

The integration of Nigeria's rural and urban foodstuffs markets

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Abstract

The study intended to determine the presence and level of integration of the rural and urban foodstuffs markets of Nigeria. A central prediction of the law of one price is that prices of all transactions will tend to uniformity, allowing for the transportation cost between different spatial markets. Using the Johansen bivariate test of cointegration, it was established that the rural and urban foodstuffs markets are pair-wise cointegrated. The test for convergence to the law of one price as well as the test for weak exogeneity for urban foodstuffs prices (Y1) could not be rejected at the 1% level of significance. Hence, we conclude that the rural and urban foodstuffs markets are well integrated and are in the same market for arbitrage. The results further suggest that the urban market price drives the rural market price. The size of the adjustment coefficient for the rural foodstuffs price (Y2) shows that the speed of adjustment to disequilibrium is moderate. The persistence profile further shows that it would take about five months for the effects of a shock on the market system to die out. The findings of this research have significant policy implications for Nigeria's domestic foodstuffs market system as well as its international trade policies.

1. Introduction

The attainment of inter-regional equity is of vital importance if Nigeria is to realize its marketing and pricing policy objectives. The attainment of inter-regional equity also implies the presence of a well integrated market system. Market integration is used to refer to the phenomenon of synchronous movement of prices of a commodity or a group of commodities (e.g., foodstuffs) over time in spatially differentiated markets. Market integration as an important aspect of market research provides the basic data for understanding how specific markets work. The usefulness of such information lies in its application to policy formulation and decisions, on the extent to which market development may be promoted. Market integration also helps in understanding the movement of equilibrium paths of demand and supply for a particular produce or group of commodities. The degree of proximity of the price movements, the speed and accuracy of diffusion of price information, or the efficiency of price transmission or information spread are prerequisites for achieving efficient allocation of resources across space and time (Jayara, 1992).

Again, the knowledge of the state of integration in the domestic market system will help market intermediaries to identify the possibilities for substituting between markets and between commodities. This is particularly important for the dichotomized Nigerian economy with its increasing population of urban food deficit centres and food surplus rural areas. There is a need to develop the capacity of the market system to efficiently distribute and transfer the increased (excess over farmers consumption) foodstuffs supply from food surplus rural areas to food deficit urban centres. This would involve unimpeded food price information flow between producing regions and consuming regions.

In Nigeria, foodstuffs are produced by a large number of smallholder farmers who also market the commodity along with a few wholesalers who dominate the market. Nigerian farmers cultivate a wide variety of staple food crops: cassava, yam, maize, sorghum, acha, potatoes (sweet and Irish), cocoyam, plantain and vegetables. Farmers also engage in other non-food/non-farm activities. The decision to produce food crops often depends on the perceived earnings advantage of one activity over the others.

Nigeria's agricultural policy objectives over the years have centred on increasing agricultural production with a view to achieving self-sufficiency in food and raw materials for industries as well as improvement of the socioeconomic welfare of rural farmers. Foodstuffs pricing and marketing have never come under government control. The objectives of marketing and pricing policies have been to ensure stability and remunerative incomes for farmers. The reforms that followed the adoption of a structural adjustment programme (SAP) in 1986 led to the liberalization (abolition of marketing boards in 1986) of marketing of cash/export crops, while the foodstuffs markets were ordered by

farmers' and traders' decisions to produce and sell, rather than the liberalization policies. However, the greater openness experienced by the Nigerian economy since the liberalization policy in 1986 (including the new General Agreement on Tariffs and Trade of 1995, the World Trade Organization, and globalization) has enhanced the supply of imported foodstuffs, representing a real danger and threat to domestic foodstuffs producers (Okoh and Egbon, 1999). The lower priced imported foodstuffs are gradually replacing the locally produced ones, particularly in the urban centres.

The market boundaries covered by each trader are generally narrow, however, as a result of a number of factors that contribute to market separation. The first of these is the occurrence of temporal and spatial frictions resulting from high transport costs, primarily because of poor roads and road networks. Second in line is inadequate price information about other markets. This, in turn, results from poor information transmission channels, inefficient communication systems and absence of official (government) price communication/media (Okoh, 1999). The third factor is the incidence of individualized price formation processes resulting from haggling. Factors that may contribute to these include lack of product homogeneity and lack of standardized units of measure. Finally, the presence of market associations may limit the market access of poor rural farmers who may be discriminated against by the capital rich wholesaler. The majority of farmers and retailers have poor access to credit, which may reduce their ability to respond to price changes.

Consequent to these factors, market service areas covered by traders may overlap, with several sellers operating within the same market or village. There is, therefore, a possibility that a price change in one market would result in a series of price responses that spread throughout contiguous market areas (rural markets). But, such price changes may not have discernable effects on more distant markets, making the attainment of an integrated foodstuffs market system a mirage. This is the *raison d'être* for this study. The question is, on the basis of these observations about the markets, could the Nigerian rural and urban foodstuffs market systems be integrated? And, if so, to what extent?

The major objective of the study is therefore to determine the presence and level of integration in Nigeria's foodstuffs market system. Specifically the study focuses on the:

- Determination of the existence and level of inter-market price dependencies;
- Description of short-run interactions through cross-market lagged price changes;
- Evaluation of long-run responses to contemporaneous price changes in the foodstuffs markets; and
- Speed of price adjustments to long-run equilibrium.

Through the application of bivariate cointegration modelling with its implied error correction approach in rural and urban markets, the study attempted to obtain conclusions about the integration of the Nigerian foodstuffs system. In what follows we first review previous studies on market integration in Nigeria; this is followed by a characterization of Nigerian foodstuffs markets. Next, we present the application of cointegration in the analysis of the law of one price (LOP) and market integration problems, which involves a discussion on the theoretical framework for the study, model specification and methods of data analysis. The time series characteristics of data and analysis of an error correction

model follow, with an assessment of short-run and long-run responsiveness of rural prices to urban prices. The final section examines the conclusions and policy implications of the empirical analysis of Nigerian foodstuffs markets.

Review of previous studies on market integration in Nigeria

There has been quite a bit of research over the years on the integration of various combinations of Nigerian foodstuffs markets. The principal studies in this area include those of Anthonio (1968, 1988), Jones (1969), Gilbert (1969), Thodey (1969), Hays and McCoy (1977), Delgado (1986), Adekanye (1988), Ejiga (1988), Dittoh (1994), Okoh (1999), and Okoh and Akintola (1999). These studies covered market integration, price efficiency and pricing conduct of various foodstuffs (gari, rice, cowpeas, cassava roots, vegetables) in different regions of Nigeria. The price series used for the various studies were collected weekly or fortnightly by the researchers except for Okoh (1999) and Okoh and Akintola (1999), which used monthly series collected by staff of agricultural development projects (ADPs). With the exception of Dittoh (1994), Okoh (1999), and Okoh and Akintola (1999), the studies used correlation coefficients and simple static regression equations of the form $(P_i = a + bP_j)$ to reach conclusions about the integration and efficiency of the markets for various foodstuffs.

Markets were adjudged to be integrated or efficient if the correlation coefficient (R) or regression coefficient (b) attained values greater than zero but not greater than one. If $R > 0.9$, markets were said to be highly integrated; if $R > 0.8$, then markets were said to be moderately integrated. But if $R < 0.5$, then there is no integration and the series move independently of each other (Adekanye, 1988). The general conclusion from these studies is that apart from gari, cowpeas and rice, the markets are poorly integrated. The findings of these studies are doubtful. This is because the bivariate correlation coefficient and static regression methods are beclouded by problems of overwhelming seasonal and secular trends, as well as the possibility of autocorrelation from a static model calibrated to non-stationary time series, leading to spurious correlations and inferential errors (Granger and Newbold, 1974; Harriss, 1979; Blyn, 1973; Delgado, 1986; Ravallion, 1986; Palaskas and Harriss-White, 1993). Delgado (1986) adopted the variance decomposition approach, which decomposed the variance of food-grain price into components. With Delgado's approach, market integration is defined as the existence of stable price spreads among markets in a given season, despite considerable variations in prices. The study concluded that the markets are not well integrated. The method is dependent on correlation of non-stationary time series with its flaw of possible spurious correlation and inferential errors.

Dittoh (1994) applied the Ravallion model to the study of market efficiency in vegetable markets in northern Nigeria. The Ravallion approach used an autoregressive distributed lag (ADL) model for testing "short-run" and "long-run" integration involving the correlation of price series of reference (urban) markets as well as non-price determinants of demand and supply. It is a one-way approach to market integration. Its basic flaws are

the problems of simultaneity, failure to measure the level of integration where the flow between rural and urban areas reverses with the season, and colinearity among explanatory variables, as well as the problems associated with non-stationary time series data.

Okoh (1999) and Okoh and Akintola (1999) adopted the Mendoza and Rosegrant (1995) methodology, which applied a bivariate autoregressive model fashioned after the Ravallion approach but avoiding the problems associated with it by ascertaining the stationarity of data and differencing where necessary to obtain differenced stationary series. The study showed that cassava root and gari markets in the study area were weakly associated. The study also showed the presence of some form of price leadership in the market system. However, it is now known that the models based on differenced series alone eliminate all long-run information in the series, and hence ignore any possible long-run relationship between the series (Farret and Page, 1998).

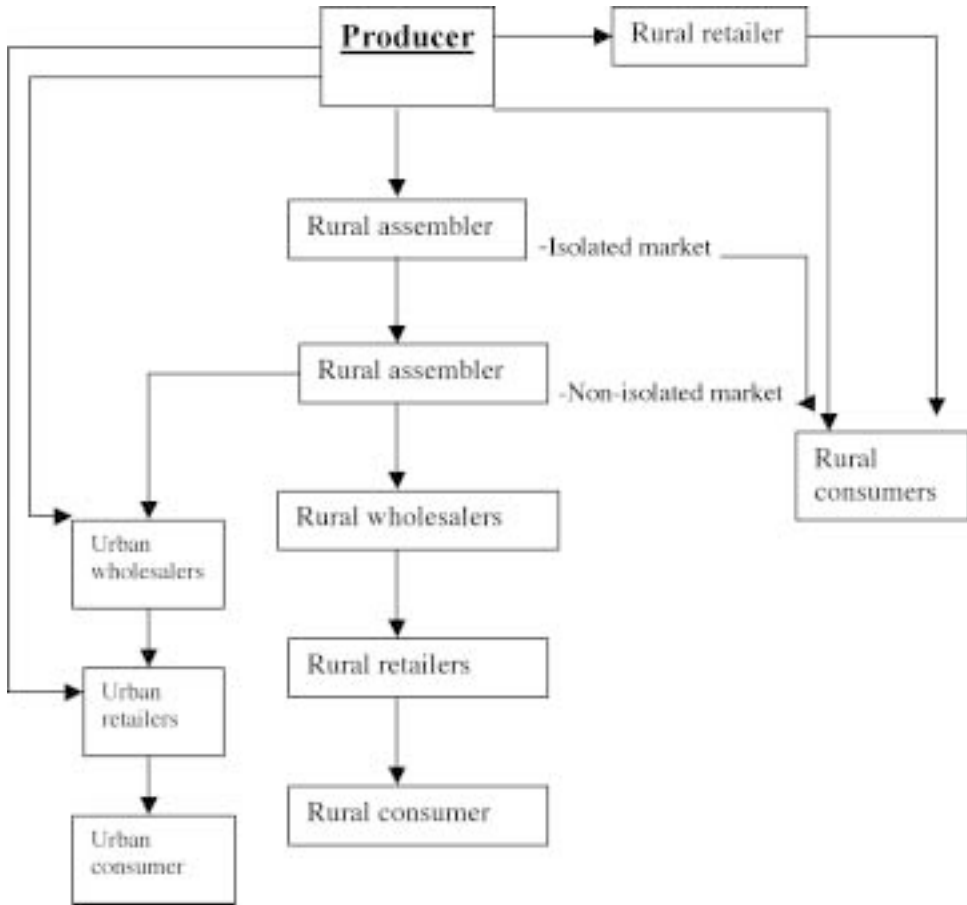
The various studies on the integration of Nigerian markets suggest that the major sources of poor integration and inefficiency include the poor price information transmission channel, too many intermediaries and the high cost of transportation, as well as the sources and validity of price data. An important observation is that while markets have characteristics of perfect competition, the price correlation results show that they are not integrated. This conclusion could be a result of faulty methodology. The notion of cointegration, which accommodates both the short and long responses, has not as yet been applied to the study of integration of Nigerian foodstuffs markets. The current study therefore adopts Johansen's procedure for cointegration analysis with its implied error correction model. None of the earlier studies covered a nationwide study of foodstuffs as a group, but this study does.

Marketing Nigeria's staple foodstuffs

The Nigerian foodstuffs markets exhibit characteristics of both perfect and imperfect markets. The poor state of the market infrastructure and high transportation costs, coupled with inefficient price information transmission channels, tend to limit the market boundaries covered by each trader. Market associations are present and the markets are more concentrated at the wholesale level than at the retail subsector. Wholesalers play vital roles in the distribution of foodstuffs in Nigerian rural and urban foodstuffs markets.

The marketing channels for staple foodstuffs can be classified according to the number of channel levels. In Nigeria, the channels are decentralized and exhibit remarkable complexities although certain features are common to all of them. There are as many as seven flow channels for the various staple foodstuffs. Gari market channels usually begin with the farmer (whether at the farm, home or rural market) producing and processing cassava roots into gari (or selling cassava roots to processors). Flow diagrams for locally produced foodstuffs are shown in Figure 1.

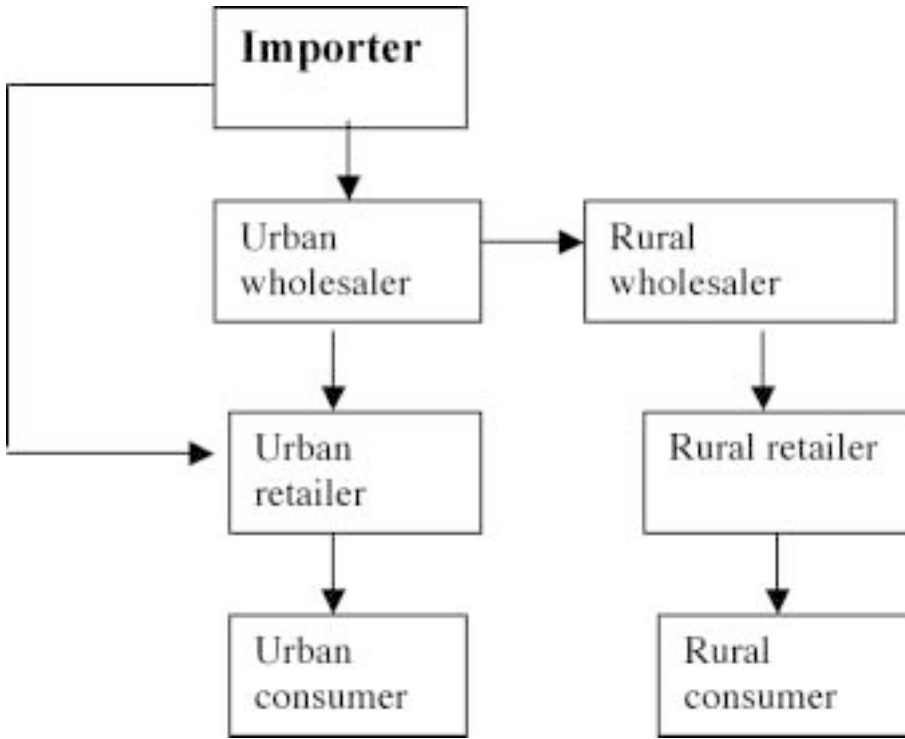
Figure 1: Marketing channels for locally produced staples



Trade flow is not uni-directional. In practice, urban wholesalers and retailers often travel to producing areas to make purchases from producers or rural assemblers/wholesalers, while others purchase directly from the farms. Wholesalers are largely responsible for the intra and inter-state flow of foodstuffs in Nigeria. Most wholesalers buy the foodstuffs from rural assemblers or commissioned agents; some buy directly from producers and others buy from a combination of other wholesalers and commissioned agents. They sell to urban retailers, urban consumers, rural wholesalers and retailers. Caterers may purchase food items from any of the other intermediaries in the market chain depending on their level of operation and ability to buy in large stock.

The marketing channel for imported foodstuffs is quite defined and developed. Well-established companies move the imported food from the seaport to the various urban and rural markets in Nigeria. The marketing channels for imported foodstuffs are shown in Figure 2. Empirical evidence from various studies revealed that there is some level of concentration in the rural and urban foodstuffs markets in Nigeria. The degree of concentration at the wholesale level is greater than the degree of concentration in the retail subsector (Adekanye, 1988; Okereke, 1988; Anthonio, 1988; Okoh, 1999).

Figure. 2: Marketing channels for imported foodstuffs



2. Methodology

The ability of a market system, whether domestic or foreign, to efficiently perform its development functions depends on the ease with which price changes and responses are transmitted spatially and temporally. Hence, the synchronous movement over time among prices in different markets becomes an important indicator of market efficiency. Market integration is a concept with application in spatial, temporal and product form interrelatedness. This study concentrates on spatial market integration, which involves a study of price relationships of one commodity, or a group of commodities (such as foodstuffs), in spatially differentiated markets. The perfectly competitive market condition is thus said to be ideal market structure for market integration, given its attributes that ensure that prices adjust instantaneously to any new information. The concern of market integration analyses therefore is to determine the possibility of obtaining some gains by trading across commodity markets, exploiting price movements in one market (urban) for the prediction of price movements in another market (rural).

Theoretical framework and model specification

The principle of market integration is hinged on the “law of one price” (LOP), which is the hallmark of the model or theory of perfect competition. A central prediction of the theory of perfect competition is that the price of all transactions will tend to uniformity, allowing for differences in transportation costs between different spatial markets. The Marshallian propositions on the economic market state that two regions are in the same economic markets for a homogenous good if the price for that good differs by exactly the inter-regional transportation cost. The most common expression of LOP is given by

$$Y_{1t} = K + Y_{2t} \quad (1)$$

where Y_{1t} and Y_{2t} are equal prices of a commodity in two spatially differentiated markets, rural and urban respectively. If $K = 0$, then the two prices are equal. This is the strict version of the LOP. If on the other hand, K is not equal to 0, then the prices have a proportional relationship, but their levels would differ owing to factors such as transportation cost, interest rates, market fees, quality differences, etc. This is the weak version of the LOP (Asche, Bremnes and Wessells, 1999).

The static price correlation or regression approach has traditionally been the basic approach for testing the presence and level of integration in pairs of spatially dispersed

markets. A typical regression model to test for market integration between two markets under the traditional static method is specified as follows:

$$Y_{2t} = K + BY_{1t} + e_t \quad (2)$$

Where

Y_{1t} = price for a central (urban) market in time T

Y_{2t} = price series for a peripheral (rural) market in time t

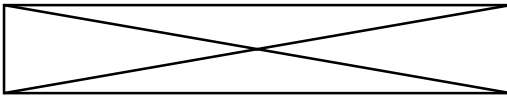
K = the intercept term

B = a parameter of the slope

e_t = error term

The test for convergence to LOP was carried out by testing the null hypothesis: $H_0: B = 1$.

The static model fails to determine the structure of the error term, nor does it produce an unbiased estimate. Also, the possibility of the presence of unit roots in the price series cannot be ruled out. Hence, normal inferences are not valid on the parameters in Equation 2. The LOP can therefore not be tested for by running this regression (Asche et al., 1999). The next plausible step is to test the series for non-stationarity. It is expected that two price series of the same group of commodities might have a long-term equilibrium relationship between the series. Stationarity tests were proposed by Dickey and Fuller (1979) and Philips and Perron (1988). The augmented Dickey– Fuller test for unit roots requires the following regression:



(3)

where DY_t = the 1st difference of Y_t ; t = is the time horizon; T = deterministic trend; n = the number of lags required to make the error term; and U_t = white noise.

The null hypothesis that the series has a unit root requires that: $(P - 1) = 0$ or $P = 1$. If this is accepted, the series is non-stationary. In this case differencing the series would yield a stationary series, that is, the process is difference stationary. A series is said to be integrated of order d if it becomes stationary after differencing d times. It is written as $I(d)$. A stationary series is an $I(0)$ series. If the t -ratio for coefficient $(P - 1)$ is less than the critical value, the hypothesis of a unit root is accepted and the series is non-stationary. If $(P - 1) < 0$ or $P < 1$ the coefficient of Y_t will be negative and if the trend coefficient B is significant, then Y_t is trend stationary. Once the series are found to be non-stationary then there should exist a linear combination of these variables, which is integrated of order one or non-stationary.

The next logical step is to test for cointegration. The concept of cointegration states that if there exists a long run relationship between two variables then the deviation from the long run equilibrium path should be bounded, and if this is the case then the variables are cointegrated. Two conditions must be met for variables to be cointegrated. First, the series must have the same order of integration. Second, there must be some linear

combinations (r) of variables, which must be, at most, of order one less than the number of individual variables (n), that is $r = n - 1$ (Townsend and Thirtle (1997)). If $r = n$, then the series are stationary and cointegrated. The cointegrating relation is specified as follows:

$$Y_{2t} = A_1 + A_2 Y_{1t} + V_t \quad (4)$$

Where A_1 is intercept term, and Y_{1t} and Y_{2t} are jointly determined endogenous variables (series of urban and rural foodstuffs prices). The difference between these two series must be stationary, that is

$$V_t = Y_{2t} - A_2 Y_{1t} \quad (5)$$

If V_t is stationary, then Y_{1t} and Y_{2t} are said to be cointegrated and A_2 is the cointegrating parameter. It measures the long-run relationship between Y_{1t} and Y_{2t} . V_t is the equilibrium error and it measures the extent to which the system diverges from its long-run equilibrium. If there is a stable long-run relationship between Y_{1t} and Y_{2t} , then divergence from it should be bounded.

The Johansen test of cointegration using maximum likelihood, allows hypothesis testing on the cointegrating parameters (Johansen and Juselius, 1990). It allows the LOP to be tested with non-stationary data. Since cointegration implies that there is a linear long-run relationship between the rural and urban price series, it might be interpreted as a test of the parameter $A_2 \neq 0$. If $A_2 \neq 0$, the series are cointegrated and there is a long-run relationship between the prices. Cointegration tests for market integration are only tests of whether there is a statistically significant linear relationship between different data series.

Engle and Granger (1987) developed the bivariate two-step cointegration testing procedure. The procedure requires that one of the two price series should be designated as exogenous. The method has been found to be flawed on the grounds that there is potential for small-sample biases in parameter estimates (Banerjee et al., 1993) and that the parameter estimates do not have well defined limiting distributions and as such the testing procedures are not straightforward (Hall, 1989). Another important flaw of the Engle and Granger procedure in the analysis of LOP is the endogeneity problem caused by the fact that the prices are simultaneously determined. The Johansen test is based on a vector auto regressive (VAR) model; it is a reduced form, which avoids the problem of simultaneity (Asche et al., 1999). The Johansen bivariate and multivariate cointegration tests (Johansen, 1988; Johansen and Juselius, 1992) have gained popular acceptance and have been widely used for the test of the law of one price. The tests follow a maximum likelihood estimation procedure that provides estimates of all the cointegrating vectors existing among a group of variables. The existence of cointegration among pairs of price series indicates the existence of integration among the series and a further test of residuals and the test of variable exclusion confirm the existence of market integration between spatially differentiated markets. The Johansen procedure is preferred to the Engle and Granger procedure since it uses test statistics that have been an exact limiting distribution

that is a function of a single parameter.

The use of cointegration procedures in market integration analysis has been criticized by Mastroiannis and Pippenger (1993) who argue that cointegration is a necessary but not sufficient condition for the law of one price (LOP) or market integration. Barret (1996), on the other hand, argues that cointegration is neither a necessary nor a sufficient condition for the LOP. According to him, if transaction costs are non-stationary, failure to find cointegration between two market price series can be completely consistent with LOP, so cointegration is unnecessary. Barret went further to enumerate four reasons why cointegration is not sufficient: First, negative estimates of an error correction model (ECM) imply that prices move in opposite directions rather than together; second, the magnitude of the cointegration coefficient is informative about the relative rates of change, and many reported coefficients have magnitudes implausibly far from unity. Third, trade flows are often temporally discontinuous because of perturbations and seasonal shifts in underlying demand and supply patterns, or in transactions costs. Experience with the structure of Nigerian price series suggests the existence of unit roots in the series and so cointegration is necessary. Further, not all agricultural goods are discontinuous; staple foodstuffs, for example, maintain a steady flow throughout the year so that demand and supply conditions are relatively stable throughout the year. Finally, a logarithmic transformation of time series data may help to ameliorate the problems that may arise from the non-linear conditional expectation function (Pesaran and Pesaran, 1997).

These criticisms notwithstanding, cointegration procedure presents the most efficient method for dealing with a non-stationary price series. According to Miljkovic (1999), cointegration (both bivariate and multivariate) models have been the most frequently used procedure for testing the law of one price (LOP) in agricultural goods and food markets in recent times. The current study adopts the Johansen procedure for cointegration analysis with its implied error correction model. This model also incorporates transaction costs, interest rates and seasonal dummies as explanatory variables.

The vector error correction model

The econometric model that underlines the cointegrating VAR options is given by the following general vector error correction model:

$$\Delta Y_t = \alpha + \beta Y_t + \gamma X_t + \delta \Delta Y_t + \epsilon_t \quad (6)$$

Where

Y_t = an $m_y \times 1$ vector of jointly determined (endogenous) $I(1)$ variables

X_t = a $q \times 1$ vector of $I(0)$ of exogenous variables

a_{oy} = intercepts, it is an $m_y \times 1$ vector

w_y = the $m_y \times q$ matrix of coefficients on the $I(0)$ exogenous variables

Π_Y = the long-run multiplier matrix of order $m_y \times 1$

L_{iy} = $m_y \times 1$ (p = number of lagged differences of y_t) coefficients of lagged y_t variables

D = change operator

Under the assumption that $\text{rank}(\Pi_y) = r$, that is, there exist r cointegrating relations among the variables of Y_t , if the rank $(\Pi_y) = 0$, and full rank, then variables in Y_t are stationary. If $0 < \text{rank}(\Pi_y) = r < m_y$, then dY_t responds to the previous period's deviation from the long-run equilibrium and therefore including the error correction term in the model is appropriate. In this case the Π_y matrix is the product of two $m_y \times r$ matrixes, α_y and β , that is $\Pi_y = \alpha_y \beta$. Each of them is of full rank. α_y represents the speed of adjustment to disequilibrium coefficient. The β matrix, on the other hand, represents the unique nature of the cointegration space. β contains the cointegrating vectors (error correcting mechanism) in the system.

Substituting Π with $\alpha\beta$, Equation 6 becomes:

(7)

where α_y = the speed of adjustment coefficient and β = is a matrix that contains the cointegrating vectors (error-correcting mechanism) in the system. All other variables are as defined above.

For the purpose of this study a VECM model was specified as follows:

(8)

where:

$Y_t = Y_1$ and Y_2 are urban and rural market prices as defined above.

$X_t = X_1$ and X_2 are transportation cost index and interest rates (lending), respectively. These variables are integrated of order $I(0)$.

S_i are seasonal dummies, while b_i represent the coefficients of the dummy variables.

ECM_y = the error correction mechanisms.

If a group of markets is to be in the same market boundary all the prices must be pairwise cointegrated. This also allows a multivariate test of the LOP because it implies that there is only one common stochastic trend in the system, and hence, with n prices in the system there must be $n - 1$ cointegrating relations. As the cointegration vectors are identified only up to a non-singular transformation, any set of restrictions that makes the columns of β matrix sum to zero will suffice. A natural procedure is to normalize upon the price. This makes the cointegrating vector $(1, -1)$ with respect to price.

The Johansen test allows a number of hypotheses testing the coefficients of α and β using likelihood ratio tests. The test for the LOP hypothesis involves the test of restrictions on parameters in the cointegrating vectors β . A test of LOP is a test of whether $\beta = (1, -1)$ (Asche, et al 1999). A test of weak exogeneity is a test of whether no information is

lost when inference is based on parameters of the conditional density function rather than the joint density function. A test of cointegration space or exclusion and linear hypothesis involving cointegration vectors helps to strengthen the conclusions about LOP. Finally, a test of the residuals from the VECM, which measures the absence of unit roots, further confirms the LOP.

Persistence profile for cointegrating relations

The study used the persistence profile as developed by Microfit's long-run structural modelling techniques to measure the effect of system-wide shocks on the j th cointegrating relationship. The effect is measured by the following:

$$h(\beta_j Y_t, N) = \frac{\beta_j A_N Q A_N \beta}{\beta_j Q \beta_j} \quad (9)$$

where $h(\beta_j Y_t, N)$ = persistence profile; $\beta_j Y_t$ = Cointegrating relation $j = 1 = r$; r = number of cointegrating relations; and $N = 0, 1, 2 \dots 108$. The value of the profile is equal to unity on impact, but should tend to zero as N tends to infinity as long as β_j is a cointegrating vector. A = a matrix of coefficients in the VECM, while Q = is the covariance matrix of the shocks, U_t .

The persistence profile viewed as a function of N provides important information on the speed with which the effect of system-wide shocks on the cointegrating relation, $\beta_j Y_t$, disappears. The persistence profile provides estimates of the speed with which Nigerian rural and urban market systems return to their equilibrium state when shocked (Pesaran and Pesaran, 1997).

3. Data and time series properties

The study used monthly time series of rural (Y_1) and urban (Y_2) composite food price indexes, transportation cost index (X_1) and lending rates of interest. These were collected from the Federal Office of Statistics (FOS) and Central Bank of Nigeria CBN publications. Price indexes have been said to be preferred to prices because nominal prices may lead to the conclusion that cointegration exists between two time-series, even when there is no actual market relationship between them. In other words, co-movements may be observed between two price series as a result of inflationary trends (Zhou et al. , 2000). Missing observations were replaced by computing the simple averages of the two preceding observations. Transportation costs and interest rates are the most prominent components of arbitrage or transaction costs. Difficulties in obtaining credit (measured by interest rates) are likely to reduce the speed of adjustments in the same way as increases in transportation costs (Ousmane, 1998). Transportation costs and interest rates play an important role in determining both the level and speed of adjustment of market prices to changes in supply and demand conditions.

Data computation

Central Bank of Nigeria and Federal Office of Statistics compute the price and transportation cost indexes in two stages. First, the simple index is computed for a particular period, n , by dividing the current actual average price for the components by its level in the base year:

$$P_{sin} = \frac{P_{in}}{P_{oi}}$$

where

P_{sin} = simple price index for the i th component in n th period

P_{in} = average level in ₦/unit for the i th components in n th period

P_{oi} = average price level for the i th components in the base year

The second stage involves the computation of the aggregate or overall consumer price index (I_n), which is computed as a weighted average of the simple price relatives as follows:

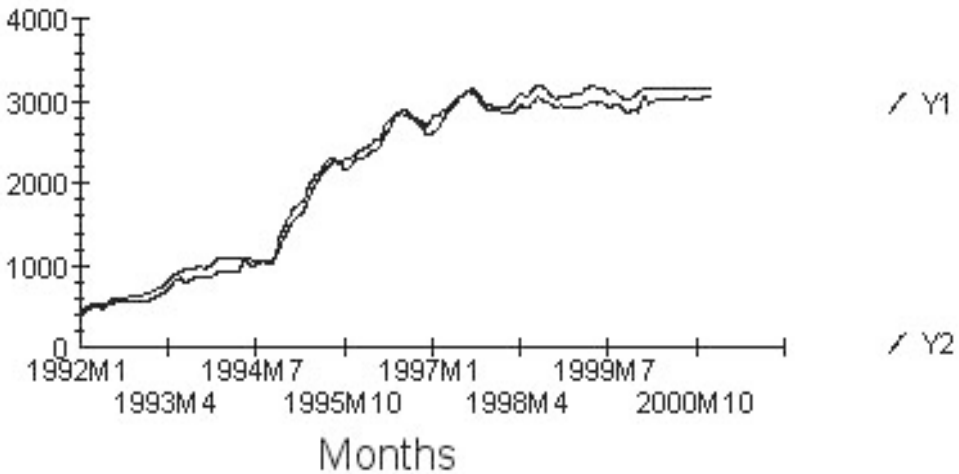
$$I_n = \frac{\sum P_{sin} * W_{oi}}{\sum W_{oi}}$$

I_n = aggregate or overall consumer food price index for period n, and W_{oi} is the weight for the base period for ith components. The population weights are thereafter applied to both the all-rural and all-urban indexes for a particular component and summed up to obtain the composite index (CBN, 1998).

Time series properties of data

The urban (Y_1) and rural (Y_2) price series were trended and first order autoregressive processes Y_1 and Y_2 were also highly positively correlated, as the product moment correlation coefficient was 0.996. The plots of the two series are shown in Figure 3.

Figure 3: Rural (Y_2) and urban (Y_1) foodstuffs price series



The augmented Dickey–Fuller (ADF) test for unit roots was conducted for the price series, the transportation cost index and interest rates. Since the ADF test is likely to give a result of non-stationarity in a situation where the series is close to I(1), the Philips–Perron test is said to be better suited, particularly where the data set is large. With 12 lags the test statistics from the Dickey–Fuller and Philips–Peron tests of the series are shown in Table 1. The ADF results show that the price series as well as the transport cost and interest rates were non-stationary. The Philips–Perron test, on the other hand, rejected the null hypothesis of non-stationarity for the price series Y_1 and Y_2 at the levels but not

at the first difference levels at 5% significance level. For the transportation and interest rates, the null hypothesis of non-stationarity could not be rejected at the 5% significance level. Hence the price series Y_1 and Y_2 are non-stationary of order $I(1)$, while the exogenous $I(0)$ series include: $X_1, X_2, S_1, S_2, S_3, S_4, S_5, S_6, S_7, S_8, S_9, S_{10}$ and S_{11} (S_1 to S_{11} are seasonal dummies). The presence of non-stationary time series implies the need for estimation of a vector error correction model (VECM). The Philips–Perron test result was adopted for this study.

Table 1: ADF, DF and Philips–Perron tests of unit roots

S/No.	Variables	ADF range of test statistic	ADF/P-P critical values	Philips–Perron test statistic *	Order of integration	
					ADF	P-P
1	Urban price (Y1)	(-2.237) - (-1.869)	-2.8919	-2.3806[0.019]	I(1)	I(1)
2	Rural price (Y2)	(-2.086) - (-1.857)	-2.8919	-2.190[0.031]	I(1)	I(1)
3	Transportation cost (X1)	(-0.534) - (-0.761)	-2.8919	-3.985[0.691]	I(1)	I(0)
4	Interest rates (X2)	(-1.764) - (-2.775)	-2.8919	-1.140[0.257]	I(1)	I(0)
5	D(Y1)	(-1.571) - (-4.526)	-2.8922	-0.590[0.557]	I(0)	I(0)
6	D(Y2)	(-1.331) - (-4.973)	-2.8922	-0.679[0.499]	I(0)	I(0)
7	D(X1)	(-2.704) - (7.472)	-2.8922	-	I(0)	-
8	DX2	(-3.337) - (-6.750)	-2.8922	-	I(0)	-

Notes: D = difference operator.

* = Values in parentheses are probabilities.

4. Results and discussions

The test statistics and criteria for selecting the order of VAR model resulted in a choice of VAR of 3 by the log likelihood (LL) statistics, 4 by the Akaike information criterion (AIC) and 2 by the Schwarz–Bayesian criterion (SBC). According to Paseran and Paseran (1997), the SBC is more reliable for large data sets and hence we adopted the SBC choice of VAR = 2. The bivariate cointegration test of rural and urban foodstuffs prices was carried out with VAR = 2.

Testing for cointegration and the LOP

As a starting point for our general to specific procedure of analysis, the test for cointegration included a deterministic trend variable “t”. The resulting cointegration relation (result not included) was tested for exclusion by imposing a zero restriction on the trend coefficient. The likelihood ratio (LR) statistic was $CHSQ(1) = 0.0025713$ with a probability of 0.960. The result suggests that the null hypothesis of exclusion of deterministic trend from the cointegrating relations cannot be rejected.

To determine the direction of causality between the two price series Y_1 and Y_2 , the LR test of block Granger non-causality $CHSQ(12) = 17.3455$ with probability of 0.137, shows that the null hypothesis that says that the coefficients of the lagged values of Y_2 in the block of equations explaining the variable Y_1 are zero cannot be rejected. The results suggest that the Y_2 (rural price) does not Granger cause Y_1 (urban price). The LR test of block non-causality $CHSQ(12) = 43.1075$ with probability of 0.000 indicates that the null hypothesis that says that the coefficients of the lagged values of Y_1 in the block equations explaining the variable Y_2 are zero should be rejected. The results suggest that the Y_1 (urban price) Granger causes Y_2 (rural price). There is thus a one-way causal relationship between Y_1 and Y_2 and it goes from Y_1 to Y_2 .

The cointegrating relations were then re-specified with unrestricted intercepts and no trend in the VAR, placing Y_2 as the first endogenous variable. The test commenced with a test for the number of cointegrating relations or rank of Π_y . The study used Johansen’s maximum eigenvalue of the stochastic matrix and the LR test based on the trace of the stochastic matrix (Table 2).

The two LR tests reject the null hypothesis that there is zero cointegrating relationship between the two price series Y_1 and Y_2 , but do not reject the null hypothesis that there is at least one cointegrating relation. In summary, the cointegration test showed that rural (Y_2) and urban (Y_1) food prices have an equilibrium condition that keeps them in proportion to each other in the long run.

Table 2: Johansen's Bivariate tests for Y_1 and Y_2 .

S/N.	HO: rank = r /No. of cointegrating relations (r)	Eigenvalues in descending order	Max. LR test statistic	95% critical values	Trace LR test statistic	Critical value 95%
1.	R = 0 R <= 1	0.18326 0.012201	21.4583 1.3013	14.850 8.070	22.7596 1.3013	17.860 8.070

The unrestricted estimate of Johansen's maximum likelihood (ML) estimates, subject to exactly identifying restrictions, are shown in Table 3.

Table 3: Estimated cointegration vectors in Johansen estimation

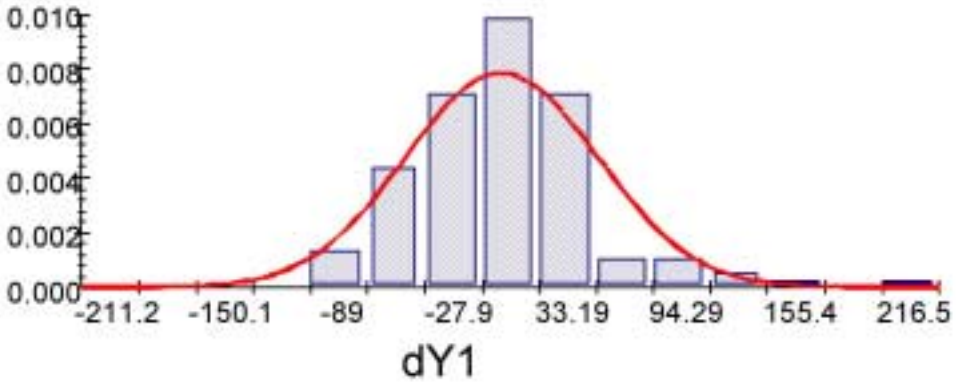
Variables	Un-normalized estimates	Normalized (to Y_2) estimates
Y_2	0.002108	1.0000
Y_1	- 0.001935	- 0.91817

By imposing one normalization restriction on the cointegration equation, Y_2 exactly identifies the system. This implies that the prices Y_2 and Y_1 are pair-wise cointegrated, indicating that all the prices contain the same stochastic trend. The economic interpretation of this result is that there is some factor, most probably arbitrage, that binds the prices together over time. The rural and urban foodstuffs markets are in the same market.

Next step is to test for LOP. This is the test of whether $\beta = (1, -1)$. The test statistic was 4.72 and distributed as chi-square (CHSQ) with one degree of freedom. With a critical value of 6.63 at 1% significance level, the null hypothesis cannot be rejected. Thus using the Johansen bivariate test, the results suggest that the rural and urban foodstuffs markets are well integrated. A number of diagnostic tests were conducted on the residual. First, ADF tests of unit roots, with and without a linear trend, were conducted and the results show that the null hypothesis cannot be rejected. The residuals are stationary. A Lagrangian multiplier test of residual serial correlation showed that there was an absence of serial correlation in the residuals. Ramsey's RESET test of functional form showed that the model was properly specified. The skewness and kurtosis tests of normality, however, reject the null hypothesis that the residuals are normally distributed. Based on the strength of the Ramsey's RESET tests and the test on the constant term, it can be stated that the effect of the result of the normality test is not substantial enough to warrant any concern. The histograms of the residuals are shown in Figure 4. The test for absence could not reject the null hypothesis, hence there is an absence of heteroscedasticity. The results are shown in Table 4.

Figure 4: Histograms of residuals for dY_1 and dY_2

Histogram of Residuals and the Normal Density



Histogram of Residuals and the Normal Density

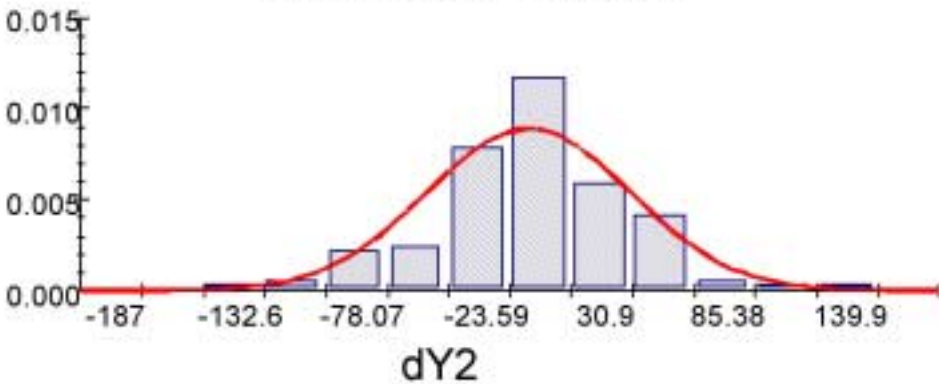


Table 4: Misspecification tests in the system

S/No.	Test/Equation	Y_2 rural markets	Y_1 urban markets
1.	Unit roots	-2.534	-2.684
	Critical values CHSQ (12)	-3.458	-2.893
2.	Residual serial correlation CHSQ (1)	16.744 (0.159)	11.072 (0.523)
3.	Ramsey's RESET-CHSQ (1)	0.199 (0.656)	0.0294 (0.864)
4.	Normality-CHSQ (2)	10.189(0.006)	93.054 (0.000)
5.	Heteroscedasticity -CHSQ (1)	0.1996(0.655)	3.2049 (0.075)

Notes: (1) Probability values are in parentheses.

(2) All test conclusions were reached at the 5% level of significance.

Test for weak exogeneity

Having confirmed that there is only one stochastic trend in the system, it is necessary to test the extent to which this might be caused by either of the markets series, rural prices (Y_2) or urban prices (Y_1). The procedure involves a test of whether any of the price series drives the other in the long run. This amounts to testing for weak exogeneity. It tests the hypothesis that α , that is, the speeds of adjustment coefficients are equal to zero ($H_0: \alpha=0$). The results are shown in Table 5.

Table 5: Weak exogeneity test

Potentially exogenous variable	Test statistics CHSQ (1)	Probability values
Y_2	16.544	0.000
Y_1	1.560	0.212

The results in Table 5 show that the null hypothesis that says that the urban foodstuffs prices are weakly exogenous cannot be rejected. Hence we can conclude that in the long run, the urban prices of foodstuffs in Nigeria drive the rural prices. It is therefore valid to condition on Y_1 . The weak exogeneity test rejects the null hypothesis that Y_2 (the rural market price) is weakly exogenous. The size of the a_{Y_2} coefficient shows that the system adjusts fairly quickly to disequilibrium ($a_{Y_1} = 0.145$ and $a_{Y_2} = 0.418$).

Test for linear hypothesis on cointegration relations

Here we test for the hypothesis that each b_1 is zero (exclusion) and that the different variables are stationary. The results are shown in Table 6.

Table 6: Testing for exclusion

Variables	Test statistics – CHSQ (1)	Probability value
Y_2	19.963*	0.000
Y_1	20.099*	0.000

Note: * = significant at 1% level.

Since all variables in the cointegrating relations are significant, we reject the null hypothesis that coefficients of the price series are all equal to zero. We can now discuss the results of the VECM model. The co-efficient of the b vector are highly significant and have signs consistent with economic theory. There is evidence of synchronous movement between the two price series.

Results of vector error correction model

So far we have determined that the rural and urban markets for foodstuffs in Nigeria are integrated. In addition, the urban foodstuffs price is weakly exogenous and can be said to drive the rural price. We can obtain further information about short-run dynamics of the prices by examining the single equation error correction models. Equation 8 was estimated for this analysis.

The analysis began with a lag length of $P = 12$ in all equations to cover a full annual cycle (Asche et al., 1999). The lags from P_{12} down to $P = 1$ were not significant, hence a lag of 1 was used for the analysis. The results reported in Table 7, show that most of the coefficients of the seasonal dummies were not statistically significant. A test of exclusion, however showed that they were significant at the 10% level. They were thus included in the model. The most important estimates of interest were the coefficients of the short-run dynamic price changes and the ECM_y .

The results suggest that the contemporaneous urban prices (Y_1) appear not to adjust to long-run disequilibrium through the ECM_{y1} , since the magnitude of its coefficient is small and statistically not significant. The urban prices, however, respond to short-run disequilibrium through the lagged changes in the rural market prices. The adjustment coefficient (ECM_{y2}) for the rural market price was -0.418 and was statistically significant at the 1% level. The rural price adjustment is at a moderate speed; about 42% of price adjustment takes place within the first period, that is, within the first month. The foodstuffs market responds to short-run disequilibrium through the lagged changes in its own prices. The significance and magnitude of its coefficient and its high statistical significance suggest that the previous period rural foodstuffs change is a significant determinant of the contemporaneous rural market prices. Transportation cost was highly significant (1%) in determining current changes in rural foodstuffs prices. It was positively signed, while the interest rate was also significant at the 10% level albeit negatively signed. It is clear that these two variables are very likely to contribute to market segmentation by directly impeding the speed of adjustment.

Table 7: Results of the VECM for Y_1 and Y_2

S/N.	Regressors	DY ₁		DY ₂	
		Coefficients	Probabilities	Coefficients.	Probabilities
1.	Intercepts	44.12	0.233	31.896	0.328
2.	Dy ₂₁	0.4771	0.001	0.371	0.003
3.	Dy ₁₁	-0.201	0.150	-0.0318	0.808
4.	Ecm ₁ (-1)	-0.145	0.215	—	—
5.	Ecm ₂ (-1)	—	—	-0.418	0.000
6.	X1	0.009	0.517	0.0399	0.001
7.	X2	-0.901	0.389	-1.7368	0.062
8.	S1	10.758	0.139	3.069	0.899
9.	S2	-25.443	0.352	-34.055	0.160
10.	S3	12.129	0.653	14.453	0.544
11.	S4	0.462	0.986	17.945	0.447
12.	S5	2.310	0.931	17.730	0.457
13.	S6	8.548	0.750	9.634	0.683
14.	S7	3.279	0.901	1.675	0.943
15.	S8	-20.794	0.431	7.932	0.733
16.	S9	-45.145	0.098	-33.3161	0.165
17.	S10	-27.943	0.302	-40.659	0.090
18.	S11	40.851	0.133	21.669	0.365
19.	R ²	0.347	—	0.508	—
20.	Adj.R ²	0.229	—	0.420	—
21.	F-statistic	2.954	0.001	5.747	0.000
22.	DW-statistic	1.967	—	2.036	—

Stability test

This involves a test of the constancy of the intercept term since it is said that most of the changes take place in the intercept (Asche et al., 1999). A Wald test of a shift in the constant term of cointegrating vectors at the midpoint yielded 0.086 and 0.083 with probabilities of 0.769 and 0.774 for Y_2 and Y_1 , respectively. The null hypothesis of no shifts in the constant term cannot be rejected. A further test for structural stability of the model was carried out with the cumulative sum (CUSUM) and the cumulative sum of squares (CUSUMSQ). The plots in figures 5–8 suggest that the models are correctly specified and that they are structurally stable since the CUSUM and CUSUMSQ lie within the two standard deviation band.

Figure 5: CUSUM test for Y_1

Plot of Cumulative Sum of Recursive Residuals

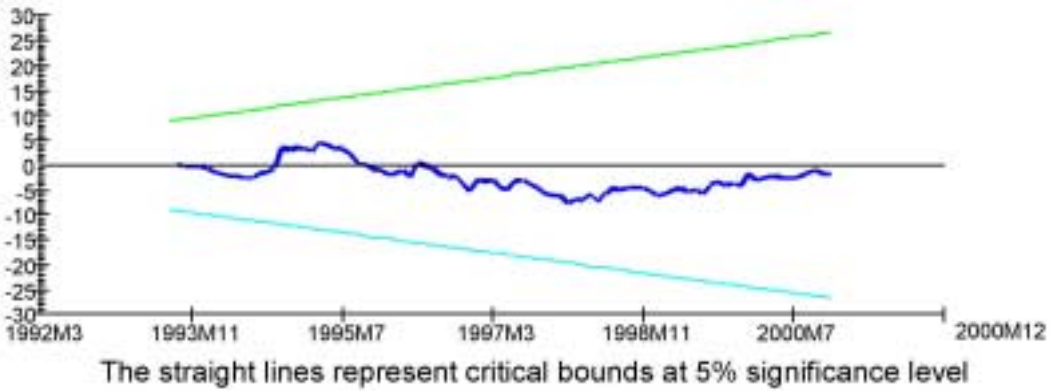


Figure 6: CUSUMSQ test for Y_1

Plot of Cumulative Sum of Squares of Recursive Residuals

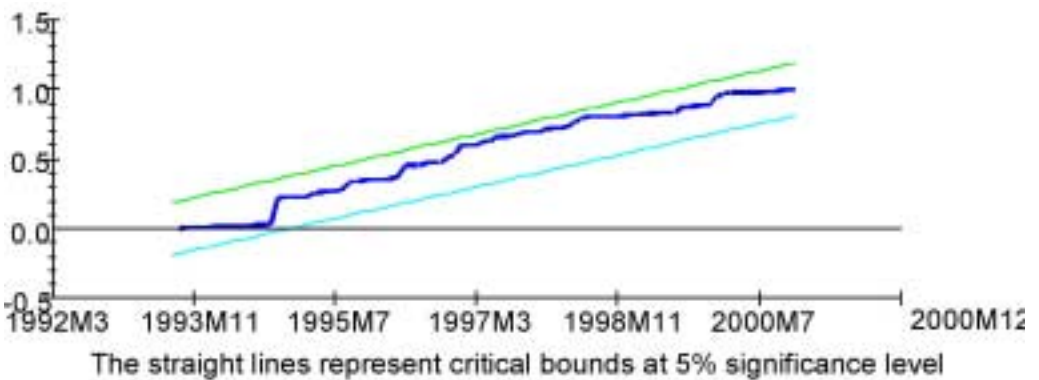


Figure 7: *CUSUM* Test for Y_2

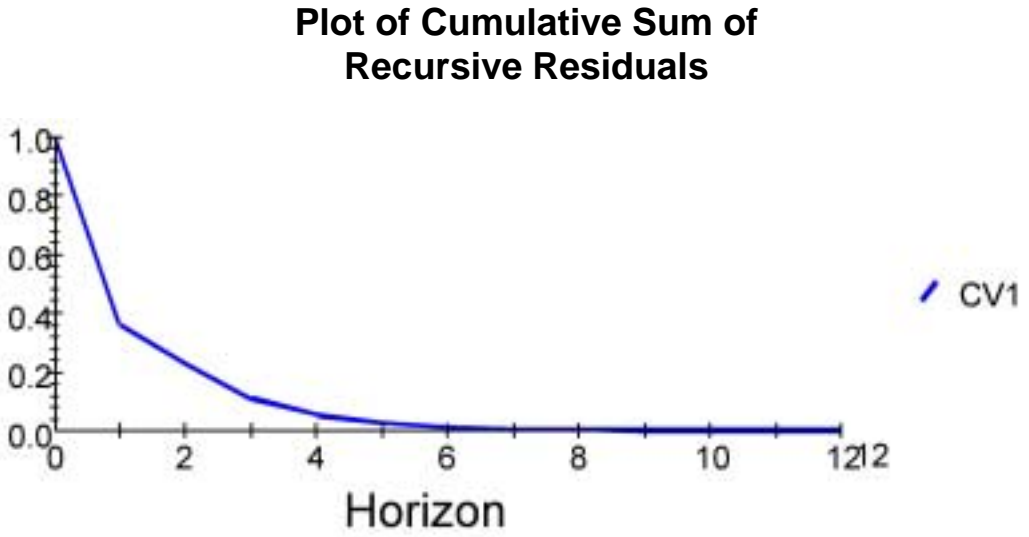
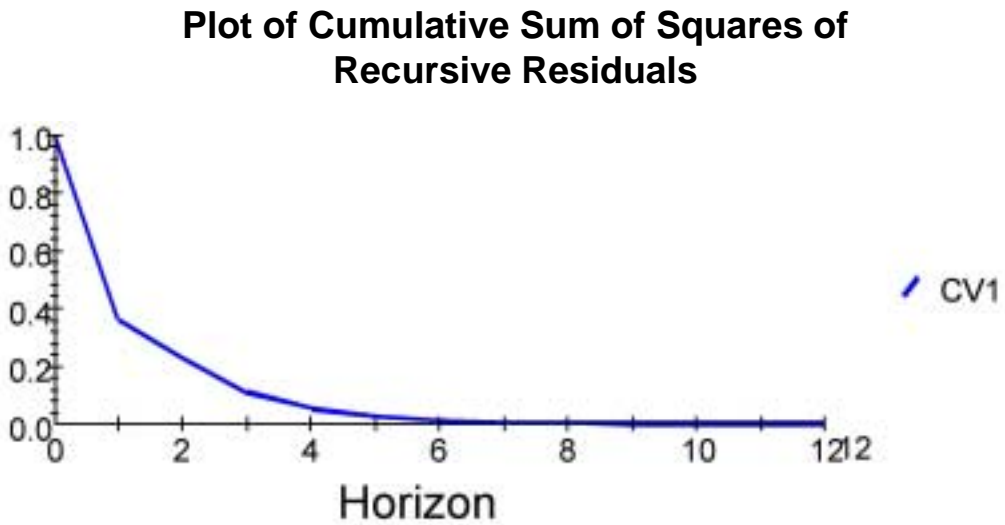


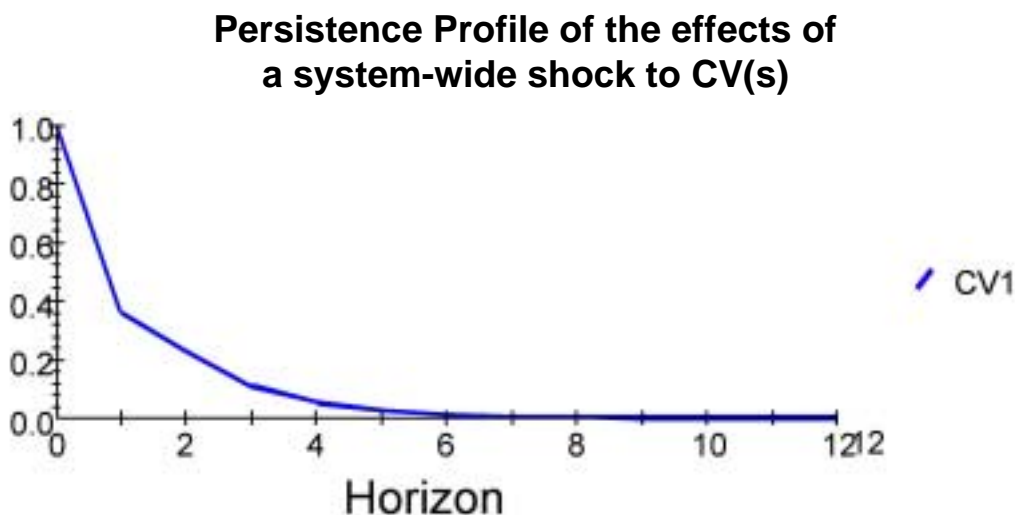
Figure 8: *CUSUMSQ* Test for Y_2



Persistence profile

The persistence profile shows the effect of one unit shock to the cointegrating relations. The results show that it would take the rural and urban market system about five months for the effect of a shock on the system to die out. The prices have a strong tendency to converge to their respective equilibrium. The result is shown in Figure 9.

Figure 9: Persistence profile of the effect of a system wide shock to CV1



Test for non-nested regression models

As a further step in our general to specific procedure the model was subjected to non-nested tests against log transformed regressors. The N-test, NT-test, W-test, J-test and JA-test yielded highly significant statistics. The encompassing test was also highly significant for both equations, indicating that model M_1 fails to encompass model M_2 (Log linear model). This is valid since it is an evidence of two weak models (Adams, 1992). The model selection criteria, Akaike information criterion and the Schwarz-Bayesian criterion favour model M_1 . The results are shown in tables 8 and 9.

Table 8: Alternative tests for non-nested regression models

Test statistic	M1 against M2		M2 against M1	
N-test		-3.3275[.001]		-18.3109[.000]
NT-test		-2.8253[.005]		-3.1223[.002]
W-test		-2.7676[.006]		-2.8436[.004]
J-test		2.6993[.007]		6.4965[.000]
JA-test		2.7119[.007]		-1.4103[.158]
Encompassing	F(2, 87)	3.6966[.029]	F(17, 87)	2.6405[.002]

Akaike's information criterion of M1 versus M2 = 2.7275 favours M1
Schwarz–Bayesian criterion of M1 versus M2 = -17.2483 favours M2n

Table 9: Alternative tests for non-nested regression models

Test statistic	M1 against M2		M2 against M1	
N-Test		2.9643[.003]		-77.3076[.000]
NT-Test		2.6415[.008]		-9.2531[.000]
W-Test		2.6845[.007]		-7.1553[.000]
J-Test		-3.4696[.001]		10.3047[.000]
JA-Test		-3.6216[.000]		3.3006[.001]
Encompassing	F(2, 87)	7.6719[.001]	F(17, 87)	6.9141[.000]

Akaike's information criterion of M1 versus M2 = 21.6985 favours M1
Schwarz–Bayesian criterion of M1 versus M2 = 1.7227 favours M1

5. Policy implications and conclusions

This study has attempted to provide a more robust explanation of market integration in the rural and urban foodstuffs markets of Nigeria. Using the cointegration approach, the study attempted to establish that the law of one price holds in the rural and urban foodstuffs market systems. Specifically, the Johansen's bivariate procedure was used in this study since it permits the test for cointegration parameters. This feature is not present in other methods of analysis, particularly those used in previous studies of integration of foodstuffs markets in Nigeria. This study has important implications for the validity of previous studies on the subject matter in Nigeria.

The results from the study of rural and urban foodstuffs prices indicate, first, that the rural and urban foodstuffs markets are in the same market boundary as a result of arbitrage as evidenced by the existence of cointegration between them. Second, the law of one price holds in the foodstuffs market system, and so the markets are integrated albeit moderately. Third, urban foodstuffs prices are weakly exogenous and hence drive the rural prices, with a significant amount of the adjustment taking place in the first one month. Finally, transportation costs affect current price changes directly, while interest rates affect them inversely.

There are several policy implications from these findings. First, since urban food prices drive rural food prices (based on the estimation of monthly food price indexes), food production may be adversely affected if prices in urban centres decline over time. Such a decline may arise when domestically produced foodstuffs are substituted for imported foodstuffs. Policy options should be adopted that protect the rural food producers from the negative effects of dumping and World Trade Organization (WTO) agreements. Some trade restriction measures may have to be taken to save the rural food producers from collapse, Nigeria being signatory to the treaties/protocols notwithstanding, good governance dictated by national interest calls for this assertion. Secondly, the presence of LOP should encourage profitable arbitrage for both intra- and inter-regional transfer of foodstuffs from food surplus rural areas to food deficit urban areas. As noted earlier, however, market segmentation is encouraged by the presence of poor roads, inefficient transport facilities and hence high transportation costs.

The policy implication is that the news about contemporaneous price changes is transmitted between rural and urban markets in the long run fairly quickly. This suggests that if the price dichotomy is a result of differences in quantity of foodstuffs supplied in rural and urban markets, farmers/sellers in the low price areas may be able to take advantage of higher prices in the other areas by moving their foodstuffs from food surplus areas to food deficit areas. This will also redistribute food supply between rural and

urban regions as well as reduce income inequalities between rural and urban inhabitants.

Market integration may be improved by policy intervention, which may take the form of general financial interventions and alternative credit sources. This will enhance the ability of farmers/sellers to keep stocks of staple foodstuffs for many more months after harvest. In the long run, response to changes in price information between rural and urban markets is slower. It is obvious that the performance of the market system between rural and urban areas of Nigeria will determine how production increases of various foodstuffs will affect food prices. Policy intervention for improvement of market integration in the long run may take the form of improvements of marketing infrastructure, price information channels, road networks and transportation facilities, which may eventually reduce transport cost and enhance interregional trade. It is expected that this will eventually lead to expansion of the market boundary within which each foodstuffs farmer/seller operates.

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