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Price Fluctuations, Linkages and Causality in the Nigerian Beef Market

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Abstract

Since beef accounts for 71% of meat consumption in Nigeria, efficient functioning of the beef market network is very important in Nigeria's development. This study tested for the degree of integration in the beef market using secondary data from twelve states of Nigeria. The analytical techniques used included descriptive statistics, Augmented Dickey Fuller (ADF), Johansen Co-integration and Granger Causality models. Empirical results showed that retail price growth rates were highest in 2002. Growth was highest in Benue Market in 2002 (99.7%), Sokoto Market in 2009 (95.4%) and Imo Market in 2002 (54.9%). Growth rates were generally stable in 2001 except in Kwara Market. The lowest growth rates were recorded in Benue Market (-35.1%) and Imo Market (-14.5%) in 2003. Average growth rates were highest in Borno Market (17.4%), Sokoto Market (16.0%) and Bauchi Market (15.6%) while it was least in Lagos Market (11.3%). Generally, growth rate was higher in the producing areas (15.3%) than in the consuming areas (13.6%). The markets with the highest monthly retail prices were Imo, Rivers, Lagos and Enugu and were all located in southern Nigeria, a sink region for cattle. The ADF test showed all price series were non-stationary at their levels but stationary after first-differencing. Pair-wise market integration model indicated that prices were co-integrated in 72.7% of beef market locations indicating a high degree of marketing efficiency in the beef market. Prices were tied together in the long run in seven out of every 10 market locations in spite of short run divergences. The result of pair-wise Granger causality showed that 80 market pairs had evidence of price causation. Sixty two (62) market links of the 80 exhibited bi-directional Granger causality while 18 market pairs showed uni-directional Granger causality. The results of Granger causality test did not reveal that there are no clear price leaders in the beef market network. Despite the fairly high level of beef market linkage, there is need for all stakeholders to continue to effectively perform their roles so that there can be perfect linkage that will allow economic benefits derivable from this scenario of strong pricing contacts to be fully realized and sustained.

Keywords: Beef market; Demand and supply; Fluctuations and causality; Nigeria

Introduction

Background information

Different categories of individuals need different quantities and types of protein for growth, development, regeneration of ageing, worn-out tissues and building of new ones [1]. Protein is especially necessary in the diets of children, expectant and nursing mothers. Protein needs can be best met through consumption of meat, fish, eggs and other animal protein sources [2]. The meat obtained from cattle is referred to as beef. Proteins from animal origin usually possess a higher biological value for its being easily metabolized with less waste in the human body than proteins from plant sources [3,4], defined meat as the edible flesh of those animals which are socially, ethically and religiously acceptable for consumption by man. Beef is a major source of animal protein in the diets of Nigerians [1]. The wide acceptability of beef is attributable to absence of religious and socio-cultural taboos against its consumption by nearly all the over 250 ethnic nationalities in Nigeria [5]. Considering the high importance of beef as a source of protein in humans' diet and its wide consumption which makes it an option for solving the widespread problem of protein malnutrition in Nigeria, its marketing and degree of marketing efficiency need be examined.

Marketing of beef encompasses all business activities associated with the transfer of cattle from the producers to the point of slaughter and from where beef begins its journey *en route* the final consumers. Thus, the marketing of beef commences with the movement of cattle from the pastoralists in northern Nigeria to the consumers who are located in both urban and rural areas [6]. Beef marketing makes it possible for beef to reach the buyers in the form, place and time it is wanted. This involves bringing the beef from the point of slaughter, where they are surpluses to where they are shortages, a process known as arbitraging [7,8].

Demand for and supply of beef in Nigeria

The national meat supply position in Nigeria is critical. The situation appears to be deteriorating with time, but for the needed support given in the form of massive importation of meat and meat products, in recent years, the national demand supply gap for meat would have reached crises dimension [1,9]. Beef accounts for about 71% of Nigeria's total meat consumption. Although it has always been difficult to specify by number or by its proportion of the national herd, it is nevertheless known that a significant portion of the locally produced beef are derived from cattle brought from Nigeria's neighbouring countries like Chad, Niger and Cameroon. This has significantly reduced the beef shortage that would have been experienced if Nigeria had relied entirely on her own resources for meat supply.

Problem statement

Cattle is mostly produced in the northern Nigeria and mostly consumed in the southern parts of the country. Thus, while the north is dependent on the south for livestock market to dispose of its product, the south is equally dependent on the north for the supply of the product [10]. The above phenomenon has raised a lot of challenges one of which is the involvement of so many stakeholders participating as intermediaries in the marketing chain. This has led to increased

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marketing costs and upward trending final retail price of cattle and beef [5]. The effect of the activities of these intermediaries on marketing costs is capable of putting a limit on the accessibility of the poor to beef meat which is a major source of protein.

Justification of the study

Marketing is an economic activity which, if efficiently done, stimulates further production [11,12]. If marketing is efficient, both the producer and consumer get satisfied in the sense that the former obtains a better price for the product while the latter buys it at a cheaper price [13]. However, since marketing efficiency is measured mainly in terms of the benefit derived by both the producers and consumers, concerns need to be raised in terms of the distance involved in moving cattle and cattle products from the production areas to the consumption points, the associated risks encountered, the level of access to market information, the involvement of too many intermediaries and its implications on the operational efficiency of beef marketing in Nigeria. Thus, to improve the competitiveness of beef marketing in Nigeria, cost effective marketing channels and coordinated supply chains which reduce the transactions costs along the supply chains, are crucial.

Objectives

The broad objective of the study is to examine the extent of price variability, market linkage and leadership in beef marketing in Nigeria.

The specific objectives are to:

I. Compute the variability and explain the trend in beef prices in selected market centers in Nigeria,

II. Investigate the presence and extent of integration and linkage in the market for beef, and

III. Test for the presence of evidence of price leadership and the identify the markets exhibiting leadership positions in beef marketing.

Theoretical Framework and Literature Review

The concept of market integration

Barret [14] defined market integration as tradeability or contestability between markets. Markets integration can be interpreted as the extent to which price shocks are transmitted between spatially separated markets. The goal of market integration analysis is to determine marketing efficiency which is basically the extent and speed of price transmission between spatially separated markets. Market integration is built on the premise that if a pair of markets is integrated, a price change in one of them will be reflected in a price change in the other. For example, the demand for and price of a given unit of beef would have a dominant effect on the beef trade, and by extension, price formation in other trading markets. This would be an indicator for marketing efficiency since price differences between the given markets would reflect only transportation costs including normal profit [15]. Thus, the more integrated a network of markets is, the more efficient the individual physical markets in that network [16]. Increasing marketing efficiency is a way to increase the social welfare by generating income for the local producers and value chain actors and by prompting its sustained use.

The extent of integration in markets gives the government a direction on how to formulate policies of providing infrastructure and regulatory services to avoid exploitation [17]. Price behavior along supply chains is an important indicator of overall market performance [18]. Markets that are not integrated will convey inaccurate price information capable of distorting the marketing decisions of food marketers and contribute to inefficient product movements [8].

Co-integration and unit roots

The use of ordinary least square (OLS) regression to estimate price integration has the shortcoming of assuming that data series are stationary when it is known that most agricultural time series data tend to be non-stationary. Also, the OLS is unable to give the short- and long-run adjustments. Thus, fitting OLS to non-stationary data may result in spurious regression estimates [12,19]. To avoid these problems, co-integration analysis is used to check for the relationship among prices in different levels. When a long-run linear relation exists among different price series, these series are said to be co-integrated. A prerequisite for undertaking co-integration tests is to verify that the series is non-stationary and to ascertain integration order of variables. The most commonly used test for determining whether or not a series is non-stationary is the Augmented Dickey-Fuller (ADF) unit root test. In this test, a null hypothesis is imposed that the data are non-stationary (that is contain a unit root) against the alternative hypothesis of being a stationary variable. Differencing a non-stationary variable generally results in a stationary variable. If a series is differenced d times before it becomes stationary, thus containing d unit roots, it is said to be integrated of order d and is denoted $I(d)$. Variables that are stationary in their levels that is $I(0)$ should be discarded from co-integration analysis as they at most show trivial integration [20]. In most cases, it is not strictly necessary for all the variables in question to have the same order of integration.

Another important implication of co-integration is that co-integration between two variables implies the existence of causality (in the Granger sense) between them in at least one direction. Co-integration itself cannot be used to make inferences about the direction of causation between variables, and thus causality tests are necessary. Proposed an empirical definition of causality based only on its forecasting content as follows. If xt causes yt then yt+1 is a better forecast if the information in xt is used, since there will be a smaller variance of forecast error. More so, if two markets are integrated, the price in one market, $p1$, would commonly be found to Granger cause the price in the other market, $p2$ and/or vice versa. Therefore, Granger causality provides additional evidence as to whether, and in which direction, price integration and transmission is occurring between two price series or market levels [18]. In line with this, Granger causality test was executed in this study to make inferences about the direction of causation between the prices series involved.

Review of past studies

Several studies on market integration of agricultural products have been carried out which included [12,21,22], in their study, examined the extent and degree of price integration in the Nigerian rice markets. They reported that the markets for local rice are generally integrated while markets for imported rice are characterized with some imperfections. Price integration was only discovered between markets that are close to the source of imported rice. This, according to [21,22], may be due to the fact that most of these other markets are serving as secondary markets, hence the non-integration of those markets. Also, no interaction was found between imported and local rice markets indicating that the markets for the two rice types are highly segregated [12].

In his study of spatial equilibrium, market integration and price exogeneity in dry fish marketing in Nigeria, reported that there is a low level of price integration in dry fish marketing in Nigeria as only 59.0%

of market pairs examined had prices tied together in the long run and thus exhibit efficiency in price formation and transmission in relation to supply-demand situation. This reflects the low level of economic development in the country and the need for a national policy to improve dry fish marketing.

Akintunde [22], in a study on long run price integration in food grain marketing in Osun State of Nigeria reported that none of the market locations studied had prices tied together in the long run. The index of market connection (IMC) obtained indicated that the market also exhibited low short-run market integration. The study concluded that agricultural marketing in the state showed a high degree of marketing inefficiency and a statewide policy to improve food marketing efficiency was recommended.

Research Methodology

Study area

The area under study is the Federal Republic of Nigeria since the secondary data used covered the six geo-political zones. Nigeria is located in West Africa and lies between longitudes 3° and 14° East and latitude 4° and 14° North. Nigeria has a land area 923,768 square kilometres and stretches 1605 km from the north to the south and 767 km from the east to the west. Nigeria is bounded on the west by the Republic of Benin, on the east by the Republic of Cameroon, on the north by Niger and Chad Republics and on the south by the Gulf of Guinea and the Atlantic Ocean. It has a population of about 141 million people in 2006 [23] which are projected to have grown to 167 million in 2011.

Method of data collection

Secondary data were used for this study. The secondary data on retail prices of beef were sourced mainly from published documents of National Bureau of Statistics while some missing data about (5%) were unpublished data from the Federal Department of Livestock Services.

Sampling, sampling techniques and data collected

Monthly retail prices covering between January, 1997 and December, 2010 inclusive (i.e 168 months) were obtained for twelve spatial markets located in 12 state capitals across the six geo-political zone of Nigeria. Two state markets were selected per zone and price series data were collected for the biggest beef market in the state capital. The states included Ondo, Oyo, Edo, Rivers, Enugu, Imo Kwara, Benue, Sokoto, Kaduna, Bauchi and Borno states for South-west, South-south, South-east, North-central, North-west and North-east zones, respectively.

Analytical tools

The data collected for this study were analyzed using the following analytical tools.

Market integration and measurement

(a) Test for stationarity: A series is said to be stationary if the means and variance remain constant over time [13]. It is referred as I(0), denoting "integrated of order zero." A stationary series tends to constantly return to its mean value and fluctuations around this mean value have broad amplitudes, hence the effect of shocks is at most, transient. Other attributes of stationary and non-stationary data and their implications in econometric modelling can be found fully treated by [19,24,25]. The first step in the test for co-integration is to investigate the order of stationarity or econometric integration to avoid spurious relationship. Augmented Dickey Fuller (ADF) unit root test of stationarity was used in this study for its simplicity and ease of interpretation of results. The DF test is applied to the regression of the form below;

$$\Delta P_{it} = \beta_1 + \beta_{2t} + \delta P_{it-1} + \ell_{it} \quad (1)$$

Δ=first difference operator

P_{it}=beef price series being investigated for stationarity

t=time or trend of variable

The null hypothesis that δ=0 implies existence of a unit root in P_{it} or that the time series is non- stationary. If the need arises to increase the number of lagged difference terms in the equation above, then, the DF test, is now termed the ADF test and equation (1) modified to:

$$\Delta P_{it} = \beta_1 + \beta_{2t} + \delta P_{it-1} + \alpha_1 \sum_{t=i}^{m} \Delta P_{it-1} + \ell_{it} \quad (2)$$

The null hypothesis of a unit root or non-stationary is still that δ=0. The critical values which have been tabulated by [26,27] are always negative and are called ADF statistics rather than t-statistics. If the value of the ADF statistics is less than (i.e. more negative than) the critical values, it is concluded that P_{it} is stationary i.e. p_{it} ~I (0). When a series is found to be non-stationary, it is first differenced (i.e. the series $\Delta P_{it}=P_{it}-p_{it-1,}$ is obtained and the ADF test is repeated on the first-differenced series. If the null hypothesis of the ADF test can be rejected for the first-differenced series, it is concluded that P_{it} ~ I(1). The price series for all the twelve states included in this study were investigated for their order of integration. The optimal lag length for each of the price series was selected using Akaike Information Criterion (AIC).

(b) Co-integration test: Two or more variables are said to be co-integrated if each is individually non-stationary (i.e. has one or more units roots) but there exists a linear combination of the variables that is stationary [5,12]. Other attributes of co-integration are as shown in [27,28]. After the stationarity test, the study proceeded to test for co-integration between market price series that exhibited stationarity of the same order. The maximum likelihood procedure for co-integration propounded by [29-31] was utilized. This method was preferred because the two-step Engle and Granger procedure faces the problem of simultaneity thus rendering the results to sensitive the dependent variables included in the model specified [17]. To circumvent the simultaneity problem created and permit rule of decision on the co-integration vector, r, the one-step vector auto-regression method is preferred. The maximum likelihood procedure relies on the relationship between the rank of a matrix and its characteristic root. The Johansen maximal eigen value and trace tests reveal the number of co-integration vector(s) that exist(s) between two or more time series that are econometrically integrated. The variable system was modelled as a vector auto-regression (VAR) as follow:

$$\Delta X_t = \mu_t + \sum_{i=1}^{k=1} \Gamma_i \Delta X_{t-i} + \pi X_{t-k} + \varepsilon_t \quad (3)$$

Where

X_t is an nx1 vector containing the series of interest (beef spatial price series)

Γ and π are matrices of parameters

K=number of lags and should be adequately large enough to capture the short-run dynamics of the underlying VAR to obtain normally distributed white noise residuals

ε_t=vectors of errors assumed to be white noise.

(c) Test for causality: When two series are stationary of the same order and co-integrated, one needs to conduct test for causality since there must be at least one Granger-causal relationship when there is a group of co-integrated series [5,12,32-34]. The causality test is represented by the error correction equation below:

$$\Delta P_{it}=\beta_o+\beta_1+P_{i(t-1)}+\beta_{2j(t-1)}+\sum_{k=1}^{m}\delta_k\Delta P_{i(t-k)}+\sum_{k=1}^{m}\alpha_h\Delta P_{j(t-h)}+\ell t \qquad (4)$$

Letters m and n denote numbers of lags determined by Akaike Information Criterion. Rejection of the null hypothesis (by a suitable F-test) that $\alpha_h=0$ for h=1, 2 ...n and β=0 indicates that prices in market j Granger cause prices in market i. If prices in i also granger prices in j, the price determination is through a simultaneous feedback mechanism, which is termed bidirectional Granger-causality. If the Granger-causality is a one way or called uni-directional type, the market which Granger-causes the other is called the exogenous market.

Results and Discussion

Average growth rates in beef prices

Analysis of the data on retail prices showed that growth rate was highest in 2002 in most of the selected market centres. Table 1 showed that growth was highest in Benue in 2002 (99.7%) followed by Sokoto (95.41) in 2009 and Imo (54.92%) in 2002. In 2001 growth rates was generally stable with the exception of Kwara. The lowest growth rates was recorded in Benue (-35.1%) and Imo (-14.5%) in 2003. The average growth rates of the entire period of observation was highest in Borno (17.43%), followed by Sokoto (16.02%) and Bauchi (15.64%) but was least in Lagos (11.32%).

Comparing prices in the producing areas with those in the consuming areas, indications are that growth in retail prices was higher in the producing areas than in the consuming areas. For example, the average growth rate was 15.33% in the producing areas while it was 13.58% in the consuming areas.

Going by this trend of high average growth rate in retail prices, there appears to be some dangers in the beef market. Given the stable wages/salaries and the increasing inflation in the Nigeria, there would be reduced purchasing power and decreasing welfare of the citizens. However, the general stability in prices observed in 2001 may be a good development on the part of consumers, marketers and producers. The negative growth experienced in some locations while becoming an advantage to consumers may constitute a disincentive to consumers. This development may not be healthy for the beef industry considering the increasing demand for beef that local producers are struggling to meet.

Average retail price

Four markets recorded the highest monthly retail price as shown in Table 2. They are Imo, Rivers, Lagos and Enugu. This finding is however not surprising as these states are located in the southern part of the country which are very far from the main cattle producing regions.

Thus, the cost of arbitraging must have been factored into the final retail price as observed for fresh fish by [5]. Another pertinent cause of this, as earlier reported in a study on fresh fish by [5] might be the fact that the markets in these states are cited in highly urbanized and industrialized towns/cities accommodating the elites and high income earners who sufficient purchasing power to spend a large chunk of their income on beef as a reputed animal protein source. It is a well known fact that in towns/cities accommodating elites and high income earners, there is usually a numerous arrays of social functions especially during weekends and festive periods where beef meat is mostly served. This may have led to pressure on demand for beef in these states with the consequence being jacking up of prices.

It is however surprising that Lagos has a price lower than Imo and Rivers. Considering the population and industrialization status of Lagos State in comparison with Imo and Rivers, this finding becomes puzzling. The market locations with the lowest mean retail prices were Sokoto, Borno, Bauchi and Kwara (in descending order). The fact of having the lowest average market prices in Sokoto and Borno Markets is understandable considering the fact that these markets are located in states which share boundaries with Cameroon, Chad and Niger republics where massive illegal (cross border) importation of cattle into the country are taking place because of the porous nature of the borders with these countries. Such illegal trades have been reported by [10]. This cross border trade may definitely have impacted on beef prices in these markets culminating in excessive supply of the products thus reducing competition on pricing of cattle and consequently beef. The case of low average retail price in Borno is further justified when one remembers that a lot of fresh fish from Lake Chad are produced which could provide an alternative for consumers of beef. The availability of fish as a substitute may have crashed the price of beef. Above all, it is noteworthy that all the markets with very low mean prices (except

Year	Bauchi	Borno	Benue	Edo	Enugu	Kwara	Imo	Lagos	Kaduna	Ondo	Sokoto	Rivers
1997												
1998	3.82	2.9	-10.8	16.53	9.785	7.876	5.108	-10.99	9.589	-3.498	2.691	-1.963
1999	8.34	0.56	12	7.162	4.91	5.118	21.45	-1.138	5.478	-5.316	-0.048	5.616
2000	35	1.01	17.3	14.11	-3.58	4.495	-1.633	4.293	7.566	16.93	6.015	11.69
2001	0	0	0	0	0	21.06	0	0	0	0	0	0
2002	19.8	87.2	99.7	26.59	43.14	4.128	54.92	39.9	20.75	26.25	35.81	6.85
2003	1.73	21.1	-35.1	5.043	11.61	43.41	-14.15	17.89	12.68	15.85	-1.542	16.64
2004	53.3	23.1	23.9	19.09	33.1	30.21	41.33	22.86	26.26	32.38	53.66	34.46
2005	-14	7.65	9.54	22.13	-2.332	7.263	16.87	15.39	17.16	3.722	6.543	31.03
2006	38.7	20.7	31.7	19.65	26.52	-6.542	-0.785	1.966	2.718	7.577	15.86	3.325
2007	-0.7	-5.47	36.7	8.077	7.827	16.17	39.41	21.15	-4.549	0.144	-7.584	6.074
2008	20.9	48.8	-3.95	1.982	11.6	12.87	3.712	3.609	31.66	19.17	5.737	29.71
2009	31.5	13.6	22.3	37.12	37.64	45.8	27.09	34.49	22.53	44.75	95.41	10.38
2010	5.13	5.39	2.41	15.66	4.658	-0.11	8.09	-3.531	0.548	-0.034	-4.296	7.67
AVG.	15.64	17.43	15.83	14.85	15.22	15.32	15.49	11.32	11.72	12.15	16.02	12.42

Table 1: Average growth rates in retail price of beef in Percentage (1997-2010).

Market Location	Retail Price (₦/KG)	Coefficient of Variation (CV)
Bauchi	373.27	56.1127
Borno	342.90	63.8404
Benue	388.97	54.9668
Edo	386.91	56.2661
Enugu	393.23	57.8058
Kwara	377.58	54.4813
Imo	435.46	53.5822
Lagos	397.58	49.0292
Kaduna	388.89	47.1146
Ondo	379.93	50.7331
Sokoto	317.19	62.4884
Rivers	406.09	53.3685
Overall Average	382.33	54.9808

Table 2: Beef Average Retail Prices and Its Variability (1997-2010).

Variable (Market Price Series)	Price Level I(0) *ADF* Statistic	First Difference I(1) ADF Statistics	Order of Integration
Bauchi	-0.2940(3)NS	-9.2490(2)S	I(1)
Benue	-0.3425(4)NS	-8.8537(3)S	I(1)
Borno	-0.0384(2)NS	-11.8778(1)S	I(1)
Edo	0.6949(3)NS	-10.2918(2)S	I(1)
Enugu	-1.3785(7)NS	-6.8626(6)S	I(1)
Kwara	-0.7489(3)NS	-9.312525(2)S	I(1)
Imo	-0.9696(1)NS	-14.5672(0)S	I(1)
Kaduna	-0.0944(4)NS	-8.9406(3)S	I(1)
Lagos	-0.5739(2)NS	-12.2520(1)S	I(1)
Ondo	0.2405(2)NS	-11.9466(2)S	I(1)
Rivers	-0.8399(3)NS	-8.9466(2)S	I(1)
Sokoto	-0.1267(3)NS	-10.5476(2)S	I(1)

Notes:

1. Critical values are -3.4722, -2.8829 and -2.5782 at the 1%, 5% and 10% confidence levels, respectively.
2. The number in parenthesis indicate the optimal number of lags as dictated by the Akaike Information Criterion.
3. If the absolute value of ADF is lower than the 5% critical ADF statistic, we fail to reject the null hypothesis of non-stationarity.
4. NS means non stationary and S means stationary

Table 3: Result of Test for Stationarity.

Ondo) are located in the northern regions of the country. Thus, the implication of the findings on average retail prices is that transportation cost can be said to be an important component of final retail prices for beef in the Nigerian market.

Variability in average retail prices

Variability in average monthly retail price as shown in Table 2 was somewhat high for the period under consideration. It varied between 47.1 percent for Kaduna to 63.8 percent for Borno. It is generally known that a high variability index indicates that the prices of beef fluctuate greatly within the period and markets analyzed. According to [12,21] high variability in prices leads to unstable producer incomes which adversely affect production planning with negative effect on consumers' welfare. Commodity consumers cannot effectively plan their expenditure with high degree of expectation that prices are not likely to deviate from their prevailing levels.

Test of stationarity

The result of unit root test by the ADF method is shown in Table 3. The price series in all the markets accepted the null hypothesis at their levels at 5% significance level. When first differenced, however, the null hypothesis of non-stationarity was rejected in favour of the alternative in all the markets. This observation is in consonance with earlier findings that food commodity price series are mostly stationary of order 1 i.e I (1) [12,32,35]. The result is probably explained by the fact that most food prices series have trends because of inflation and they therefore exhibit mean non-stationarity thus requiring first differencing to become stationary [5,12]. The economic implication of stationary variables is that if there is a disturbance in such variables, the variable will revert back to equilibrium level at the same rate. In other words, stationarity helps to surmount the problems of spurious regression.

Since the entire variables (price series) are integrated of order one I(1), then it is generally true that any linear combination of these variables will also be I(1). This enables one to proceed to the co-integration tests with all these variables.

Co-integration test (Johansen Maximum Likelihood test)

Results from two tests of co-integration (Maximal Eigen value and Trace Tests) are shown in Table 4. Out of the 66 ($^{12}C_2$) market pairs investigated for co-integration, 48 rejected the null hypothesis of co-integration at less than full rank at the 5% level of significance. These 48 market pairs accepted the alternative hypothesis that there is full rank in the co-integrating vector. Thus, by the co-integration analysis, 72.7% of beef market pairs were co-integrated of the order (1). These beef market pairs have prices that are tied together in the long run. It can thus be concluded that there is a high long run equilibrium relationship in the Nigerian beef market.

According to [5,12], the long run notion of equilibrium in market price series has, in recent time, become more important to development economists because markets with price series that are stationary at same order and co-integrated are those capable of exhibiting economic integration. Modern developments in econometrics have shown that such series cannot wander in different directions without bounds and hence, the existence of long run equilibrium between them [5,12,19,28,33]. The more direct conclusion from this result is that there is perfect transmission of price information in 9 of every 12 markets for beef pairs in Nigeria. When there is perfect transmission of price information in a network of markets, producers, marketers and consumers will realize the appropriate gains from the trade because correct price signals will be transmitted down the marketing chain thus enabling producers to specialize according to comparative advantage [5].

Markets that are not economically integrated will convey inaccurate price information that has the tendency to distort production and marketing decisions and contribute to inefficient product movements. According to [5], if markets are integrated, the price differentials and spread between markets cannot exceed transfer costs. The arbitrage activities of traders who ship commodities between high and low price locations will raise price in some markets whilst lowering them in others until price differentials equal transfer costs and all opportunities for earning excess profit have been exhausted [17]. In short, if getting prices right is seen as the crucial policy prescription for agricultural (and marketing) development, the presence of market integration is a vital precondition for it to be effective [12,15].

Granger causality test

The result of the pair-wise Granger causality is shown in Table 5. Out of the 94 market pairs tested for Granger causality, 80 pairs rejected the null hypothesis of no causality. Sixty two (62) market links

Market pairs P_i-P_j	Maximal eigen value test			Trace statistics Test		
	Hypothesis		Test statistics	Hypothesis		Test statistics
	Null	alternative		Null	Alternative	
Bau-Bor	r ≤ 2	r=2	29.8131	r ≤ 2	r=2	29.9257
Bau-Edo	r ≤ 2	r=2	23.4420	r ≤ 2	r=2	23.4589
Bau-Enu	r ≤ 2	r=2	26.2977	r ≤ 2	r=2	29.2997
Bau-Kwa	r ≤ 2	r=2	16.7269	r ≤ 2	r=2	17.5534
Bau-Imo	r ≤ 2	r=2	22.6681	r ≤ 2	r=2	22.9950
Bau-Kad	r ≤ 2	r=2	17.4683	r ≤ 2	r=2	17.6081
Bau-Lag	r ≤ 2	r=2	19.0884	r ≤ 2	r=2	20.2592
Bau-Ond	r ≤ 2	r=2	21.7329	r ≤ 2	r=2	21.8448
Bau-Riv	r ≤ 2	r=2	21.9809	r ≤ 2	r=2	23.0071
Bne-Bor	r ≤ 2	r=2	19.0529	r ≤ 2	r=2	19.2497
Bne-Edo	r ≤ 2	r=2	15.3337	r ≤ 2	r=2	15.4894
Bne-Enu	r ≤ 2	r=2	14.9299	r ≤ 2	r=2	15.0331
Bne-Imo	r ≤ 2	r=2	19.9829	r ≤ 2	r=2	20.1650
Bor-Edo	r ≤ 2	r=2	21.1327	r ≤ 2	r=2	21.3278
Bor-Enu	r ≤ 2	r=2	44.1648	r ≤ 2	r=2	44.3712
Bor-Kwa	r ≤ 2	r=2	25.2010	r ≤ 2	r=2	25.2460
Bor-Imo	r ≤ 2	r=2	19.8810	r ≤ 2	r=2	19.8528
Bor-Kad	r ≤ 2	r=2	26.5991	r ≤ 2	r=2	26.6270
Bor-Lag	r ≤ 2	r=2	16.7425	r ≤ 2	r=2	16.8831
Bor-Ond	r ≤ 2	r=2	27.0938	r ≤ 2	r=2	27.1197
Bor-Riv	r ≤ 2	r=2	17.5812	r ≤ 2	r=2	27.1197
Bor-Sok	r ≤ 2	r=2	19.0123	r ≤ 2	r=2	19.1886
Edo-Enu	r ≤ 2	r=2	33.8168	r ≤ 2	r=2	33.6690
Edo-Imo	r ≤ 2	r=2	26.0704	r ≤ 2	r=2	26.2920
Edo-Kad	r ≤ 2	r=2	28.9177	r ≤ 2	r=2	28.8009
Edo-Riv	r ≤ 2	r=2	15.8551	r ≤ 2	r=2	16.1889
Edo-Sok	r ≤ 2	r=2	20.5734	r ≤ 2	r=2	20.8389
Enu-Kwa	r ≤ 2	r=2	19.3990	r ≤ 2	r=2	19.3994
Enu-Imo	r ≤ 2	r=2	30.5026	r ≤ 2	r=2	30.6433
Enu-Lag	r ≤ 2	r=2	17.4720	r ≤ 2	r=2	17.5558
Enu-Ond	r ≤ 2	r=2	21.9477	r ≤ 2	r=2	22.1711
Enu-Sok	r ≤ 2	r=2	18.6177	r ≤ 2	r=2	18.7628
Kwa-Imo	r ≤ 2	r=2	21.6094	r ≤ 2	r=2	22.4697
Kwa-Kad	r ≤ 2	r=2	29.7928	r ≤ 2	r=2	30.2812
Kwa-Lag	r ≤ 2	r=2	17.4367	r ≤ 2	r=2	34.0530
Kwa-Ond	r ≤ 2	r=2	33.8706	r ≤ 2	r=2	34.0530
Kwa-Sok	r ≤ 2	r=2	16.7782	r ≤ 2	r=2	17.4493
Imo-Kad	r ≤ 2	r=2	21.3024	r ≤ 2	r=2	21.8395
Imo-Lag	r ≤ 2	r=2	19.3949	r ≤ 2	r=2	20.2671
Imo-Ond	r ≤ 2	r=2	16.4852	r ≤ 2	r=2	16.6233
Imo-Riv	r ≤ 2	r=2	17.8910	r ≤ 2	r=2	18.4231
Imo-Sok	r ≤ 2	r=2	15.5850	r ≤ 2	r=2	15.7651
Kad-Lag	r ≤ 2	r=2	17.4772	r ≤ 2	r=2	17.6753
Kad-Ond	r ≤ 2	r=2	29.8748	r ≤ 2	r=2	29.9862
Kad-Riv	r ≤ 2	r=2	17.8910	r ≤ 2	r=2	18.4231
Kad-Sok	r ≤ 2	r=2	23.2883	r ≤ 2	r=2	23.0541
Lag-Riv	r ≤ 2	r=2	30.6164	r ≤ 2	r=2	30.7841
Ond-Sok	r ≤ 2	r=2	30.6164	r ≤ 2	r=2	30.7841

Note:

1. only the 48 market links with significant parameters are shown.
2. r=number of co-integration vectors.
3. *means significant at 5% level.
4. The 95 percent critical values are 14.2646 and 15.4947 for Eigen maximal value and Trace tests, respectively.

Table 4: Result of Co-integration Test.

of the 80 exhibited bi-directional Granger causality. The market pairs showing price linkages are highlighted in Table 5. The remaining 18 market pairs exhibited uni-directional (one way) Granger causality.

S/N	Null hypothesis	F value	P value	Causality type
1	Bor -→ Bau	20.4028	0.0000**	Uni-directional
2	Edo -→ Bau	7.4014	0.0009**	Bi- directional
3	Bau → Edo	12.2587	0.0000**	
4	Enu -→ Bau	6.2505	0.0025**	Bi-directional
5	Bau -→ Enu	12.3363	0.0000**	
6	Kwa -→ Bau	5.3236	0.0061**	Bi - directional
7	Bau -→ Kwa	21.3526	0.0000**	
8	Bau —→ Imo	4.5983	0.0120*	Bi - directional
9	Imo -→ Bau	4.1609	0.0180*	
10	Kad -→ Bau	8.2810	0.0004**	Uni-directional
11	Bau -→ Lag	3.8278	0.0242*	Bi- directional
12	Lag —→ Bau	9.2142	0.0002**	
13	Ond-→ Bau	14.2502	0.0000**	Bi –directional
14	Bau -→ Ond	4.8572	0.0092**	
15	Riv -→ Bau	6.3967	0.0022**	Bi –directional
16	Bau -→ Riv	6.8794	0.0014**	
17	Bne -→ Bor	7.6934	0.0007**	Bi –directional
18.	Bor -→ Bne	5.8358	0.0036**	
19	Bne -→ Edo	8.2210	0.0004**	Bi –directional
20	Edo -→ Bne	7.1449	0.0011**	
21	Bne —→ Enu	4.4076	0.0137*	Bi -directional
22	Enu -→ Bne	7.0860	0.0011**	
23	Bne-→ Imo	4.5949	0.0118*	Bi –directional
24	Imo-→ Bne	3.6631	0.0284*	
25	Bor -→ Edo	9.6782	0.0375*	Bi –directional
26	Edo -→ Bor	3.3574	0.0001**	
27	Bor -→ Enu	21.8690	0.0000**	Uni – directional
28	Kwa -→ Bor	4.6344	0.0114**	Bi –directional
29	Bor-→ Kwa	13.8484	0.0000**	
30	Bor -→ Imo	5.8662	0.0167*	Bi – directional
31	Imo -→ Bor	4.2353	0.0037**	
32	Bor -→ Kad	18.5337	0.0000**	Uni-directional
33	Bor -→ Lag	8.6591	0.0003**	Bi – directional
34	Lag -→ Bor	3.2172	0.0432*	
35	Ond -→ Bor	4.7809	0.0099**	Bi – directional
36	Bor-→Ond	17.8370	0.0000**	
37	Bor-→ Sok	13.3949	0.0000**	Uni- directional
38	Bor -→Riv	7.3529	0.0009**	Uni – directional
39	Enu -→ Edo	5.0838	0.0072**	Bi – directional
40	Edo-→ Enu	20.0858	0.0000**	
41	Edo -→ Imo	6.6888	0.0017**	Bi - directional
42	Imo-→ Edo	3.9212	0.0223*	
43	Edo – Kad	6.9107	0.0014**	Bi – directional
44	Kad -→ Edo	16.6338	0.0000**	
45	Riv -→ Edo	2.5518	0.0002**	Uni- directional
46	Edo -→ Sok	6.5586	0.0018**	Bi – directional
47	Sok-→ Edo	4.9742	0.0080**	
48	Kwa -→ Enu	3.3574	0.0377*	Bi – directional
49	Enu -→ Kwa	7.6131	0.0007	
50	Imo -→ Enu	3.5646	0.0312*	Bi – directional
51	Enu -→ Imo	17.0346	0.0000*8	
52	Lag -→ Enu	10.5899	0.0000**	Bi – directional
53	Enu -→ Lag	3.4751	0.0336*	
54	Ond -→ Enu	11.7697	0.0000**	Uni-directional
55	Enu -→ Sok	7.8162	0.0006**	Bi – directional
56	Sok -→ Enu	3.3932	0.0361*	

Summary, Conclusion and Recommendation

Summary and conclusion

This study examined price fluctuations, market linkage and

57	Kwa -→ Imo	3.9728	0.0214*	Bi- directional
58	Imo -→ Kwa	3.0995	0.0487*	
59	Kad -→Kwa	37.5022	0.0000**	Bi – directional
60	Kwa -→ Kad	3.6468	0.0288*	
61	Lag -→ Kwa	14.0963	0.0000**	Uni – directional
62	Ond -→ Kwa	18.2373	0.0000**	Uni – directional
63	Riv -→ Kwa	10.3594	0.0000**	Uni-directional
64	Kwa-→ Sok	6.8353	0.0015**	Uni – directional
65	Kad -→ Imo	13.0143	0.0000**	Uni – directional
66	Lag -→ Imo	1.2822	0.0001**	Uni – directional
67	Imo -→ Ond	3.8505	0.0239*	Bi – directional
68	Ond -→ Imo	8.4261	0.0004**	
69	Riv -→ Imo	8.8221	0.0003**	Uni – directional
70	Imo -→ Sok	3.7608	0.0259*	Bi- directional
71	Sok-→ Imo	3.3370	0.0387*	
72	Kad -→Lag	7.1436	0.0011**	Bi – directional
73	Lag -→ Kad	6.3272	0.0024**	
74	Kad -→ Ond	10.2176	0.0000**	Bi – directional
75	Ond -→ Kad	9.5586	0.0001**	
76	Kad -→ Riv	7.6179	0.0007**	Bi – directional
77	Riv -→ Kad	5.8120	0.0038*	
78	Kad -→ Sok	25.6180	0.0000**	Uni – directional
79	Lag -→ Riv	7.5063	0.0008**	Uni – directional
80	Ond -→ Sok	14.3441	0.0000**	Uni – directional

Notes:

1. Only the 80 market links with significant parameters are shown.
2. Market pairs with same level of significance indicate bi–directional Granger-Causality. Where only one market pair carried a sign of significance, there is exogenity in favour of the former market.
3. A maximum of two lags were used in the augmentation.
4. Horizontal arrows between two market pairs indicates that price in the market to which the arrow is pointing does not Granger cause price in the other market.

Table 5: Result of Pair-wise Granger Causality Test for Beef Markets (1997-2010).

leadership in beef marketing in Nigeria. The Johansen co-integration model was used to determine whether or not long run equilibrium relationship exists between prices for beef markets selected across the country. The Granger-causality model helped to identify beef markets that assume leadership positions in price formation and transmission. Variability in average monthly retail price varied between 47.1% for Kaduna Market to 63.8% for Borno Market with the overall average variability recorded in the study area for the period covered by the data being 54.9%. Results of average growth rate showed that with the exception of Kwara Market, prices were generally stable in 2001 in all the markets studied. However, there was high growth rates in the retail price of beef in the period studied. This has the tendency to negatively impinge on consumers' welfare. Results of unit root test showed that all of the price series were stationary at first difference. When co-integration tests were applied, 72.7% of the market pairs had prices which were tied together in the long run showing that there is long run co-integrating relationship between markets for beef while the balance of 27.3% was not co-integrated. This could have been caused by factors such as poor road infrastructures. Results of Granger causality test did not reveal any significant causality link between the peripheral and central markets, suggesting that there are no clear trends in price leadership.

Recommendations

There is need to strengthen the existing market information system in Nigeria as a policy option for improving beef pricing and pricing efficiency. The government should, as a matter of urgency, declare emergency in road construction and rehabilitation to help ameliorate the challenge of poor road infrastructure, while at the same time resuscitating the moribund railway transportation to provide a cheap alternative means of transport to marketers and their merchandise. Government should tighten the porous borders of the nation to arrest the huge loss of revenue resulting from illegal importation of cattle into the country and therefore reduce unhealthy competition that may arise from beef pricing.

Efforts to boost beef marketing in Nigeria will need to incorporate policy measure that will improve transportation infrastructure and basic facilities in rural and urban markets. There is a need as well to improve price information system in the markets.

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