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RESEARCH ARTICLE

Price Discovery and Price Volatility of Vertical Integrated Cowpea Market (Rural-Urban) In Niger State of Nigeria

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ABSTRACT

The present study focused on price discovery and volatility of cowpea in the three major urban markets and their respective adjunct rural markets across the zones in Niger state of Nigeria. Monthly time series data spanning from January 2003 to December 2016 were used for the present study. GARCH and SUR were the models used to analyze the data. The results indicated that Bida market and its adjunct rural market (Lefane market) were found to be more efficient in marketing than their counterparts as evident from the cyclical trends of their respective seasonal pattern which were less pronounced. Also, the relationship between the urban market price and rural market price in terms of price discovery revealed non-occurrence of hedging in almost all the market periods, with neither urban nor rural market dominating the process of price discovery, thus, indicating the efficient performance of trading in cowpea by both markets. The extent of volatility in prices of cowpea due to trading was persistent in Kontagora market, and explosive in Bida and Minna markets due to some arbitrage activities in the latter markets. Therefore, the study recommends the strengthening of physical infrastructure, use of information and communication technology and well-defined transparent agricultural policy-market measures in the state that will help in the development of the single uniform economic market in the region in particular and country in general.

Keywords: Price discovery; volatility; seasonal pattern; cowpea market; Nigeria

INTRODUCTION

In considering changes in the prices of agricultural commodities, it is imperative to distinguish between changes in trend and mere fluctuations. Changes in trend occur over medium- or long-term periods and are due to structural alterations in the factors affecting supply and demand – in this case food, while volatility, is a technical concept, which refers to changes in rates of price variation over successive periods of time. There is a great deal of volatility when prices are rising and falling frequently. This new round of price increases has focused attention on the issue of volatility and its causes, much more so than during the cycle of increases in the past periods. Two important questions emerge in the current context: how much of this increase can be associated with volatility created by short-term factors, and how much do prices converge at a higher level due to structural factors; with respect to volatility, what is the role of factors such as speculation in the markets of agricultural commodities, uncertainty regarding the pace of the recovery of the economy, the application of measures designed to restrict trade, the declining value of the naira, the over-reaction of the agents in the markets to announcements of lower than expected harvests, among others.

The current high volatility in the agricultural commodities markets has important economic implications for Nigeria where cost of living and malnutrition is very high. Sadiq *et al.*(2016) reported that volatility in the prices of agricultural commodities has always been higher than that of manufactured products. Consequently, dependence on the subsistence farming which accounts for the marketable surplus is a fundamental cause of instability in the national

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terms of trade, thus makes the country more vulnerable economically. Volatility in the prices of agricultural commodities can have serious consequences on rural and national economy of the country: losses in economic efficiency, increased food insecurity, more malnutrition, and negative impacts on their trade balance, possible social unrest and greater risks for producers, especially small-scale producers, due to uncertainty regarding expected levels of income. However, there exists a broad range of policy instruments available for government institutions to address volatility issue. Though, the ability to apply them will be determined by the level of development of the institutions, the existence of the necessary technical expertise and the commitments they have assumed under trade agreements. In addition, some instruments that may be useful in the short term may not be in the long term. One of the major challenges facing the country, therefore, is to effectively combine policy instruments, taking into account the current international context and social and production-related conditions in each state, addressing short-term problems without losing sight of the long-term, and considering any international commitments assumed and budget constraints faced. The objective of the present research is to provide answers to these questions in order to serve as input for a discussion on them. However, literature showed similar studies conducted in other parts of the globe (Zhong *et al.*, 2004; Zapata *et al.*, 2005; Easwaran and Ramasundaram, 2008; Sendhil *et al.*, 2013; Burak *et al.*, 2013; Achal *et al.*, 2015; Bhavani *et al.*, 2015; Sadiq *et al.*, 2016) with no evidence of any study conducted in Nigeria, thus, the reason for this attempt. The objectives of the study were to determine:

1. Determine the temporal market price behavior of cowpea in the study area;
2. Determine the efficiency of rural and urban cowpea market with respect to price discovery in the study area.;
3. Determine the source and extent of price volatility in the selected cowpea market; and,
4. Determine the cowpea price formation in the short-run.

RESEARCH METHODOLOGY

The study made use of monthly time series data spanning from January 2003 to December 2016 of one major urban cowpea market with its respective one major adjunct rural market in each of the three zones cutting across the state. The chosen urban adjunct rural (urban – rural) markets were Bida- Lafene, Minna – Zungeru and Kontagora – Manigi. The data were obtained from Niger State Bureau of Statistics (NIBS). Inferential statistic was used to achieve the stated objectives: objective I was achieved using ordinary least square model, 12 month centre moving average and intra-year price variation indexes; objective II was achieved using Seemingly Unrelated regression model; and objectives III and IV were achieved using GARCH and Index market connection (IMC) models, respectively. The analytical tools used are given below:

Ordinary Least Square (OLS) model

Trend component of time series was calculated by using least square equation:

$P_t = \alpha_0 + \beta T_t + \varepsilon_t$……………………………….. (1)

Where,

P_t = Price during the year‘t’;

T = serial number assigned to the t^{th} year;

ε_t= random disturbance term with usual assumptions;

α= intercept value; and,

β = slope.

Percentage of Centered 12-Month Moving Average Method

This method is also termed as percentage of moving average or just moving average method. It differs from the percentage of-trend method in the sense that the original prices are expressed as percentages of the moving averages instead of percentages of trend values. This method is a good estimate of the trend and cyclical components combined. Therefore, ratio-to-moving average provides an index of seasonal and irregular components combined because

$$\frac{P_t}{MA_t} = \frac{T\times C\times S\times I}{T\times C} \times 100 = (S\ X\ I)$$ ……………………….. *(2)*

Where P_t is an observation on price index for period *t*, MA_t is moving average at period *t*, *T* is trend component, *C* is cyclical component, *S* is seasonal component and *I* is irregular component.

Averaging this over years and adjustment through correction factor provides a better estimate of seasonal index.

$K = 1200/S$………………………………….. *(3)*

Where *K* is the correction factor and *S* is the sum.

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Intra-Year Price Variation indexes

One of the objectives of construction of seasonal price indices is to assess the extent of intra-year price variation and quite often the interest is in knowing whether this variation has changed over time and whether it differs between markets. The following approaches can be used to precisely measure the intra-year price variation:

1. Extent of intra-year price rise (IPR): The prices of most agricultural commodities usually remain the lowest in the harvest season and rise thereafter till they reach the highest level in the next pre-harvest season. The extent of this price rise is termed as intra-year price rise. One way of measuring this price rise is to compute the following percentage coefficient:

   $$IPR = \frac{HSPI - LSPI}{LSPI} \times 100 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(4)}$$

   Where IPR is intra-year price rise (expressed in percentage terms), HSPI is the highest seasonal price index and LSPI is the lowest seasonal price index during the year
2. Coefficient of average seasonal price variation (ASPV): This coefficient can be calculated as follows:

   $$ASPV = [(HSPI - LSPI) \div \{(HSPI+LSPI)/2\}]*100 \quad \ldots\ldots\ldots\ldots\ldots\ldots \text{(5)}$$

   Where, ASPV is the average seasonal price index variation.
3. Coefficient of variation (CV): The coefficient of variation is a well known statistical concept and is calculated as follows:

   $$CV = \frac{S}{\bar{P}} \times 100 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(6)}$$

   Where CV is coefficient of variation, S is standard deviation of seasonal price indices and $\bar{P}$ is the mean of seasonal price indices.

Price Discovery using Seemingly Unrelated Regression (SUR)

The Garbade and Silber's (GS) approach was used for estimating the efficiency of rural and urban market in terms of price discovery. The basic structure of model is given below:

$$\begin{matrix} Rt \\ Ut \end{matrix} = \begin{matrix} \alpha R \\ \alpha U \end{matrix} + \begin{vmatrix} 1-\beta R & \beta R \\ \beta U & 1-\beta U \end{vmatrix} \begin{matrix} Rt-1 ER,t \\ Ut-1 EU,t \end{matrix} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(7)}$$

Where, R_t is the natural logarithm of monthly rural market price at the t^{th} period, U_t is the natural logarithm of monthly urban market price at the t^{th} period, α_R and α_U reflect the constant secular trend in rural and urban markets, respectively. The β_R and β_U reflect the influence of lagged price from one market on the current price in the other market. In the GS framework, the estimated equations are given as:

$$R_t - R_{t-1} = \alpha_R + \beta_R(U_{t-1} - R_{t-1}) + E_{R,t} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(8)}$$

$$U_t - U_{t-1} = \alpha_U + \beta_U(R_{t-1} - U_{t-1}) + E_{U,t} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(9)}$$

Here, the explanatory variable (*Ut–Rt*) forms the 'basis' that is the difference between urban and rural market prices. The 'basis' variable should reflect the cost of capital from the trading date till expiry date, and should contain a negative time trend, i.e.

$$U_{t-1} - R_{t-1} = \alpha_b + \beta_b(t-1) + E_{b,t} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(10)}$$

The 'basis' was regressed for each time period, on a time variable (*t-1*), where t was the time to maturity of the urban market time period; and it was found that the estimated coefficient on time trend (β_b) had turned negative, as expected. In the GS framework, Equations (8) to (10) were estimated using 'seemingly unrelated regression' (SUR) model. If the estimated coefficient of β_R is significant and β_U is insignificant, the price discovery occurs only in the urban market. This would imply that the rural market is a pure satellite of the urban market and there is a convergence of urban and rural market prices because rural market prices move towards urban market prices. If β_U is significant and β_R is insignificant, price discovery occurs only in the rural market. If both β_R and β_U are significant, price discovery occurs in both the markets. If $\beta_R > \beta_U$, urban market dominates the rural market, and if $\beta_U > \beta_R$, rural market dominates the urban market. If both β_R and β_U are insignificant, then price discovery occurs in neither market.

GARCH Model

The representation of the GARCH (*p, q*) is given as:

$Y_t = \alpha + b_1 Y_{t-1} + b_2 Y_{t-2} + \mathcal{E}_i$ (Autoregressive process) …………………………. (11)

And the variance of random error is:

$\sigma^2_t = \lambda_0 + \lambda_1 \mu^2_{t-1} + \lambda_2 \sigma^2_{t-1}$ …………………. (12)

$$\sigma^2 t = \omega + \sum_{i=1}^{p} \beta_i \sigma^2_{t-i} + \sum_{j=1}^{q} \alpha_i \mathcal{E}^2_{t-i} \quad \ldots\ldots\ldots\ldots\ldots\ldots (13)$$

Where Y_t is the price in the i^{th} period of the i^{th} market, p is the order of the GARCH term and q is the order of the ARCH term. The sum of $(\alpha + \beta)$ gives the degree of persistence of volatility in the series. The closer is the sum to 1; the greater is the tendency of volatility to persist for a longer time. If the sum exceeds 1, it is indicative of an explosive series with a tendency to meander away from the mean value.

Index of Market Connection (IMC)

The index of market concentration was used to measure price relationship between integrated markets, and the model is specified below:

$$P_R = \beta_0 + \beta_1 P_{Rt-1} + \beta_2 (P_{Ut} - P_{Ut-1}) + \beta_3 P_{Ut-1} + \mathcal{E} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots.. (14)$$

P_{Ut} = Terminal market price or reference price

P_{Rt} = Rural market price

P_{Ut-1} = lagged price for Terminal market

P_{Ut}-P_{Ut-1} = difference between Terminal market current price and its lag

$\mathcal{E}$ = stochastic/ noise/disturbance term

β_0 = Intercept

β_1= coefficient of secondary wholesale market price

β_2 = coefficient of the difference between Terminal market current price and its lag

β_3 = coefficient of Terminal market lagged price

IMC = β_1/β_3, where $0 \leq IMC \leq \infty$

Where,

IMC < 1 implies high short-run market integration;

IMC > 1 implies low short-run market integration;

IMC = ∞ implies no integration; and,

IMC = 1 implies moderate short-run integration.

RESULTS AND DISCUSSION

Trends in Prices of Cowpea

The results in Table 1 show that between January 2003 and December 2016, the market prices of cowpea increased in all the selected markets. However, the increase in price was highest in Zungeru market, followed by Bida market and then Kontagora market. However, the entire trends in prices for all the selected markets were found to be significant.

Table 1: Trends in prices of cowpea for all the selected markets

Markets	Coefficient of linear trend
	Change in price (₦)
Bida	Y = 1.323P - 0.706
Lefane	Y = 1.211P – 6.818
Minna	Y = 0.989P + 14.314
Zungeru	Y = 4.618P – 159.118
Kontagora	Y = 1.303P + 3.043
Manigi	Y = 1.211P + 5.509

Source: Authors computation, 2017

Seasonality Variation in Prices of Cowpea for all the Selected Markets

The indices of seasonal variation of prices for all the selected markets are given in Table 2 and also graphically depicted in Figure 1. The price indices for all the selected markets were below average (100) in December in all the selected markets; while the indices of prices were above the average (100) from January to March in almost all the markets. From the seasonal indices analysis of prices, it can be concluded that when the major portion of the produce was received in the market, the prices were at lowest barring few exceptions. Furthermore, graphically, it can be observed that the prices of cowpea in each of the selected markets exhibit a cyclical trend, with the trend been highly pronounced in Zungeru, Kontagora and Manigi markets; moderately pronounced in Minna market; and less pronounced in Lefane and Bida markets.

Table 2: Seasonal indices of monthly prices of cowpea in selected markets (2003-2016)

Months	Bida	Lefane	Minna	Zungeru	Kontagora	Manigi
January	101.17	103.51	103.77	97.37	93.73	96.78
February	104.10	103.60	97.45	103.53	96.19	98.78
March	106.36	103.33	100.40	100.10	99.72	101.65
April	98.82	98.64	102.24	106.79	101.96	98.45
May	98.57	104.29	125.10	100.46	109.79	112.69
June	105.11	106.27	98.77	99.14	94.64	100.74
July	96.53	94.38	98.22	95.94	108.79	107.35
August	105.56	101.65	97.91	95.16	106.89	109.00
September	99.70	100.95	92.66	132.35	97.78	94.08
October	97.85	96.92	94.47	93.60	104.71	99.19
November	96.72	97.13	97.60	95.94	96.31	91.77
December	89.52	89.35	91.43	79.63	89.51	89.52

Source: Authors computation, 2017

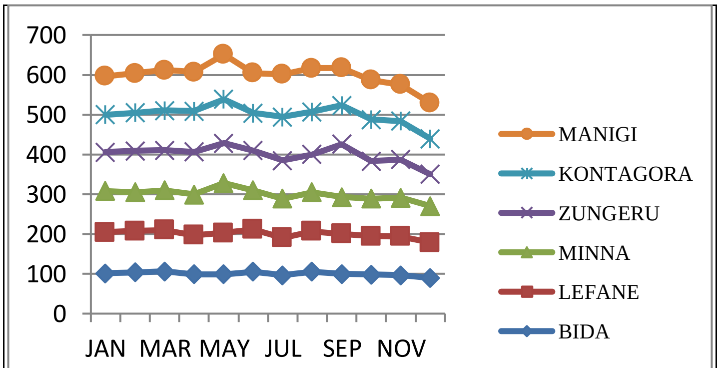

Figure 1: Seasonal pattern of cowpea prices in Niger State

Seasonal Movement of Prices in all the Selected Markets

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The intra-year price rise (IPR) for cowpea over the next several years has important implications for producers, merchandisers, and consumers. For different cowpea markets in Niger state, the intra-year variations in cowpea prices ranged between 18.81 and 66.19%, the values of average seasonal price variation (ASPV) ranged between 17.19 and 49.73%, and observed to be highest in Zungeru market and lowest in Bida market. For the IPR, it implies that the price rise during the year in these selected markets were between 18.81 and 66.19%; while the ASPV indicates that the average variation in prices during the year for all the selected markets were between 17.19 and 49.73%. The intra-year variations and average seasonal price variation in cowpea may have important implications for the decisions related to pricing in annual production. The coefficients of variations in all the selected markets were found to be very low, indicating that price fluctuations in all these selected markets were very low.

Table 3: IPR, ASP and CV of prices in the selected cowpea markets

Market	IPR (%)	ASPV (%)	CV
Bida	18.81	17.19	0.048
Lefane	18.93	17.29	0.049
Minna	36.83	31.10	0.087
Zungeru	66.19	49.73	0.12
Kontagora	22.66	20.35	0.065
Manigi	25.89	22.92	0.069

Source: Authors computation, 2017

Price Discovery of the Bivariate Vertical Integrated Markets

The results in Table 4 shows the estimated coefficients from the 'seemingly unrelated regression' (SUR) model in the GS framework fitted for each market period, pair-wise vertical integrated markets. For the Bida-Lefane market pair, six market periods out of the seven helped in the process of price discovery, and neither Bida market nor Lefane market dominating in price discovery. This implies that this market pair were not a satellite of each other in the process of price discovery i.e. each market is independent of each other with respect to price discovery, and there is a convergence of Lefane market and Bida market cowpea prices because prices of cowpea at Lefane market move towards prices of cowpea at Bida market. In addition, it can be inferred that both markets were a pure satellite of their counterparts in price discovery in the seventh market period. In the case of Minna-Zungeru market pairs, all the seven market periods were efficient in price discovery i.e. each of the market in pair discovered its price independently based on its arrival. And in these market periods, non-dominated the process of price discovery i.e. neither Minna market nor Zungeru was a pure satellite of each other. Six market periods out of seven were useful in the process of price discovery of cowpea in Kontagora-Manigi market pair. It implies that this pair of the market is independent of each other in price discovery from first to the sixth market periods, but in the seventh market period they were not efficient in the process of price discovery, thus, a pure satellite of other markets in other regions of the state. The reason might be that the quantity of arrival in either Kontagora or Manigi markets during the seventh market period were low, the need to rely on other markets for price discovery. For certain market periods, price discovery occurred in both markets (bidirectional); and the possible reason could be that the most quantity arrivals occur during the harvest period. On the whole, Minna-Zungeru market pair was more efficient in terms of price discovery.

Table 4: Estimated coefficients of seemingly unrelated regression for price discovery of pair-wise vertical integrated markets (Urban-Rural)

Market pair	Market period	Estimated coefficients		Price discovery
		Urban (β_S)	Rural (β_P)	
Bida-Lefane	Jan. 2003- Dec. 2004	0.953***	0.797***	Both
	Jan. 2005- Dec. 2006	0.871***	0.845***	Both
	Jan. 2007- Dec. 2008	0.949***	0.643***	Both
	Jan. 2009- Dec. 2010	0.943***	0.619***	Both
	Jan. 2011- Dec. 2012	0.951***	0.812***	Both
	Jan. 2013- Dec. 2014	1.13***	0.867***	Both
	Jan. 2015- Dec. 2016	0.352^{NS}	0.165^{NS}	None
Minna – Zungeru	Jan. 2003- Dec. 2004	1.03***	0.790***	Both
	Jan. 2005- Dec. 2006	0.985***	0.797***	Both
	Jan. 2007- Dec. 2008	0.055***	3.88***	Both
	Jan. 2009- Dec. 2010	1.12***	0.623***	Both
	Jan. 2011- Dec. 2012	1.21***	0.760***	Both
	Jan. 2013- Dec. 2014	-0.134***	-1.744***	Both
	Jan. 2015- Dec. 2016	-0.628***	-1.04***	Both
Kontagora -Manigi	Jan. 2003- Dec. 2004	1.02***	0.808***	Both
	Jan. 2005- Dec. 2006	0.964***	0.539***	Both
	Jan. 2007- Dec. 2008	0.629***	0.479***	Both
	Jan. 2009- Dec. 2010	1.04***	0.819***	Both
	Jan. 2011- Dec. 2012	0.620***	0.326***	Both
	Jan. 2013- Dec. 2014	0.961***	0.606***	Both
	Jan. 2015- Dec. 2016	0.176***	0.156^{NS}	Rural

Note: ***, ** and * indicate the significance at 1%, 5% and 10% levels of probability

Extent of Price Volatility in Urban and Rural Markets

The results of GARCH model showed that only GARCH (1,1) model order fits all the different bivariate vertical integrated markets (Table 5). A perusal of the GARCH analysis for two bivariate vertical integrated markets *viz.* Bida-Lefane and Minna-Zungeru indicated that volatility in their current month prices depends on the information of the preceding month price volatility and volatility of the preceding month prices, which were evident from the significant ARCH and

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GARCH-term termed family shock. Also, it was evident that volatility in the current month prices of these markets depends on the volatility in the prices of their respective annexed rural markets termed external shock, as evident from their estimated coefficients which were different from zero at 10% probability level (p<0.10) i.e. they are significant. On the basis of ARCH and GARCH-terms, it was observed that only the sum of the (α + β) estimated coefficients of Kontagora was closer to 'one', indicating the persistence of volatility in its cowpea prices; while the sum of the (α + β) estimated coefficients of Bida and Minna markets were greater than 'one', indicating 'explosive' pattern in volatility of cowpea prices in these markets. The reason for explosive volatility in Bida and Minna markets is that there are some sharp practices such as arbitrage activities which affect allocative efficiency, thus hampering the usefulness of trading in these markets. Also, the reason for persistence volatility in prices of cowpea in Kontagora market is simply linked to its closeness to larger markets of cowpea situated in the neighbouring Kebbi and Sokoto states, thus making trading activities in this market lukewarm.

Table 5: Estimates of GARCH model for measuring volatility in prices of cowpea from Jan. 2003 - Dec. 2016

Particulars	Bida market	Minna market	Kontagora market
Constant	9.67(2.59)***	-	9.87(3.03)***
External shock			
Lefane market	1.033(0.051)***	-	-
Zungeru market	-	0.224 (0.007)***	-
Manigi market	-		1.05(0.06)***
Family shock			
Alpha (0)	2.35(2.84)^{NS}	70.53 (98.41)^{NS}	105.98(0.686)^{NS}
Alpha (1)	0.28(0.059)***	0.346 (0.07)***	0..862 (0.686)^{NS}
Beta (1)	0.72(0.118)***	0.654 (0.045)***	1.28E-012 (0.033)^{NS}
Log likelihood	-602.54	-	-671.81
GARCH fit	1,1	1,1	1,1
α + β	**1.00**	**1.00**	**0.86**

Notes: Figures within the parentheses indicate the calculated standard errors
*** ** and * indicate the significance at 1%, 5% and 10% probability levels respectively
NS: Non-significant

GARCH Diagnostic Testing

The results of the diagnostic statistics to validate the GARCH models for each of the pair-wise vertical integrated markets are shown in Table 6. The test of autocorrelation for each of the pair vertical integrated market shows that the residuals were not correlated as evident from the Q-statistics which were not different from zero at 10 percent probability level (p>0.10). For normality tests, results show that the residuals for all the bivariate vertical integrated markets were not normally distributed as evident from the χ^2 test statistics which were different from zero at 10% probability level (p<0.10). However, non-normality in the distribution of residuals when dealing with time series data is not considered a serious problem because data in most cases are not normally distributed. Therefore, all the results obtained were valid and the models were the best fit.

Table 6: Diagnostic checking for GARCH

Model	Market	Autocorrelation (Q-stat)	Normality Test (χ^2)
GARCH	Bida	0.696 (0.404)^{NS}	480.67(4.21E-105)***
	Minna	0.814 (0.367)^{NS}	3574.26 (0.000)***
	Kontagora	12.739 (0.121)^{NS}	389.93(2.13E-085)***

Note: Values in parentheses are probability levels

The Indices of Market Concentration

Table 7 shows the result of the indices of market concentration for all the vertical integrated markets (Urban-Rural market). The validity of these results was verified/investigated *viz.* diagnostic statistics to see whether the models used best fit the specified equation. The diagnostic statistics for all the best models *viz.* Autocorrelation, Arch effect, heteroscedasticity and stability tests shows that the residuals have no autocorrelation, no Arch effect, the variance was homoscedasticity and no structural break in the specified models, as evidenced from the Q-statistics, Lagrange multiplier test statistics, Breusch pegan Lagrange multiplier test statistics and Harvey-Collier (Cusum test) test statistics, respectively, which were not different from zero at 10% probability level (p>0.10) (Table 7a). In addition to autocorrelation test, the Durbin-Watson statistics falls within the recommended range (1.50-2.50) which indicates that the residuals are not serially correlated. However, the results of the normality test for all the best models indicated that the residuals were not normally distributed as evidenced by the χ^2 which were different from zero at 10% probability level (p<0.10). As earlier posited, when dealing with time series data, non-normality of the residuals are not considered a serious problem, because in most cases these data are not normality distributed. It should be noted that when dealing with dynamic model/Autoregressive model not differenced, homoscedasticity and normality are not considered a serious problem. Therefore, based on these diagnostic tests it can be concluded that these results are valid, as all the selected models

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are the best fit for the regression equations specified. A perusal of the Table 7b shows the IMC for Bida-Lafene, Minna-Zungeru and Kontagora-Manigi market pairs to be 0.28, 1.99 and 0.79, respectively. The IMC for market pairs Bida-Lafene and Kontagora-Manigi were less than one, thus indicating high short-run market integration, while the IMC for market pair Minna-Zungeru was greater than one, implying low short-run market integration. With the exception of Minna-Zungeru market pair, the results further shows that price change in rural markets causes an immediate change in the urban market. The short run market integration was faster in the Bida-Lefane market pair relative to the Kontagora-Manigi market pair. This, however, confirms the pair-wise vertical VECM results discussed previously most especially for Bida-Lefane market pair and further substantiates the perfect price transmission mechanism between rural and urban cowpea markets in the state. The low short-run market integration between Minna-Zungeru market pair clearly indicates that quantity of arrivals in this market comes from many produce markets i.e Zungeru market is not the major producing market linked to Minna market, like-wise Zungeru market is a satellite of other markets in discovery its price, thus, the reason for low instantaneous causality between this market pair.

Table 7a: Diagnostic statistics IMC results

	Lefane Bida	Zungeru Minna	Manigi Kontagora
Autocorrelation LMF	0.979 (0.472)^{NS}	1.47(0.141)^{NS}	1.365(0.189)^{NS}
Durbin-Watson	2.004	2.38	1.94
Arch LM	1.42 (0.999)^{NS}	7.11(0.85)^{NS}	6.50(0.889)^{NS}
Heteroskedasticity	704.91 (1.81E-027)***	3.61(0.307)^{NS}	22.14(6.097E-005)***
Normality	832.26(1.89E-181)***	342.04(5.34E-075)***	342.09(5.20E-075)***
Stability (CUSUM)	1.378 (0.170)^{NS}	0.445 (0.657)^{NS}	1.82(0.70)^{NS}

Note: Values in parentheses are probability levels

Table 18a: Indices of market connection

Market pair	β_1	β_2	IMC	R^2	Classification
Lefane Bida	0.204	0.721	0.28	0.98	**High short-run**
Zungeru Minna	0.879	0.441	1.99	0.90	**Low short-run**
Manigi Kontagora	0.417	0.529	0.79	0.98	**High short-run**

Source: Authors computation, 2017

CONCLUSIONS & RECOMMENDATIONS

The present study focused on price discovery and volatility of cowpea in the three major urban markets and their respective adjunct rural markets across the zones in Niger state of Nigeria. The results revealed an increasingly positive trend in prices of cowpea in all the selected markets. Furthermore, it was observed that Bida market and its adjunct rural market (Lefane market) were found to be highly efficient in marketing as evident from the cyclical trends of their respective seasonal pattern which were less pronounced. The relationship between the urban market price and rural market price in terms of price discovery revealed non-occurrence of hedging in almost all the market periods, with neither urban nor rural market dominating the process of price discovery, thus, indicating the efficient performance of trading in cowpea by both markets. The extent of volatility in prices of cowpea due to trading as measured by the coefficients of GARCH model showed the persistence of volatility in Kontagora market, and explosive type of volatility in Bida and Minna markets due to some arbitrage activities in the latter markets. Also, in terms of the market connection in the short-run, Bida-Lefane markets were more connected that their respective counterparts in the state. Based on these findings, the researchers suggest some policies for a more focused and pragmatic approach for increasing the system's efficiency and generating benefits for the farmers:

- Exclusive market regulator for agricultural commodities which behave quite different from non-agricultural commodities should be established to govern, monitor and regulate the cowpea trade.
- There is need to strengthen physical infrastructure, use of information and communication technology and well-defined transparent agricultural policy-market measures in the state that will help in the development of a single uniform economic market in the region in particular and country in general.

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