root (Ho: $a_1=1$) could not be rejected if the ADF statistic is greater than the critical value given as -2.89 for the 95% confidence levels. Default maximum lag provided by the Standard Version of Eviews was used for all tests. The lag lengths in the ADF test were based on the Schwartz Information criterion (SIC).

Table 3: Pair-wise cointegration tests results between rural and urban market price

Hypothesis	$r = 0$	$r \leq 1$
Trace statistic	16.407**	1.408
5% critical value	15.41	3.76
1% critical value	20.04	6.65
Maximum eigenvalue statistic	14.999**	1.408
5% Critical value	14.07	14.07
1% critical value	18.63	6.65

***=Significant at 1%; **=Significant at 5%.

Trace and Max-eigenvalue tests indicate 1 cointegrating equation at 5% levels; lag interval is 1 to 2

Table 4: Vector error correction estimates for pair-wise prices of *lafun*

Cointegrating Equation		CointEq1:
$\Delta RP_t(-1)$		1.0000
$\Delta UP_t(-1)$		-2.3743*** (-6.0933)
Constant		6.8369
Error Correction	ΔRP_t‡	ΔUP_t§
CointEq1:	-0.0316 (-1.16269)	0.1276*** (3.72208)
$\Delta RP_t(-1)$	-0.0015 (-0.0145)	0.1049 (0.7863)
$\Delta RP_t(-2)$	-0.1862 (-1.7562)	-0.1407 (-1.0515)
$\Delta UP_t(-1)$	-0.0489 (-0.5632)	0.0632 (0.5757)
$\Delta UP_t(-2)$	-0.0869 (-1.0427)	0.1382 (1.3126)
Constant	0.0247 (1.6444)	0.0081 (0.4250)
R-squared	0.0598	0.1700
F-statistic	1.0931	3.5239
Log likelihood	53.1085	31.6801

***=Significant at 1%; **=Significant at 5%.

‡RP_t= Rural market price of *lafun*; §UP_t= Urban market price of *lafun* (both RP_t and UP_t entered the model as natural logarithm of the actual price values, given in Nigerian Naira); figures in parentheses are t-values.

Table 5: Granger Causality test for rural and urban market prices of *lafun* (lag: 2)

Null hypothesis	No. of Observations	F-value	Prob.
Up_t does not Granger cause RP_t	93	0.470	0.627
RP_t does not Granger cause UP_t	93	4.016**	0.021

***=Significant at 1%; **=Significant at 5%.

Table 6: Impulse response of rural and urban prices of *lafun* to a one standard deviation shock

	RP_t response to		UP_t response to	
Period	RP_t	UP_t	RP_t	UP_t
1	0.14051	0.00000	0.00047	0.17736
2	0.13587	0.00461	0.03303	0.13485
3	0.10627	0.00122	0.02222	0.11691
4	0.10318	0.01366	0.03041	0.07364
5	0.10826	0.02305	0.03723	0.04965
6	0.10715	0.02865	0.04229	0.02929
7	0.10516	0.03127	0.04358	0.01874
8	0.10481	0.03292	0.04453	0.01306
9	0.10505	0.03357	0.04489	0.01129
10	0.10506	0.03363	0.04492	0.01109
11	0.10503	0.03344	0.04474	0.01168
12	0.10508	0.03324	0.04458	0.01239
13	0.10513	0.03306	0.04445	0.01301
14	0.10516	0.03294	0.04437	0.01343
15	0.10517	0.03287	0.04432	0.01369
16	0.10517	0.03283	0.04429	0.01382
17	0.10518	0.03281	0.04428	0.01387
18	0.10518	0.03281	0.04428	0.01388
19	0.10518	0.03281	0.04429	0.01387
20	0.10518	0.03281	0.04429	0.01386

The response coefficients are based on Cholesky decomposition

Table 7: Percentage decomposition of 1 to 10 weeks ahead forecast error variance

	RP_t deviation		UP_t deviation	
Period	RP_t	UP_t	RP_t	UP_t
1	100.0000	0.000000	0.000689	99.99931
2	99.94446	0.055536	2.150672	97.84933
3	99.95414	0.045857	2.442161	97.55784
4	99.65299	0.347010	3.522532	96.47747
5	98.98008	1.019918	5.187403	94.81260
6	98.16143	1.838568	7.311583	92.68842
7	97.38133	2.618668	9.480559	90.51944
8	96.67687	3.323128	11.64553	88.35447
9	96.08047	3.919528	13.74050	86.25950
10	95.59021	4.409793	15.73519	84.26481

Decompositions are based on Cholesky ordering (standard errors are not reported)

0.1276 in the error correction equation. The results show that if there is a positive deviation from the long-run equilibrium the market tends to respond with a decrease in the rural price (RP) or an increase in the urban price (UP). The urban price appears to respond faster relative to the rural price. The adjustment coefficient is statistically significant at 1% level for the urban market price, suggesting that the rural price of *lafun* is weakly exogenous. By implication, movements in the rural price are less affected by events in the urban market while movements in the urban price are dictated by events in the rural markets. This means that the long-run equilibrium in the *lafun* market after an exogenous shock is restored primarily by corrections made by the urban market prices.

Granger Causality Tests: The pair-wise Granger causality tests were conducted and the results reported in Table 5. The null hypothesis that the rural market price (RP_t) does not Granger cause the urban market price (UP_t) could not be accepted at 1% significant level. This suggests that Granger causality runs from rural to the urban markets and not the other way round this means that there was no feedback loop. This finding corroborates the VECM results. The interpretation is that given the nature of the adjustment coefficient as depicted in the VECM and the causality tests, the rural supply market located in Benue State of Nigeria was a dominant market for determining price of *lafun* in the short-run.

Impulse Response Analysis: The coefficients of the impulse responses based on Cholesky's decomposition are presented in Table 6 for twenty periods. It can be interpreted as the response of the rural or urban prices series of a particular cassava product to a one standard deviation shock originating from itself and from the other variable. From results in the Table, it is evident that the rural price responds more to shocks emanating from the rural markets than to shocks emanating from the urban markets. The effect of rural shocks on the rural price materialized one week later while the effect on urban price was experienced after two weeks. The effect of rural prices shocks on urban price appears to be very negligible at 3.0% after about 10 weeks. Also the price shocks originating from the urban market virtually do not have much impact on the rural prices. Rural markets shocks are mainly responsible for variations in the rural market prices. The Table reveals that the impulse response of rural market prices to a one-percent standard deviation shock originating from itself stabilized at about 10.5% from the ninth month. The impulse responses in Table 6 suggest that the urban market prices adjust to changes in the rural prices in a positive manner.

Forecast Error Variance Decomposition: The impulse response analysis could only provide information on the effect of a standardized price shock, but do not indicate the extent to which a given shock contributes to the level of uncertainty in the price regime. To further assess the relative importance of price shocks, we decomposed the forecast error variance into proportions that are attributable to shocks emanating from rural and urban markets prices (Table 7). The result shows that for the rural market price changes, the urban prices' shock accounts for a very small percentage of the total forecast error variance. Price shocks from the rural market account for 95.6% for *lafun* at the tenth week. In other words, the uncertainty in the rural market is mainly generated by shocks to its own price. External shocks from the urban market play a limited role in determining the rural market's uncertainty. Similarly, uncertainty in the urban price changes was largely determined by shocks to the urban market. This deviation was high to the tune of 84.3% at the tenth week.

CONCLUSION

The study investigated the interaction between the rural and urban markets' prices of *lafun* in typical urban-demand and rural-supply markets in Nigeria using an advanced time series econometric techniques. The pair of prices was integrated of order one and appropriate cointegration tests revealed that the prices were cointegrated. Results of both the vector error correction modeling and causality tests revealed significant causality link between the peripheral and central markets of *lafun*.

It was found further that the rural price of the cassava product responded more to shocks emanating from the rural markets than to shocks emanating from the urban markets. The findings suggest clear trends in price leadership with the rural market being the dominant market for determining price for the processed cassava products. Invariably, it follows that efficiency can be achieved in the transmission of price information among operators of the traditional cassava food markets in Nigeria, especially the processed and relatively less perishable cassava product like *lafun*.

However, to maximize the benefits accruing to farmers and processors, efforts should be intensified at maintaining relative price stability in the rural markets. The farmers should be placed at the center of the marketing policy such that they should be able to determine the direction of price movement. The recent efforts at promoting modern cassava processing technologies and cassava-related food options under the cassava enterprises development initiative is a step in the right direction. However, the technologies should be made affordable and accessible to the farmers to enable them to adopt them and realize their full benefits.

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