



SPATIAL MARKET INTEGRATION AND PRICE TRANSMISSION OF COWPEA (*Vigna unguiculata*) IN NIGERIA

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ABSTRACT

The study investigated spatial market integration and price transmission of cowpea in Nigeria. Secondary data on monthly basis for wholesale cowpea price per kilogram were used for the study. Augmented Dickey Fuller Test, Johansen Co-integration model, Granger Causality Test and Variance Decomposition of Vector Autoregressive Model and Error Correction Model were used as analytical tools. Augmented Dickey Fuller test revealed that first difference all the price series were stationary and lag one (1) is the optimum lag length appropriate for the specified variables. Cointegration test results of the markets proved that despite that these markets were spatially separated geographically, they were connected in terms of price transmission across them, both in the long and short run but the level of integration is weak. It was observed that price changes are temporary and would converge to an equilibrium within a given time span. Granger causality test results indicate that one pair showed bi-directional causation between Bauchi and Enugu States. Thirty two (32) links showed unidirectional and three (3) pairs such as Niger→Abia, Niger→Lagos and Sokoto→Cross River States pairs showed no causal relationship between them. The study showed that Gombe and River States cowpea price had a faster speed of adjustment to equilibrium than other states. It also revealed that that 1% increase in Jigawa State will result to 20.5% increase in Enugu state and 1 % increase in River State will lead to 40.6% and 64.8% increase in Gombe and Nasarawa States in the short run respectively. The study concluded that, there is integration between the cowpea prices of source and destination states, but the degree of integration is weak. It is recommended that market participants should adopt standardize trading, settlement practice and invest in technology (electronic trading platform) to reduce operational inefficiencies in different markets to support integration.

Keywords: Market integration, Co-integration, Price transmission, Cowpea.

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INTRODUCTION

Cowpea, an ancient crop originated from Southern Africa and is widely adapted and valued in semi-arid tropics of Africa, Asia, Europe, the United States, and South and Central America (Ayodeji *et al.*, 2014). It is a good source of protein and has potential to alleviate malnutrition.

Cowpea's economic value lies in its dietary value, which aids in trade between producing and nonproducing areas and countries, and provides income for middlemen (Girei *et al.*, 2013). Agricultural markets and market information are crucial for farmers, especially smallholder farmers, to participate effectively in trade and take advantage of seasonal and spatial arbitrage (Mawazo *et al.*, 2014). Lack of market price information can lead to farmers negotiating for the price provided by buyers, endangering their marketing decisions and also poor market price knowledge and structural flaws contribute to inefficiency (Ross and De Klerk, 2012 and Adekoya *et al.*, 2013). Understanding commodity price trends is essential for good planning and efficient commodity markets (Zoellick, 2008). Spatial market integration is the comovement of prices and/or flows between markets. More broadly, it explains the interactions between two geographically separated marketplaces. A well-integrated market system is required not only for the effective allocation of productive resources, but also for the reduction of price risks that are likely to harm the well-being of economic actors, particularly the poor and food insecure families (Ddungu *et al.*, 2015).

Price transmission refers to the change in one price causing another to change, measured by transmission elasticity. Asymmetric price transmission occurs when price adjustments are not homogenous (Pratap, 2016). In spatially integrated markets, price signals are communicated simultaneously, leading to more stable prices and a lack of long-term comparative advantage for agricultural producers. This results in lower prices, increased profits, and economies of scale in more integrated marketplaces (Ifejirika *et al.*, 2013 and Vollrath, 2003). Middlemen's intervention in Nigerian cowpea markets leads to increased buying prices for consumers and lower selling prices for producers, lowering farmer profit margins. This research is needed to understand long-run market behavior, proximity of price movements, and effectiveness of price transmission, aiming to balance food-deficit and food-surplus regions. This will help to combat poverty by raising farmers and marketers personal income and improving their prospects for food security as reported by Famine Early Warning Systems Network, FEWSNET (2008) and Akpan *et al.* (2014).

METHODOLOGY

Study Area

The study was conducted in Nigeria, a West African country with 36 states and FCT. The country covers 923,769 square kilometers and has a projected population of 220,544,164. It has a relatively high temperature range with a narrow seasonal and diurnal variation. The country has two seasons: wet (April-October) and dry (November-March). The dry season starts with Harmattan, a dry chilly spell, and the hottest period is February-March. Extremes of the wet season are felt on the southeastern coast (Nigeria High Commission, 2022).

Sources and Methods of Data Collection

Secondary data was used for the study. Secondary data on monthly basis for cowpea price per kilogram were obtained from National Bureau of Statistics website for the period of 6 years (2017 – 2022).

Sampling Procedure/Techniques

Purposive sampling technique was adopted for the selection of two (2) states from each geopolitical zone so as to get the representation of all parts of the country which gives a total of twelve (12) states. The selected states were Bauchi, Gombe, Jigawa, Sokoto, Nasarawa and Niger States as source markets, while Abia, Enugu, Ekiti, Lagos, Cross River and Rivers States as destination markets. Selection of states was based on prominence in cowpea production and marketing activities.

Method of Data Analysis

Augmented dickey fuller test

Augmented Dickey Fuller test is an extension of Dickey Fuller DF test that was used in testing stationarity of variables. Augmented Dickey-Fuller (ADF) was performed to test the stationarity series in the data for theoretical and practical reasons. The ADF tests can be expressed as:

$$\Delta P_t = \alpha_0 + \delta_1 t + \beta_1 P_{t-1} + \sum_{j=0}^q \beta_1 \Delta P_{t-j} + \varepsilon_t \quad (1)$$

Where:

$\Delta P_t = P_t - P_{t-1}$, $\Delta P_{t-1} = P_{t-1} - P_{t-2}$, $\Delta P_{n-1} = P_{n-1} - P_{n-2}$ etc.

P = the price in each state α_0 = constant or drift t = time trend variable

q = number of lag length selected based on Schwartz information criterion (SIC) ε_t = pure white error term

The test for a unit root in the price series was carried out by testing the null hypothesis that β_1 (coefficient of P_{t-1}) is zero. The alternative hypothesis is that β_1 is less than 0. A non-rejection of the null hypothesis suggests that the time series under consideration is non-stationary (Gujarati, 2004).

Testing for lag length

A test for a suitable lag length included in the co-integration test was performed because the results of co-integration tests can be quite sensitive to this (Hafer and Sheehan, 1991; Hai, 2003). The number of lag was selected by applying the Akaike information criterion (AIC). A vector auto-regression (VAR) on the differenced series was conducted and lag length of the model with the least AIC was chosen as the appropriate lag length to be included in the cointegration test.

Johansen co-integration test

After conducting the stationarity test on each price series, cointegration test was conducted between the price series. In this study, the Johansen co-integration procedure was used because of its obvious advantages over the Engle Granger procedure (Silvapulle and Jayasuriya, 1994). Co-integration analysis is concerned with the existence of a relationship among prices in different locations (Engle and Granger, 1987).

It constructs a test statistic, called the likelihood ratio test, to determine the number of cointegrating vectors in a co-integration regression.

Thus, it is express as:

$$LR_{tr}(r/n) = -T \sum_{i=r+1}^n \log(1 - \lambda) \quad (2)$$

$$LR_{max}(r/n + 1) = -T \log(1 - \lambda) \quad (3)$$

Where

LR = likelihood ratio n

= number of variables λ

= max eigenvalue

T = sample size

r = number of co-integrating vector = 0, 1, 2, ..., $n - 1$

Σ = summation

Therefore, the criterion for selection cointegrating equation is that the trace statistical value must be greater than the critical value at 5% level of significance, the H_0 of no co-integration i.e., $r = 0$ will be rejected.

Granger causality test

Granger causality test was used to determine whether price movements follow defined paths or to determine the leading markets between the states market price of cowpea in Nigeria. It is represented thus:

$$\ln P_{kt} = \psi_0 + \sum_{i=1}^n \psi_{ki} \ln P_{k(t-i)} + \sum_{i=1}^n \psi_{ki} \ln P_{k(t-i) + t} \quad (4)$$

Where

P_{kt} , = price in Bauchi, Gombe, Jigawa, Sokoto, Nasarawa and Niger States as source markets, while Abia, Enugu, Ekiti, Lagos, Cross River and Rivers States as destination markets. $P_{k(t-i)}$ = lagged prices in Bauchi, Gombe, Jigawa, Sokoto, Nasarawa and Niger States as source markets, while Abia, Enugu, Ekiti, Lagos, Cross River and Rivers States as a destination markets

ψ_i 's = parameters to be estimated;

n = the numbers of lags; and ε_t =

the error term.

To prove the existence of causality, an F-test, which is equivalent to the Wald Test, was used. It is expressed as:

$$F_{[m, (n-2m-1)]} = \frac{(SSE_{SEu} - (nSSE - 2m^2) / 1m)}{F_{RP}} \quad (5)$$

Where:

SSE_r = is the sum of squared errors of equation with restricted coefficients of lagged Rp (that is to say that coefficient is set to zero);

SSE_u = is the sum of squared errors of the unrestricted form of the equation is the critical value;

n = is the number of observations; and m = is the number of lags.

Vector Autoregressive Model (VAR)

The VAR models to establish the interactions among these variables. The (VAR) model is commonly used for forecasting systems of interrelated time series and for analyzing the dynamic impact of random disturbances to the system of variables. The mathematical representation of a VAR is:

$$Y_t = A_1 y_{t-1} + \dots + A_p y_{t-p} + Bx_t + e_t \quad (6)$$

Where

Y_t is a k vector of endogenous variables, and contains the endogenous variables prices, and exogenous variable price as given an order,

A_1 , A_p and B are matrices of coefficients to be estimated.

The effects of oil price shocks on gross domestic product are measured with the help of regression analysis.

The fixed regression model is as follows:

$$Y = a + bx + e \quad (7)$$

Where :

Y = endogenous variables prices,

a = intercept,

b = regression coefficient, X = exogenous variable price and

e = error term.

Vector Autoregressive Model involved the use of variance decomposition analysis to assess the dynamic interactions amongst the cowpea markets price under consideration. It showed how % change in a market is due to its own shock and % change due to shocks to other markets.

Vector Error Correction Model (VECM)

VECM was applied in order to evaluate the long run cointegration and speed of adjustment to equilibrium and short run of the co-integrated series.

The long run and short run vector error correction models was computed as:

$$\Delta X_t = C_1 + \lambda_1 Z_{t-1} + \beta_1 \Delta X_{t-1} + a_1 Y_{t-1} + \varepsilon_{xt} \quad (8) \quad \Delta X_t = C_2 +$$

$$\lambda_2 Z_{t-1} + \gamma_2 \Delta X_{t-1} + \delta_1 Y_{t-1} + \varepsilon_{xt} \quad (9) \quad \text{Where}$$

ΔX_t = price change at Bauchi, Gombe, Jigawa, Sokoto, Nasarawa and Niger States as source markets, while Abia, Enugu, Ekiti, Lagos, Cross River and Rivers States destination as markets at time t ;

ΔX_{t-1} = price change at Bauchi, Borno, Jigawa, Sokoto, Nasarawa and Niger States as source markets, while Abia, Enugu, Ekiti, Lagos, Cross river and Rivers States destination as markets in past period;

δ = the speed of adjustment parameter; and ε_{xt}

= is a bivariate white noise.

RESULTS AND DISCUSSION

Unit root test

Unit root test was carried out to check for stationarity of the series using Augmented Dikey Fuller test (ADF). The results presented in the Table 1 shows that at level, the P-value for the coefficients cowpea prices in all the states were insignificant at 5% level. This signifies that price series were not stationary and that price of the previous period influenced the current prices of cowpea. Therefore, the null hypothesis of the presence of unit root for all the price series was accepted. Since the variables were non-stationary at levels, any attempts to use them will lead to spurious regression, and this is not ideal for policy making and cannot be used for long run prediction. To make them stationary, they had to be difference once. The P-value for the coefficients of price series in all the states was significant at 5% significant level. This

signified that price series did not contain a unit root (were stationary). Therefore the null hypothesis of the existence of unit root could be rejected, meaning that the price series was stationary at first difference $I(1)$. A similar study by Adekunle and Momoh (2016) indicated that the cowpea price series were stationary at first difference $I(1)$ in Southwest Nigeria and that of Onubogu and Dipeolu (2019) who showed that the cowpea and yam markets in Nigeria contained unit root (were not stationary) at level, and had to be differenced once and became stationary.

Table 1: Results of Augmented Dickey Fuller (ADF) Test

States	AT LEVELS AT 5%							AT FIRST DIFFERENCE AT 5%						
	Intercept		intercept & trend		None		Remark	Intercept		intercept & trend		None		Order of integration
ADF	P-value	ADF	P-value	ADF	P-value	ADF		P-value	ADF	P-value	ADF	P-value	ADF	
Abia	-0.9067	0.7806	-1.3828	0.8577	0.8352	0.8892	Non-stationary	-6.7312	0.0000	-6.6799	0.0000	-6.6278	0.0000	I(1)
Bauchi	0.6325	0.9897	1.3455	1.0000	1.5991	0.9723	Non-stationary	-9.0875	0.0000	-9.4393	0.0000	-8.8547	0.0000	I(1)
Cross R.	-0.1334	0.9411	-0.9619	0.9423	1.5248	0.9677	Non-stationary	-9.6756	0.0000	-9.8825	0.0000	-9.4422	0.0000	I(1)
Ekiti	-0.3433	0.9122	-1.2223	0.8980	1.1644	0.9358	Non-stationary	-9.2615	0.0000	-9.3648	0.0000	-9.1138	0.0000	I(1)
Enugu	-0.1848	0.9348	-1.2223	0.8980	1.1549	0.9348	Non-stationary	-7.1694	0.0000	-7.1728	0.0000	-7.0495	0.0000	I(1)
Gombe	1.4552	0.9991	1.0265	0.9999	2.0807	0.9906	Non-stationary	-5.1373	0.0001	-	0.0000	-3.6634	0.0004	I(1)
Jigawa	-1.6666	0.4437	-1.9007	0.6438	0.1651	0.7311	Non-stationary	-9.3309	0.0000	-9.2943	0.0000	-9.3343	0.0000	I(1)
Lagos	-1.2959	0.6272	-1.5510	0.8022	0.3151	0.7740	Non-stationary	-	0.0000	-8.7332	0.0000	-8.7927	0.0000	I(1)
Nasarawa	-0.2627	0.9244	-0.7411	0.9657	0.9581	0.9089	Non-stationary	8.78080	0.0000	-8.9216	0.0000	-8.6555	0.0000	I(1)
Niger	0.4183	0.9825	0.1257	0.9970	1.2796	0.9479	Non-stationary	-8.4958	0.0000	-8.8167	0.0000	-8.3636	0.0000	I(1)
River	-0.0488	0.9503	-1.5936	0.7858	1.4646	0.9635	Non-stationary	-7.9414	0.0000	-8.0148	0.0000	-7.7579	0.0000	I(1)
Sokoto	-0.6483	0.8522	-1.1028	0.9211	1.0454	0.9212	Non-stationary	-8.3363	0.0000	-8.3109	0.0000	-8.2071	0.0000	I(1)

Source: Output from E-views

Optimal lag selection

Too many lags could increase forecasting error, while too few could omit important data. The best way to decide how many lags are required is typically through experience, knowledge, and economic theory (Sadiq, *et al.*, 2018). The ideal optimum lag length was chosen in order to guarantee that the errors in ADF were white noise using the most popular information criterion, namely the sequential modified (SM) test statistic, Final prediction error (FPE), Akaike information criterion (AIC), Schwarz Bayesian information criterion (SC), and Hannan-Quinn criterion (HQ). The test results in Table 2 showed that, lag one (1) is the optimum lag length appropriate for the specified variables, as specify by LR, FPE, AIC, SC and HQ. In order to obtain more interpretation, logically consistent results and prevent biases of time series due to their sensitivity to lag length, the optimal lag length of time series in the generation of ADF and all subsequent models must be one.

Table 2: Lag Order Selection Criteria

Lag						LogL
		FPE	AIC	SC	HQ	LR
0	-4041.509	NA	1.73e+36	117.4930	117.8815	117.6472
1	-3586.719	181.9005*	2.23e+32*	107.0904*	113.5356*	110.4885*
2	-3446.731	178.5354	3.59e+32	108.6009	118.3144	112.4546
3	-3250.620	738.2087	2.35e+32	108.4846	121.4664	112.7939

Source: Output from E-views

* Indicates lag order selected by the criterion

LR = Sequentially modified (LR) test statistic

FPE = Final prediction error

AIC = Akaike information criterion

SC = Schwarz Bayesian information criterion HQ

= Hannan-Quinn criterion (HQ).

Degree of Market Integration between Source and Destination Markets

Johansen co-integration was used to test the degree of market integration between source and destination markets. The findings of co-integration analysis using Johansen multivariate analysis is shown in Table 3. The statistics used in the results were trace and maximum eigenvalue statistics. The study showed that, out of 36 pairs-wise cointegration, only nine (9) pairs indicated at least one cointegrating linear equation. Therefore, both the trace and maximum eigenvalue statistics reject the null hypothesis of zero integrating linear equations between the following source and destination markets such as Bauchi-Abia, Bauchi-Enugu, Gombe-Abia, Gombe-River, JigawaCross River, Jigawa-Lagos, Sokoto-Cross River, Sokoto-Ekiti and Sokoto-Lagos States. Therefore, price signals were transferred throughout these states, and any shock occurring in one market transmits signals to another. This also implied that the nine states cowpea price pairs had

long-run equilibrium integration. Furthermore, the existence of a long-run relationship between these pairs suggested that there was supply of cowpea from the source states like Bauchi, Gombe, Jigawa, and Sokoto states to destination states (Abia, Enugu, River, Cross River, Lagos and Ekiti states).

While the remaining 27 pairs such as Bauchi-Cross River, Bauchi-Ekiti, Bauchi-Lagos, Bauchi-River, Gombe- Cross River, Gombe-Ekiti, Gombe-Enugu, Gombe-Lagos, Jigawa-Abia, Jigawa-Ekiti, Jigawa-Enugu, Jigawa-River, Nasarawa-Abia, Nasarawa-Cross River, Nasarawa-Ekiti, Nasarawa-Enugu, Nasarawa-Lagos, Nasarawa-River, Niger-Abia, Niger-Cross River, Niger-Ekiti, Niger-Enugu, Niger-Lagos, Niger-River, Sokoto-Abia, Sokoto-Enugu and Sokoto-River States showed no integration among them. This implied that there was absence of long run relationship between them. Generally, only 9 market pairs showed integration and 27 market pairs did not show any degree of integration. Therefore, the degree of market integration between source and destination states was weak (low), may be due to inefficient free flow of price signal and market information among them to keep the market participants well informed about the demand, supply and prices of cowpea. Weak degree of market integration may lead to limited access to resource (skilled labour and technology) which can hinder farmer's production capabilities and innovation, reduced competition which lead to monopolistic and oligolistic market structure, high cost of transaction and risk diversification challenges. This was in line with the findings of Sadiq *et al.* (2019) who reported that each cowpea market pair, namely Lefane-Zungeru, Lefane-Manigi, and Zungeru-Manigi, had a single cointegrating equation, indicating that these market pairs were cointegrated and had a long-run price association in Niger State and Olanrewaju *et al.* (2021) revealed that Bida-Minna, Bida-Kontagora, and Minna-Kontagora cowpea markets had one cointegrating equation, they suggested that these market pairings were co-integrated and had longrun price movement in Ondo State.

Table 3: Results of Johansen Co-integration for Trace and Maximum Eigenvalue Test

State pairs	Trace P-values statistics	Max-Eigen P-values statistics	P-values statistics
Bauchi-Abia	22.24653	0.0041**	17.99446
Bauchi-Enugu	18.47506	0.0172**	16.60851
Gombe-Abia	18.81824	0.0152**	14.86010
Gombe-River	16.33786	0.0373**	14.90247
Jigawa-Cross river	21.60317	0.0053*	21.49456
Jigawa-Lagos	16.14033	0.0399**	15.19248
Sokoto-Cross river	21.66259	0.0052**	16.70843
Sokoto-Ekiti	16.70843	0.0327**	16.33898
Sokoto-Enugu	11.62765	0.1757	10.03927
<u>Sokoto-Lagos</u>	<u>18.01258</u>	<u>0.0204**</u>	<u>17.63043</u>

Source Output from E-views

Note ** = significant at 5% and * = significant at 10%

Direction of Price Formation and Transmission between Source and Destination Markets Granger causality test between source and destination markets

Granger causality test was used to identify the causal variable between the source and destination states prices after it was established that there was co-integration between them. The study investigated 36 links. According to Table 4 of pair-wise Granger causality test results, only one pair showed bi-directional causation between Bauchi-Enugu States. This suggested that both states had a feed forward and feed backward process in price formation. This study agreed with the findings of Robinson *et al.* (2014) who reported that Adamawa and Oyo cowpea markets have a bi-causal relationship and Adenegan *et al.* (2016) who showed that there was a bi-directional granger causality between Giwa and Bodija cowpea markets in Nigeria.

Thirty three (32) links showed unidirectional causality such as Abia → Bauchi, Cross River → Bauchi, Ekiti → Bauchi, Lagos → Bauchi, River → Bauchi, Abia → Gombe, Abia → Gombe, Cross River → Gombe, Ekiti → Gombe, Enugu → Gombe, Lagos → Gombe, River → Gombe, Abia → Jigawa, Cross River → Jigawa, Ekiti → Jigawa, Enugu → Jigawa, Lagos → Jigawa, River → Jigawa, Abia → Nasarawa, Cross River → Nasarawa, Ekiti → Nasarawa, Enugu → Nasarawa, Lagos → Nasarawa, River → Nasarawa, Cross River → Niger, Enugu → Niger, River → Niger, Abia → Sokoto, Ekiti → Sokoto, Enugu → Sokoto, Lagos → Sokoto and River → Sokoto states. This indicated that price of destination states causes granger over source states, which means that the directions of price flow from destination states. Therefore, any price shock or changes in destination state were transmitted to source states all things being equal.

Finally, three (3) pairs Niger→Abia, Niger→Lagos and Sokoto→Cross River states pairs showed no causal relationship between them. This implied that there was absence of interdependence between these states. However, the study indicated that lack of causality could not mean an absence of price transmission in the long-run. It further showed that River state (destination state) cowpea prices occupied the leadership position (central state) in price formation in Nigeria since it causes granger over all the source states. This study is in line with the findings of Dorothy *et al.* (2017) who revealed that soya beans in Benue and Enugu states none of the urban retail prices of soya beans in the two states granger cause each other. Thus, an increase in price in one market in the short-run could not bring about an increase in price in another market. This implied that prices in both markets were slowly and inefficiently transmitted with the interaction of demand and supply that was regulating the prices.

Table 4: Results of Pairwise Granger Causality Tests

P-values	Decision of null	Direction	Null Hypothesis	F-statistic
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Abia → Bauchi	5.60738	0.0207**	Rejected	Unidirectional
Bauchi → Cross River	0.32210	0.5722	Accepted	
Cross River → Bauchi	7.55574	0.0077***	Rejected	Unidirectional

Bauchi → Ekiti	0.72146	0.3986	Rejected	
Ekiti → Bauchi	7.56981	0.0076**	Accepted	Unidirectional
Bauchi → Enugu	5.14538	0.0265**	Rejected	
Enugu → Bauchi	7.82108	0.0067***	Rejected	Bidirectional
Bauchi → Lagos	0.15253	0.6973	Accepted	
Lagos → Bauchi	5.31695	0.0242**	Rejected	Unidirectional
Bauchi → River	2.42181	0.1243	Accepted	
River → Bauchi	6.67592	0.0119**	Rejected	Unidirectional
Gombe Abia	0.93573	0.3368	Accepted	
Bauchi → Abia	2.69252	0.1054	Accepted	hypothesis
Abia → Gombe	4.04510	0.0483**	Rejected	Unidirectional
Gombe → Cross River	0.00262	0.9594	Accepted	
Cross River → Gombe	6.94526	0.0104**	Rejected	Unidirectional
Gombe → Ekiti	0.06972	0.7925	Accepted	
Ekiti → Gombe	9.81719	0.0026***	Rejected	Unidirectional
Gombe → Enugu	1.89509	0.1731	Accepted	
Enugu → Gombe	5.48419	0.0221**	Rejected	Unidirectional
Gombe → Lagos	0.32949	0.5679	Accepted	
Lagos → Gombe	4.34753	0.0408**	Rejected	Unidirectional
Gombe → River	0.30644	0.5817	Accepted	
River → Gombe	4.82294	0.0315**	Rejected	Unidirectional
Jigawa → Abia	1.51442	0.2227	Accepted	
Abia → Jigawa	8.64800	0.0045***	Rejected	Unidirectional
Jigawa → Cross River	1.55238	0.2171	Accepted	
Cross River → Jigawa	9.83350	0.0025***	Rejected	Unidirectional
Jigawa → Ekiti	0.05094	0.8221	Accepted	
Ekiti → Jigawa	11.1913	0.0013***	Rejected	Unidirectional
Jigawa → Enugu	2.98892	0.0884	Accepted	
Enugu → Jigawa	6.13102	0.0158**	Rejected	Unidirectional
Jigawa → Lagos	0.29187	0.5908	Accepted	

Lagos → Jigawa	10.9503	0.0015***	Rejected	Unidirectional
Jigawa → River	2.29022	0.1348	Accepted	
River → Jigawa	6.31595	0.0143**	Rejected	Unidirectional

Continuation of Table .4: Results of Pairwise Granger Causality Tests

Null Hypothesis	F-statistic	P-values	Decision	of Direction
null hypothesis				
Nasarawa → Abia	0.00029	0.9865	Accepted	
Abia ← Nasarawa	4.25268	0.0430**	Rejected	Unidirectional
Nasarawa → Cross River	0.32116	0.5728	Accepted	
Cross River → Nasarawa	6.46390	0.0133**	Rejected	Unidirectional
Nasarawa → Ekiti	0.02401	0.8773	Accepted	
Ekiti → Nasarawa	6.92163	0.0105**	Rejected	Unidirectional
Nasarawa → Enugu	0.91807	0.3414	Accepted	
Enugu → Nasarawa	4.54398	0.0367**	Rejected	Unidirectional
Nasarawa → Lagos	0.67112	0.4155	Accepted	
Lagos → Nasarawa	8.06005	0.0060***	Rejected	Unidirectional
Nasarawa → River	0.60060	0.4410	Accepted	
River → Nasarawa	5.10774	0.0270**	Rejected	Unidirectional
Niger → Cross River	0.35731	0.5520	Accepted	
Cross River → Niger	4.46888	0.0382**	Rejected	Unidirectional
Niger → Ekiti	0.07130	0.7903	Accepted	
Ekiti → Niger	3.85817	0.0536**	Rejected	Unidirectional

Source Output from E-views

Enugu → Niger	3.48014	0.0664**	Rejected	Unidirectional	
Niger → River	0.39485	0.5319	Accepted		
River → Sokoto	3.81504	0.0549*	Rejected		
Sokoto → Abia	2.26738	0.1368	Accepted		
Abia → Sokoto	16.1992	0.0001***	Rejected	Unidirectional	
Sokoto → Ekiti	0.39703	0.5307	Accepted		
Ekiti → Sokoto	12.5606	0.0007**	Rejected	Unidirectional	Note ***,
Sokoto → Enugu	3.16044	0.0799	Accepted		** , *
Enugu → Sokoto	13.5305	0.0005***	Rejected	Unidirectional	
Sokoto → Lagos	5.44182	0.0226	Accepted		
Lagos → Sokoto	7.23118	0.0090***	Rejected	Unidirectional	
Sokoto → River	1.43760	0.2340	Accepted		
River → Sokoto	10.3428	0.0020***	Rejected	Unidirectional	
Niger → Enugu	1.17839	0.2815	Accepted		denote the level of significance at 1%,

5% and 10% respectively.

Variance decomposition analysis

The study analyzed variance decomposition techniques to determine the percentage of price changes in source states explained by destination states in the short, medium, and long run. The analysis of the study revealed that the shock originating from destination states price at both time periods was more pronounce on the cowpea price itself when compared to its effect on other states price. Despite monthly increases, the overall effect was weak as also revealed by Sadiq *et al.* (2018) that Bida market of cowpea, in the short-run (first quarter), a shock to price of cowpea in Bida market accounted 84.48% variations of fluctuation in prices at Bida (own shock).

Speed of Adjustment to Equilibrium in the Long Run

Table 5 showed the results of speed of adjustment to equilibrium in the long run of the VECM. The results presented in Table 5 revealed that the adjustment coefficient of -0.100366, -0.291049, 0.234086 and -0.086936 for Bauchi, Gombe, Jigawa, Nasarawa and Sokoto States prices respectively. This Suggested that previous deviation in Bauchi, Gombe, Jigawa, Nasarawa, Niger and Sokoto States cowpea prices will be corrected within 1 week, 1 month, 3 weeks and 1 week in the long run equilibrium respectively. The study also showed that Abia, Cross River, Enugu, Ekiti, Lagos and River States had the adjustment speed of -0.466984, -0.327297, -0.482144, 0.253936, -0.341763 and -0.205107 respectively. This implied that, in the long run, the previous deviation in Abia, Cross River, Enugu, Ekiti, Lagos and River States were expected to be corrected within one and half month, one month, one and half month, three weeks, one month and two weeks respectively.

It can be deduced from the result that Gombe and Sokoto States cowpea price had a faster speed of adjustment to equilibrium in the long run than the other states because it took only one week for any disequilibrium to be adjusted, meaning that the chances of correction of any disequilibrium was high in Gombe and Sokoto States may be due to high level of market competition, market flexibility and access to capital. This could lead to reduced likelihood of market inefficiencies and price anomalies, greater stability in market and economies and efficient resources allocation. This

result agreed with the findings of Onyinyechukwu and Adewale (2021) and Onubogu and Dipeolu (2019) who observed that brown cowpea market exhibited a faster rate of adjustment to equilibrium. Similarly, Wondemu (2015) discovered that teff crops' prices adjusted quickly to market shocks induced by price increases, as compared to when prices decreased in Ethiopian grain markets.

Table 5: Speed of Adjustment to Equilibrium in the Long Run

States	Coefficient	Std. error	T-value	Period
Bauchi	-0.007789	0.07109	-0.10956	-
Gombe	-0.100366	0.05010	-2.00323**	1 weeks
Jigawa	-0.291049	0.13383	-2.17469**	1 month
Nasarawa	-0.234086	0.06752	-3.46707***	3 weeks
Niger	-0.165654	0.11794	-1.40461	-
Sokoto	-0.084936	0.08377	-5.99595***	1 weeks
Abia	-0.466984	0.07788	-5.99595***	1.5 month
Cross River	-0.327297	0.11675	-2.80343***	1 month
Enugu	-0.482144	0.07925	-6.08360***	1.5 month
Ekiti	-0.253936	0.10210	-2.48710**	3 weeks
Lagos	-0.341763	0.09834	-3.47532***	1 month
River	-0.205107	0.07867	-2.60715***	2 weeks

Source Output from E-views

Note *** and ** denote the level of significance at 1% and 5% respectively.

Short Run Relationship between the Source and Destination States

Vector error correction model was employed to analyze short run relationship between the source and destination states. The result in Table 6 revealed that the short-run coefficients of Bauchi and Abia, Bauchi and Enugu and also Bauchi and Cross River States were 0.9372, 0.7958 and 0.9870. This suggested that a % increase in Bauchi state cowpea price would lead to increase of 93.7%, 79.6% and 98.7% in Abia, Enugu and Cross River States cowpea prices respectively. The short run coefficients of Jigawa State were 0.2053. This signified that 1% increase in Jigawa State would lead to 20.5% increase in Enugu state. River State had the short run coefficient of 0.4075 and 0.6481. Meaning that a % rise in River State cowpea price would lead to 40.6% and 64.8% increase in Gombe and Nasarawa States in the short run respectively. Therefore, there was short run relationship between the source and destination states as reported by Taru (2014) that a 1% rise in the urban price of rice increased the rural price by 18% in the short run and Adekunle and Momoh (2016) who reported that rural price of cowpea in Lagos and Oyo States exert a significant ($p < 0.01$) and positive influence on urban price of cowpea in Lagos State in the short run. This also implied that 1% increase in rural price of cowpea in Lagos State and rural price of cowpea in Oyo State result to an increase in urban price of cowpea in Lagos State by 2.92 and 0.24% in the long run and evidence from the F-statistics and the adjusted R^2 suggested that the variables in the VECM

significantly explained short run changes in urban price of cowpea in Lagos State, rural price of cowpea in Lagos State and rural price of cowpea in Ogun State at $p < 0.05$, accounting for 55%, 63% and 87% of the short run variation in the series respectively.

Table 6: Short Run Relationship between the Source and Destination States

States	Coefficient	Std. error	T-value
Bauchi and Abia	0.937219	0.23862	3.92765***
Bauchi and Enugu	0.795776	0.24282	3.27726***
Bauchi and Cross River	0.986966	0.35770	2.75922***
Jigawa and Enugu	0.205307	0.09667	2.12376**
River and Gombe	0.407511	0.17453	2.33489**
River and Nasarawa	0.648094	0.23520	2.75553***

Source Output from E-views

Note *** and ** denote the level of significance at 1% and 5% respectively

CONCLUSION

The study concluded that, there was integration between the cowpea prices of source and destination states, but the degree of integration was weak. There was also an evidence of causation with River State market price occupying the lead position in Nigeria's cowpea market price. Therefore, it was the major price formation and transmission in Nigeria, and it was expected to drive the market price for other cowpea marketplaces in Nigeria and weak exogeneity among the price series of cowpea markets in Nigeria,

RECOMMENDATIONS

Based on the findings of the study, the following recommendations were made to ensure that cowpea markets price is fully integrated in the future in Nigeria.

Market participants should adopt standardized trading, settlement practice and invest in technology (electronic trading platform) to reduce operational inefficiencies in different markets to support integration.

1. Market participants, Government and non-governmental organizations (NGOs) should facilitate exchange of market information and data across markets to ensure transparency, improved decision making and strengthen causal relationship.
2. Government and non-governmental organizations (NGOs) should establish market information dissemination channels and extension service delivery about current demand, supply, and price signals to keep market participants informed about current demand, supply, and prices from various and coordinates responses to market dynamics.

3. Market participants should cross market arbitrage activities to exploit short term mispricing and quick align prices and conditions across inter-connected markets.
4. There is a strong need for private organizations and the government, through cowpea marketers, to provide more and better dissemination of market intelligence and information among farmers and traders in order to improve knowledge, which would help combat supply uncertainty and reduce risk associated with inter-market trade, as well as provide a means of storing cowpea in times of surplus.

REFERENCES

- Adekoya, O. A., Ashaolu, O. F., Adewuyi, S. A., Phillip, S. A., Dipeolu, A.O. and Omotayo, A. M. (2013). Price Trend Analysis of Selected Food Grains in Ogun state, Nigeria (1988-2012). *Journal of Agricultural Science and Environment*. 13:104-115.
- Adekunle, C. P. and Momoh, S. (2016). Spatial Integration and Price Formation of Cowpea Markets in Southwest Nigeria. *Ife Journal of Agriculture*. 28(1):15-18.
- Adenegan, K. O., Bamidele, J. A. and Nwauwa, L. O. E. (2016). Spatial Price Linkages of Brown Cowpea (*Vigna unguiculata*) in Nigerian National Markets. *Review of Market Integration*. 8(1 and 2):71-75.
- Akpan, S. B., Udoh E. J. and Udo, U. J. (2014). Monthly Price Analysis of Cowpea (beans) and Maize in Akwa Ibom state, Southern Nigeria. *International Journal of Food and Agricultural*. 2(2):65-86.
- Ayodeji, A. C., Benjamin, O., Emmanuel, O. A. and Daniel, M. (2014). Cowpea Marketing in Mashegu Local Government Area of Niger State. Implications for Sustainable Production and Inclusive Growth in Nigeria. *Journal of Sustainable Development in Africa*. 16(5), 130.
- Ddungu, S. P., Ekere, W., Bisikwa, J., Kawooya, R., Okello, K. D. and Biruma, M. (2015). Marketing and Market Integration of Cowpea (*Vigna unguiculata L. Walp*) in Uganda. *Journal of Development and Agricultural Economics*. 7(1):1-11.
- Dorothy, P. A; Sonny, A. N. C; and Anselm, A. E. (2017). Market Integration of Retail Prices of Soya Beans in Benue and Enugu States A Co-integration Approach. *International Journal of Agricultural Policy and Research*. 5(5):94-103.
- Engle, R. F. and Granger, C. W. J. (1987). Co-integration and Error Correction Representation, Estimation and Testing. *Econometrica*. 55(2):251-276.
- Famine Early Warning Systems Network FEWSNET, (2008). *Nigeria food security outlook*, March to September. Pp.2–8.
- Girei, A. A., Dire, B., Salihu, M. and Iliya, M. M. (2013). Assessment of Problems Affecting the Structure, Conduct and Performance of Cowpea Marketing in Yola North and Yola South

- Local Government Areas of Adamawa State, Nigeria. *British Journal of Marketing Studies*. 1(4):41- 50.
- Gujarati, D. N. (2004). *Basic Econometrics*. 4th edition. The McGraw-Hill Companies, United States.
- Hafer, R. W. and Sheehan, R. G. (1991). *Policy Inference Using VAR Models*. *Econ. Enquiry*. 29(1):44-52. Oxford University Press.
- Hai, L.T.D. (2003). *The Organization of the Liberalized Rice Market in Vietnam*. Proefschrift ter in de Economische Wetenschappen aan de verksuniversiteit Groningen. P. 229.
- Ifejirika, C. A., Arene, C. J. and Mkpado, M. (2013). Price Transmission and Integration of Rural and Urban Rice Markets in Nigeria. *Journal of Agriculture and Sustainability*, 2(1), 66-85.
- Mawazo, M. M., Kisangiri, M. and Ko, J. (2014). Access to Agricultural Market Information by Rural Farmers in Tanzania. *International Journal of Information and Communication Technology Research*. 4:264-273.
- Olanrewaju, O. O., Babatunde, P. E., Oluyede A. A. and Adewale, I. O. (2021). Price Variation and Transmission in Beans Consuming Market of Southwest, Nigeria. *Journal of Perspektif Pembiayaan dan Pembangunan Daerah*. 8(6):34-38.
- Onubogu, O. H. and Dipeolu, A. O. (2019). Agricultural Price Transmission across Space and Time the case of cowpea and yam markets in Nigeria. *Invited paper presented at the 6th African Conference of Agricultural Economists, September 23-26, 2019, Abuja, Nigeria*.
- Onyinyechukwu, H. O. and Adewale, O. D. (2021). Agricultural Price Transmission across Space and Time The case of cowpea and yam markets in Nigeria. *African Journal of Agricultural and Resource Economics*. 16(1):14-26.
- Pratap, K. J. (2016). Commodity Market Integration and Price Transmission Empirical evidence from India. *Theoretical and Applied Economics*. 3 (608):283-306.
- Robinson, E., Nwuneli, N., Henson, S. and Humphrey, J. (2014). Mapping Value Chains for Nutrient-dense Foods in Nigeria. *IDS Evidence Report No. 65*, Institute of Development Studies, University of Sussex, Brighton UK.
- Ross, S. and De Klerk, M. (2012). *Groundnut Value Chain and Marketing Assessment in Eastern Province*. Conservation Farming Unit. Lusaka. Zambia.
- Sadiq, M. S., Singh, I. P., Isah, M. A. and Lawal, M. (2018). Price Transmission and Signal of Cowpea across Zones and Value Chain in Niger State of Nigeria. *Journal of Advancements in Food Technology*. 1(1):4-10.
- Sadiq, M. S., Singh, I. P., Isah, M. A. and Lawal, M. (2019). Price Transmission and Signals of Cowpea across Zones and Value Chain in Niger State of Nigeria. *Agricultural Extension Journal*. 3(4):181-199.

- Silvapulle, P. and Jayasuriya, S. (1994). Testing for Phillipines rice market integration. A multiple co-integration approach. *Journal of Agricultural Economics*. 45(3):369-380.
- Taru, B. (2014). *Price Fluctuation and Market Integration of Selected Cereal Grains in North-Eastern, Nigeria*. (Published Doctorate Dissertation), University of Nigeria, Nsukka, Nigeria. Pp. 33-45.
- Volltrath, T. L. (2003). North American Agricultural market integration and its impact on the food and fiber system. *Agricultural information bulletin No. 784 market and trade economic division Economic and Research Services USDA, USA*.
- Wondemu, K. (2015). Price Transmission Asymmetry in Spatial Grain Markets in Ethiopia. *African Development Review*. 27(2):106-116.
- World Population Prospects (2022). *United Nations population estimates and projections*.
- Zoellick, R. (2008) Food Crisis: How prepared is Nigeria? *In Nigeria Sunday This Day Newspaper*. April 27. P. 25.