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Spatial Market Integration and Price Transmission of Cowpea (Beans) in Nigeria

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A R T I C L E I NFO

Key Words

Market integration

Cowpeamarketing

Cointegration analysis

Bound test

Error correction model

ABSTRACT

The study analyzed market integration of cowpea between source market of Gombe State and destination markets of Abia, Enugu and Imo States. Itused secondary data sources of monthly cowpea prices obtained from National Bureau of Statistics (NBS). The study tested the stationarity of the data series then used the first difference of the series for the study. It also conducted a cointegrated tested using the Johansen model. The trace and *eigen*value tests indicated one cointegrating vector between the source market and destination market prices of cowpea implying that the two price series were cointegraed. The ARDL model was used to establish the existence of long run relationship in the prices of cowpea from the different markets. The result of the bound test of the ARDL shows that there was a long run relationship between source and destination markets since the computed F- statistic was greater than both lower and the upper bound values at all level of significance tested ranging from 1-10 levels of significance. The study therefore concluded that there was a long run relationship in the prices of cowpea among the markets. An ECM value of -0.673was obtained. This implies that, the rate of adjustment of price of67 percent, was a fast rate of adjustment of the markets prices to equilibrium. The study recommends that government should provide good road network system between the source market and the destination markets which could further enhance market integration.

1.0 Introduction

Cowpea (*Vigna Unguiculata L*) is the second world most important grain legumes; it is a popular and important leguminous crop in Africa commonly known as beans in Nigeria, Africa Agricultural Technology Foundation (AATF, 2012). International Institute for Tropical Agriculture (IITA, 2015) stated that, it is an economically important indigenous African leguminous crop. It plays an important role in providing means of living to many people in Africa for both producers and marketers. From its production, rural families derive food, animal feed, and cash income (Akibode, 2011). It has a nutritional values of about 25% of protein and 64% of carbohydrate (Bressani, 1985; Akibode, 2011). Nigeria remains the largest producer and consumer of cowpea in the world (AATF, 2012). Abba, (2013) reported that an average yield of 27.15kg/ha was harvested from the vast area of 3.8 million hectares cultivated with cowpea in Nigeria. Abba (2013) posited that there has been an increase in demand for cowpea in the past few decades which led to the cultivation of cowpea as a sole crop in many parts of the country. The production of a crop without its adequate marketing could lead to waste of limited resources especially at peak of harvest in the production centre. However, with efficient marketing of agricultural produces in general and cowpea in particular, wastage of produces can be curtailed. This could be achieved when there is a flow of trade between markets that are geographically separated; (market integration).Integrated markets can be defined as the markets that are connected through a process of arbitrage. There is undisputable importance of well integrated markets to a country. Linkages to marketing centres have been found to contribute significantly to rural households' escape out of poverty Oladipo*et al.;*(2014). Iregui & Otero (2013) states that in a well- functioning market, competition guarantees that effect of a shock on the price of product in one location propagates to other locations within that market as well, so that producers and consumers are able to exploit arbitrage opportunities. Thus spatial integration permits distant places to absorb excess local supply preventing excessive price falls that would otherwise hurt the profitability of local producers. Trade flow between regions can lead to trade agreement that can enhance better relationship between the regions involved. Trade /agreements are often considered to be the first and smallest step on the road to further integration (Bhagwati & Panagariya, (1996). In African region, different trade agreements have been entered at different times, such agreements are: Organization of Africa Unity (OAU), that metamorphosed to African Union (AU), Economic Community of West African States (ECOWAS),General Agreement on Trade in Services among others.

In recent times, the concept of regional integration is at the centre stage of development, markets that are integrated can be a driving force that could lift people out of poverty since people could engaged on intra or inter -regional trade as long as there is trade flow between the market studied. The realization of the Africa Continental Free Trade Area (AFCFTA) agreement in the year 2018 has brought to lime lite the need for neighbouring States / countries to go into trade agreement on social, economic, political and other issues that hinders the growth and development of the region (Africa Development Bank Group) (ADBG,2018). The AFCFTA has the following objectives such reduce poverty, improve welfare, increase productivity,boost African trade, reduce tariff for member countries, create/ increase employment opportunity thereby lifting upto 30 million people out of extreme poverty. These can be achieved by putting in place trade policy reform and trade facilitation measures that reduce tariff and cover policy like trade facilitation and services; regulatory measures such as sanitary standard and technical barrier to trade as well as complementing existing sub -regional economic communities and trade agreement in African and offer a continental wide regulatory frame work through policy regulation (world Bank, 2018). The achievement of set objectives, is a stepping stone to growth and development among regions /countries, another important issues to consider is the sustenance of the achieved set goals.This calls for sustainable development goals (SGD). The SDG has common objective with the African Continental Free Trade Area (AFCFTA) agreement which are to reduce poverty and promote a peaceful coexistence between people and the planetin the present and in the future through an indicator framework arrived at through global agreement United Nations(UN, 2015).In order to achieve and sustain these goals, the set policies that can enhance the actualization and sustenance should be implemented. This applies to local (country/ region) and global (international) levels. At the local level (States /countries) policies that hinders market integration such as market unionism, high tax rate in business premises, inadequate good road network and lack of market information centreamong others, should be discouraged. At the global level, the AfCFTA agreement is a right policy direction that can help to actualize the SDGs. Therefore, when there is flow of trade (market integration) whether intra or inter-regional, the benefits are the same. It primarily reduces the poverty level of the people and improve on their welfare for economic growth and development of the regions all the things being equal. The study therefore investigated into level of marketintegration of cowpea between the source market of Gombe State and the destination markets of Abia, Enugu and Imo States of Nigeria. Specifically, the study tested (i) stationarity of the data set (ii)level of co-integration (iii) speed of adjustment (ECM) and (iv) the level of integration of the markets studied.

Literature Review

Regionaltrade plays animportant role incontributing towards food security in many regions / States by moving food from surplus to deficit areas(Sunga, 2017). Trade can also provide an important mechanism to address production shortfalls due to extreme weather events as well as natural endowment. In the long term, regional trade cancontribute towards adjusting agricultural production in an efficient manner across States (FAO,2018).Marketing canbe termed as the performance of all business activities that involved in the movement of products from producers to the consumers (Olukosi *et al*., 2007). Marketing according to Kotler (1972) is the set of human activities that ensures the completion of exchange transactions. Marketing focuses on all the activities that are responsible for delivering products from the producers to the consumers.

Spatial integration is the co-movement of price and/ or flow of price between markets. It shows the relationship between two markets that are spatially or temporarily separated (Ddungu *et al.,* 2015). Markets are integrated if their price levels are similar. Spatial integration explains whether the price of good in spatially separated locations is the same after allowance is made for the transportation cost and other barriers to trade. It helps define the degree of interaction in the market, that is, how much the interaction of producers and consumers determine the price of a product (Iregui and Otero 2013). Furthermore, Ddungu (2015) opines that if price changes in one market are fully reflected in an alternative market, then these markets are said to be spatially integrated which indicate overall market performance. The law of one price (LOOP) says that homogenous products should command same price irrespective of the markets location after transportation cost has been accounted for. Market integration occurs if there ispricing efficiency between spatially separated markets within the same state, region/countries. Villanueva *et al.,* (2014) opined that economic theory establishes that, the continuous trade flow between two regions is a sufficient condition to speak of trade integration; also availability of goods and services has effectively increased among the trading partners in the different regions and that the movement towards greater inter-regions hasformed a major agricultural food market in the countries.Generally, agricultural market integration reinforces the role of trade in terms of increasing availability of and access to food in the areas that would have been negatively affected by production disadvantage.Integrated markets can be studied to know their level of connection or integration as long as there is trade flow or arbitrage. In the test of market integration, using price data, co-integration between two data set, represents a long run equilibrium condition; which implies, that the mean and the variance of the data set reverse back to their original values (that is, they do not wonder afar).

In the past market integration were tested using bivariate correlation or ‘static’ model (Gilbert, 1969 and Gupta, 1973) and later on by Ravallion’s (1986) ‘dynamic’ model. But all of the earlier version contained methodological flaws which showed spurious relationship and inefficient estimation. To overcome those problems, Polaskas and Harris- White (1993) proposed a new method based on Engle Granger’s (1987) co-integration test. Furthermore, recent advancement in time series analysis that related to co-integration and error correction mechanism have attained thepeak in testing food market integration (Asche *et.al.,*1999). This study used the co-integrated model to establish the price transmission or long run relationship between the source market and the destination markets. More so, the Engle and Granger (1987), Autoregressive Distributed Lag

(ARDL); co-integration technique or bound test of co-integration (Pesaran *et al.,*2001) analysis were used to established whether there is co-integration between the prices in the destination markets (deficit area) and the prices in the (producer) the source markets (Jaleta, 2012). Time series data are co-integrated when two non -stationarity variable in their level becomes stationary after differencing. This mean that their linear combination make them stationary. The choice of the ARDL model was made because the technique is effective for small or finite sample sizes as well as for non-stationary series that are difference at different level.In other words, the order of integration of appropriate variables may not necessarily be the same hence the ARDL technique has the merits of not requiring a specific identification of the order of the data in question (Pesaran *et al*., 2001). The long run relationship of the underlying variables is detected through the F-statistic (Wald test). In this approach, long run relationship of the series is said to be established when the F-statistic computed exceeds the critical value band of Pesaran *et al.* (2001). It holds that the lower bound critical values assumed that the explanatory variableswere integrated of order zero, or I (0), while the upper bound critical values assumed that variablesare integrated of order of one, or I(1). Therefore, if the computed *F*-statistic is smaller than the lower bound value, then the null hypothesis is accepted and it would be concluded that no long-run relationship exists between the price of the source markets and the destination markets. Conversely, if the computed *F*-statistic is greater than the upper bound value, then it is concluded that there exist long run relationship. On the other hand, if the computed *F*-statistic lies between the lower and upper bound values, then the results are inconclusive. The major advantage of this approach lies in the identification of the co-integrating vectors where there are multiple co-integrating vectors. Furthermore, a dynamic error correction model (ECM) can be derived from ARDL through simple linear transformation. The ECM emerges the short-run dynamics with the long-run stable equilibrium without losing long-run information. The Autoregressive Distributed Lag model (ARDL) as adopted from Davids, (2017) is used in the study. Owning to the nature of non- stationarity of time series data, the following test were conducted; stationary test was conducted using the Augmented Dickey-fuller test and the Johansen co-integrated test.

Research Methodology

The study was carried in Gombe state and three southeastern states of Nigeria namely Abia, Imo and Enugu states. Gombe state is situated in the northern part of Nigeria, it represents the source market due to the fact that beans production is carried out in large capacity. While Abia, Imo and Enugu represent the destination markets (consumption center). The study made use of cowpea (beans) monthly price data from secondary sources obtained from National Bureau of Statistics Abuja (NBS). The monthly price data obtained were from January 2016 to February 2018.According to Tomek and Robinson (1972), the relationship between prices in different markets which are physically separated could be analyzed using the spatial market integration concept. This can be done by utilizing the spatial equilibrium model. This model is developed by using the excess demand and excess supply curves from two regions involved in trade so that it is possible to make forecast of the prices formed in each market and the amount of the commodities to be traded. Some of the previous studies concerning the market integration of agricultural commodities refered to the Ravallion modelMcNew (1996). The study followed the Baylis, *et al.,* (2013) approach using the ADF test stationarity and other authors as shown.

Test for Stationarity

The study used the Augmented Dickey-Fuller test as it is a widely used test for unit root of the series. The ADF is generated following the procedure of Baylis, *et al.,* (2013)

$$\Delta PGo_t = \beta_0 + \beta_1 \Delta PGo_{t-1} + \beta_2 \Delta PAb_{t-1} + \cdots + \beta_k \Delta PIm_{t-1} + \varepsilon_t \ldots (1)$$

where the vector PGo and PAb , PEn and PIm represents the price series in different marketsrepresenting the source (Gombe state, production centre) market and the destination (consumption centre)markets respectively, *t* is the time index; $\Delta P_t = P_t - P_{t-1}$, $^{k}/_{t_3^1} \rightarrow 0$ as t→ ∞and regression residuals behave as a white noise series. β_0 is the deterministic part which can either be 0, a constant or a constant plus a linear time trend. The

null hypothesis of ADF test is that the process has a unit root (nonstationary). A nonstationary time series is said to be integrated at order 1 denoted by *I(1)*.

Table 1

	Constant			Constant and trend		
	Level	1st diff.	Order of integration	Level	1st diff.	Order of integration
Source market						
Gombe	-3.673	-7.960***	I(1)	-4.416***		I(0)
Destination Market						
Abia	-1.746	-5.475***	I(1)	-5.742***		1(0)
Enugu	-2.154	-5.370***	I (1)	-1.456	-6.164***	I(1)
Imo	3.776***		I(0)	-5.700***		I(0)

*** and ** indicates significant at 1 percent and 5 percent, respectively.

The study similarly used the Johansen test to test the null hypothesis that there are at most *r* co-integration vectors in the system. The Johansen test involves the use of the trace test statistic and maximum eigenvalue test.

$\lambda_{Trace} = -T \sum_{i=r+1}^{n} In\,(1 - \widehat{\lambda_i})$... (2)
$\lambda_{Max} = -TIn\,(1 - \widehat{\lambda_{r+1}})$.... (3)

Market integration was analyzed using the Autoregressive Distributed Lag model (ARDL) adopted from Davids, *(*2017). The source market was Gombe states while the destination markets were Abia, Enugu and Imo State. The general ARDL model is stated thus:

$PGo_t = c_0 + c_{1t} + \sum_{i=1}^{PG} \phi_i PGo_{t-1} + \sum_{i=0}^{PAb} \beta_1 Ab_{t-1} + \mu_{t\ldots(4)}$

where

PGo_{ti} = the monthly retail price in the source market during the time *t*Gombe state Go,

PAb_{ti}= the monthly retail price at destination markets at timet [Abia, (Ab) , Enugu (En), and Imo (Im) state] for each market pair.

Re-parameterization yields the error correction specification below:

$\Delta PGo_t = c_0 + c_{1t} - \alpha(pgo_{t-1} - \theta pab_t) + \sum_{1=1}^{p-1} \delta pg_i \Delta PGo_{t-1} + \sum_{i=1}^{q-1} \delta^1 pab_i \Delta PAb_{t-1} + \mu_{t\ldots}$(5)

$\alpha = 1 - \sum_{j=1}^{p}$,…(6)

= speed of adjustment and the long run coefficient

$\theta = \frac{\sum_{j=0}^{q} \beta_j}{\alpha}$...(7)

μ= error correction term

c_0, c_1, δ and $\delta^1$are parameters estimated

The coefficient on the error correction term αgives an indication of the length of time required for a shock that causes dis-equilibrium to be absorbed through the system. A negative coefficient confirms convergence back to equilibrium conditions following an external shock, while the magnitude of the coefficient is indicative of the time required to return to equilibrium.

Diagnostics Tests

Normality Test: Jargue-Bera is a test statistic for testing whether the series is normally distributed. The test statistic measures the difference of the skewness and kurtosis of the series with those from the normal distribution. The statistic is computed as:

Jarque-Bera = $\frac{N}{6}\left(S^2 + \frac{(K-3)^2}{4}\right)$ ………….. (8)

Where S is the skewness, and K is the kurtosis. Under the null hypothesis of a normal distribution, the Jarque-Bera statistic is distributed as X^2 with 2 degrees of freedom. The reported Probability is the probability that a Jarque-Bera statistic exceeds (in absolute value) the observed value under the null hypothesis—a small probability value leads to the rejection of the null hypothesis of a normal distribution.

Serial Correlation Lagrange Multiplier(LM) Test

Unlike the Durbin-Watson statistic for autoregressive (AR) (1) errors, the LM test is used to test for higher order autoregressive moving average (ARMA) errors and is applicable whether there are lagged dependent variables or not. It is used when there is possibility that the errors exhibit autocorrelation. The null hypothesis of the LM test is that there is no serial correlation up to lag order *P*, where *P* is a pre-specified integer. The local alternative is ARMA (*r, q*) errors, where the number of lag terms *P* =max (*r, q*). This alternative includes both AR(*P*) and MA(*P*) error processes, so that the test may have power against a variety of alternative autocorrelation structures. The test statistic is computed by an auxiliary egression as follows. From an estimated regression

$\gamma_t - X_t\beta + \epsilon_t$ ………(9);

where β are the estimated coefficients and∈are the errors. The test statistic for lag order *P* is based on the auxiliary regression for the residuals e = $\gamma - X\hat{\beta}$ ……..(10): and

$\epsilon_t = \chi_t\gamma + \left(\sum_{\varepsilon=1}^{p} \alpha_\varepsilon \epsilon_{t-\varepsilon}\right) + v_t$ …………………………..(11)

where, γ_t and X_t = dependent and independent variables at period t.

Heteroskedasticity Test

The Breusch-Pagan-Godfrey test is a Lagrange multiplier test of the null hypothesis of no heteroskedasticity against heteroskedasticity of the form

$$\sigma_t^2 = \sigma_h^2\left(z_t'\alpha\right) \ldots\ldots\ldots (12)$$

where, z_t is a vector of independent variables. Usually this vector contains the regressors from the original least squares regression. From a given regression equation of

$Y_t = \beta_1 + \beta_2X_t + \beta_3Z_t + e_t$ ………. (13)

where the b are the estimated parameters and e the residual. The test statistic is then based on the auxiliary regression: $e_t^2 = \alpha_0 + \alpha_1X_t + \alpha_2Z_t + \alpha_3x_t^2 + \alpha_4Z_t^2 + \alpha_5X_tZ_t + v_t$ …………..(14)

where X_t and Z_t are independent variables, $\alpha_0 - \alpha_5$ are the estimated parameters and Y_t = dependent variable.

Ramsey's RESET Test

RESET stands for Regression Specification Error Test and was proposed by Ramsey (1969). The classical normal linear regression model is specified as:

Y = XB + e …………………….(15)

where the disturbance vector *e* is presumed to follow the multivariate normal distribution *N(0,* σ^2*I)*, Specification error is an omnibus term which covers any departure from the assumptions of the maintained model. Serial correlation, heteroskedasticity, or non-normality of all violate the assumption that the disturbances are distributed. In contrast, RESET is a general test for the following types of specification errors:

Omitted variables; X does not include all relevant variables; Incorrect functional form; some or all of the variables in *Y* and *X* should be transformed to logs, powers, reciprocals, or in some other way; Correlation between *X* and *e*, which may be caused, among other things, by measurement error in X, simultaneity, or the presence of lagged Y values and serially correlated disturbances.

Under such specification errors, LS estimators will be biased and inconsistent, and conventional inference procedures will be invalidated. Ramsey (1969) showed that any or all of these specification errors produce a non-zero mean vector for *e*. Therefore, the null and alternative hypotheses of the RESET test are:

$$H_0:\ \epsilon \sim N(0, \sigma^2 I)$$
$$H_1:\ \epsilon \sim N(\mu, \sigma^2 I) \qquad \mu \neq 0 \quad ..\ (16)$$

The test is based on an augmented regression:

$$y = X\beta + Z\gamma + \epsilon \quad ....(17)$$

The test of specification error evaluates the restriction Y = *0.*

CUSUM of Squares Test

The CUSUM of squares test (Brown, Durbin, and Evans, 1975) is based on the test statistic:

$$S_t = \left(\sum_{r=k+1}^{t} w_r^2\right) \Big/ \left(\sum_{r=k+1}^{T} w_r^2\right) \quad ....\ (18)$$

The expected value of S_t under the hypothesis of parameter constancy is:

$$E(S_t) = (t-k)/(T-k) \quad ....\ (19)$$

which goes from zero at t = k to unity at t = T. The significance of the departure of S from its expected value is assessed by reference to a pair of parallel straight lines around the expected value.

The CUSUM of squares test provides a plot of St against t and the pair of 5 percent critical lines. As with the CUSUM test, movement outside the critical lines is suggestive of parameter or variance instability.The cumulative sum of squares is generally within the 5% significance lines, suggesting that the residual variance is somewhat stable.

Unit Root Test

MacKinnon (1996) one-sided p-values *, ** *** , and * indicates 1 %,5% and 10% level of significance representing -3.724070, -2.9862 and -2.632604 with their values at level respectively. Their values at 1st difference of 1%, 5% and10% are - 3.737853, -2.991878 and -2.635542 respectively. Their values at Constant and Trend at level or zero order of integration are -4.374307, -3.603202 and -3.238054 while the values at first difference are -4.394309, -3.6121 and -3.243079 at 1% , 5% and 10% level of significance respectively.

The result in Table:1 shows that the prices of cowpea at the different markets were not stationary at level. The null hypothesis was that, there was a unit root among the time series. For the source markets, the price of cowpea at Gombe States was integrated at first difference I (1), with a deterministic constant only. However, the unit root test with a deterministic constant and trend shows that price of cowpea at Gombe states was integrated at order zero I (0) .

For prices of cowpea at the destination markets, Abia and Enugu states were integrated at first difference I(1) while Imo state was integrated at order zero I(0), with a deterministic constant and trend, Abia and Imo states were integrated at order zero I(0) while Enugu was integrated at first difference I(1).This shows that there was a mixed specification of the order implying that the series were not consistent over time. The prices of cowpea at both source and destination markets were influenced by time. The first differences of the price series of cowpea at the source and destination markets were generated and used in the study. Having establish the stationarity of the prices the study conducted the co-integration test to show the relationship between price of cowpea in the source and destination markets.

Johansen cointegration test

The result in Table: 2 was used to identify the cointegration relationship in price of cowpea between source and destination markets using Johansen (1995) standard linear cointegration test

More so, Gombe market of cowpea (source market) and the various markets of cowpea in Abia, Imo and Enugu states (destination markets), the null hypothesis of no co-integration was rejected against the alternative of at least one cointegration vector with p-value of 1 percent (LRtrace=29.872 and LRmax=23.712) whereas null of one cointegration vector could not be rejected (LRtrace = 5.160 and LRmax = 5.160) with p-value of greater than 10 percent for Gombe-

Abia state market chain. The study found similar results for Gombe-Imo state market prices of cowpea where the null hypothesis of no cointegration was rejected against the alternative of at least one cointegration vector with p-value of 1 percent (LRtrace=36.267 and LRmax=28.053) whereas null of one cointegration vector could not be rejected (LRtrace = 8.214 and LRmax = 8.214) with p-value of greater than 10 percent. It found Gombe-Enugu state market prices of cowpeawhere the null hypothesis of no cointegration was rejected against the alternative of at least one cointegration vector with p-value of 1 percent (LRtrace=28.097 and LRmax=22.802) whereas null of one cointegration vector could not be rejected (LRtrace = 4.295 and LRmax = 4.295) with p-value of greater than 10 percent. The findings are in consonance with the work of Mohammadand Raghbendra, (2016) who reportedthat a null hypothesis of no cointegration was rejected against the alternative of at least one cointegration vector with p-value of 1 percent (LRtrace=36.173 and LRmax=30.337) whereas null of one cointegration vector could not be rejected (LRtrace=5.836 and LRtrace=5.836). Therefore, the source market price of cowpea and destination market prices of cowpea are cointegrated.

Table 2:

GOP(c) -ABP(c)	**λ_{trace}**	**r = 0 vs r ≥ 1**	**29.872*** **	**18.398**	**Rejected**
(l=2; AIC, BIC)		**r ≤ 1 vs r ≥ 2**	**5.160**	**3.841**	**Not rejected**
	λ_{max}	r = 0 vs r ≥ 1	23.712***	17.148	Rejected
		r ≤ 1 vs r ≥ 2	5.160	3.841	Not rejected
GOP(c) -IMP(c)	λ_{trace}	r = 0 vs r ≥ 1	36.267***	18.398	Rejected
(l=2; AIC, BIC)		r ≤ 1 vs r ≥ 2	8.214	3.841	Not rejected
	λ_{max}	r = 0 vs r ≥ 1	28.053***	17.148	Rejected
		r ≤ 1 vs r ≥ 2	8.214	3.841	Not rejected
GOP(c) -ENP(c)	λ_{trace}	r = 0 vs r ≥ 1	28.097***	18.398	Rejected
(l=2; AIC, BIC)		r ≤ 1 vs r ≥ 2	4.295	3.841	Not rejected
	λ_{max}	r = 0 vs r ≥ 1	22.802***	17.148	Rejected
		r ≤ 1 vs r ≥ 2	4.295	3.841	Not rejected

Notes: Model includes only drift in the cointegration space; *** and ** indicates significant at 1 percent and 5 percent, respectively. LR =likelihold ratio

Speed of adjustment of price of cowpea between the source and the destination markets.

The speed of adjustment which tell the leading market in terms of price determination of cowpea between the source and the destination markets are presented in Table:3

Table 3

Vertical markets	Estimates	Standard errors	t-statistics
GOP(c) -	-0.885**	0.372	-2.379
ABP(c)	-0.016	0.063	-0.252
GOP(c) -	-0.208***	0.076	-2.718
IMP(c)	-0.091	0.329	-0.275
GOP(c) -	-0.195	0.249	-0.786
ENP(c)	-0.078***	0.029	-2.732

Note: *** and ** indicates level of significance at 1 percent and 5 percent, respectively.

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The estimated speed of adjustment (-0.885) for Abia state (independent market) for cowpea to Gombe state (dependent market) for cowpea prices was statistically significant at 5% level while the estimated speed of adjustment (-0.016) for Gombe (independent market) for cowpea to Abia state (dependent market) for cowpea prices was not statistically significant (t = -0.252, P > 0.05). This indicates that it takes about three months to correct the disequilibrium error for Abia state market for cowpea to Gombe market for cowpea prices. The speed of adjustment for Abia state market of cowpea to Gombe market of cowpea prices found to be significant gave an indication that only the Gombe market price for cowpea adjusted to the changes in Abia state market price of cowpea. This implies a unidirectional movement in the opposite direction. For Imo state (independent market) prices to Gombe state (dependent market) market price of cowpea, the speed of adjustment estimate was -0.208 and was significant at 1% level, but the reverse of the estimate was insignificant (t = -0.275, P > 0.05). This indicates that only the Gombe state market price for cowpea adjusts to the changes in Imo state market price of cowpea and it takes about a month to correct the disequilibriumerror. The speed of adjustment estimate of Enugu state (independent market) price of cowpea to Gombe state (dependent market) price of cowpea was -0.195 with the p-value greater than 10 percent (not significant) while the speed of adjustment estimate in Gombe state (independent market) price of cowpea to Enugu state (dependent market) price of cowpea was -0.078 with the p-value of 1 percent. This indicates that the Enugu market price for cowpea adjusts to the changes in Gombe state market price of cowpea only and ittakes at most 2 weeks to correct the disequilibrium error. This implies fast transmission, andcoroborates the work of Assunçãoa, and Wanderbc (2017) who

Table 4

Gombe-Abia	**Weak exogeneity**	**$\alpha_1 = 0$ *vs* $\alpha_1 \neq 0$** **$\alpha_2 = 0$ *vs* $\alpha_2 \neq 0$**	**6.853^{**}** **0.778^{ns}**	**GP(c) → ABP(c)**
	Short-run causality	$\Sigma\beta_i = 0$ *vs* $\Sigma\beta_i \neq 0$ $\Sigma\beta_j = 0$ *vs* $\Sigma\beta_j \neq 0$	2.065^{ns} 1.746^{ns}	GP(c) ≠ ABP(c)
	Strong exogeneity	$\Sigma\beta_i = 0, \alpha_1 = 0$ *vs* $\Sigma\beta_i \neq 0, \alpha_1 \neq 0$ $\Sigma\beta_j = 0, \alpha_2 = 0$ *vs* $\Sigma\beta_j \neq 0, \alpha_2 \neq 0$	11.998^{***} 2.110^{ns}	GP(c) → ABP(c)
Gombe- Imo	Weak exogeneity	$\alpha_1 = 0$ *vs* $\alpha_1 \neq 0$ $\alpha_2 = 0$ *vs* $\alpha_2 \neq 0$	6.146^{**} 1.869^{ns}	GP(c) → IMP(c)
	Short-run causality	$\Sigma\beta_i = 0$ *vs* $\Sigma\beta_i \neq 0$ $\Sigma\beta_j = 0$ *vs* $\Sigma\beta_j \neq 0$	0.339^{ns} 0.056^{ns}	GP(c) ≠ IMP(c)
	Strong exogeneity	$\Sigma\beta_i = 0, \alpha_1 = 0$ *vs* $\Sigma\beta_i \neq 0, \alpha_1 \neq 0$ $\Sigma\beta_j = 0, \alpha_2 = 0$ *vs* $\Sigma\beta_j \neq 0, \alpha_2 \neq 0$	12.946^{***} 2.227^{ns}	GP(c) → IMP(c)
Gombe- Enugu	Weak exogeneity	$\alpha_1 = 0$ *vs* $\alpha_1 \neq 0$ $\alpha_2 = 0$ *vs* $\alpha_2 \neq 0$	5.782^{**} 0.329^{ns}	GP(c) → ENP(c)
	Short-run causality	$\Sigma\beta_i = 0$ *vs* $\Sigma\beta_i \neq 0$ $\Sigma\beta_j = 0$ *vs* $\Sigma\beta_j \neq 0$	0.005^{ns} 1.216^{ns}	GP(c) ≠ ENP(c)
	Strong exogeneity	$\Sigma\beta_i = 0, \alpha_1 = 0$ *vs* $\Sigma\beta_i \neq 0, \alpha_1 \neq 0$ $\Sigma\beta_j = 0, \alpha_2 = 0$ *vs* $\Sigma\beta_j \neq 0, \alpha_2 \neq 0$	14.398^{***} 2.444^{ns}	GP(c) → ENP(c)

Notes: → and ≠ means unidirectional causality and no causality, respectively. ***and ** indicates level of significance at 1 percent and 5 percent, respectively.

reported that Paracatu (MG) has a transmission period of 18 days and Unaí (MG) has 11 days. The signs of the estimates are negative implying that the model convergence.

Wald causality test of prices of cowpea prices

The Wald causality test that shows the direction of flow of cowpea prices between source and destination markets are presented in Table:4.

Furthermore, Gombe market price of cowpea as the source market and the destination market prices of cowpea in Abia, Imo and Enugu states, weak exogeneity results showed unidirectional causality between the source market prices of cowpea and the destination market prices of cowpea. The X^2-test statistics 6.853, 6.146 and 5.782 for Gombe-Abia, Gombe-Imo and Gombe-Enugu market prices of cowpea respectively were rejected at 5 percent level. In addition, strong exogeneity supports similar conclusions. The X^2-test statistics 11.998, 12.946 and 14.398 for Gombe-Abia, Gombe-Imo and Gombe-Enugu market prices of cowpea respectively are rejected at 5 percent level. This finding conforms to *a prior* expectation of upstream prices dominating the prices at downstream.

Non-parameterized ARDL Result of Market Integration between Source Market (Gombe State) Price and the Destination Markets Abia, Enugu and Imo States Prices.

The result for the Non parameterized market integration between source and destination markets is presented in Table :5

Table :5 showed the non-parameterized estimate of market integration of cowpea between source market (Gombe State) price and the destination markets prices of Abia, Enugu and Imo states. The Autoregressive Distributed Lag (ARDL) result shows that cowpea prices at source market (Gombe State) are integrated with prices at the destination markets in the South east Nigeria which are Abia, Enugu and Imo State.

Table:5 Non-parameterized ARDL result of market integration between source market (Gombe State) price and the destination markets Abia, Enugu and Imo States prices

Variable	Coefficient	Std. Error	t-Statistic
LOG(GOMBE(-1))	-0.166	0.175	-0.948
LOG(ABIA)	5.899	1.569	3.759436***
LOG(ABIA(-1))	-1.503	1.505	-0.999
LOG(ABIA(-2))	-3.044	1.696	-1.794877*
LOG(ABIA(-3))	7.558	1.696	4.455785***
LOG(ENUGU)	0.502	1.606	0.312
LOG(ENUGU(-1))	-0.677	1.823	-0.371
LOG(ENUGU(-2))	1.483	1.618	0.917
LOG(ENUGU(-3))	-12.279	2.629	-4.670905***
LOG(IMO)	-0.614	0.202	-3.035417**
LOG(IMO(-1))	-0.726	0.220	-3.301192***
LOG(IMO(-2))	-0.834	0.225	-3.712132***
LOG(IMO(-3))	6.610	1.932	3.421000***
Constant	-7.003	3.302	-2.120891*
R-squared	0.816		
Adjusted R-squared	0.549		
F-statistic	3.061756**		
Durbin-Watson stat	1.665		

Source: Computed from NBS, January 2016-February 2018 (data on cowpea Gombe, Abia, Enugu and Imo states)

The R^2 value of 0.815584 implies that 81. 6% of total variation in prices of cowpea in the source market (Gombe state) was accounted for by changes in prices at the destination markets Abia, Enugu and Imo States and vice versa. The F-statistics value was 3.061756 and was significant at 5 % level of significance. This implies the goodness of fit of the model. The destination market prices that influenced source market price Gombe significantly were Abia and Imo states in the long run while in the short run, Abia, Enugu and Imo states prices significantly influenced (Gombe State) source market.

The coefficient of the price of cowpea in Abia State at level and lag 3 had positive signs and were significant at 1% respectively. While lag 2 had negative sign but was significant at 10% level as it relates to the price of cowpea in Gombe state. The net effect of the lag of prices was 10.413483. This implies that an increase in price of cowpea in the destination market (Abia State) leads to an increase in price of cowpea in the source market (Gombe State). The net regression coefficient of 10.413483 implies that a unit naira increase in the price of cowpea at the destination market leads to ₦10.413483 increase in the price of cowpea in the source market Gombe state. This could be as a result of increase in demand for cowpea at the source market by marketers as well as market information obtained from destination market on price increase. The work corroborates the work of Mayaka, (2013) who reported that there existed a long run relationship or equilibrium condition between the price of beans in Nairobi market and Nakuru, Eldoret and Kitale, Nakuru with Kitale and Eldoret with Kitale, that all the markets were co-integrated at 5 percent level ofsignificance. A unit change in prices of beans in Nairobi market leads to a proportionate change in the price of beans in Nakuru market and the other.

The coefficient of price of cowpea in Enugu state at lag 3 was negatively signed and significant at 1% level. This implies that an increase in price of cowpea in the destination market (Enugu State) leads to a decrease in price of cowpea in the source market (Gombe State). The coefficient of the regression of -12.27915 implies that a unit naira increase in price of cowpea in the destination market (Enugu state) leads to an elastic decrease in the price of cowpea at the source market Gombe State by ₦ 12.27915. This could be attributed tothe fact that Enugu state is said to have other substitute commodities to cowpea. The findings corroborate the work of Shrestha*et al.,* (2014) who reported that an increase in the price of tomato in Kathmandu market leads to a change in the price of tomato in Chitwan market.

The coefficient of price of cowpea in Imo state at lag 1 and 2 were negatively signed and significant at 1%, but Imo price at lag 3 had positive sign and was significant at 1%. The net effect of the lags price of cowpea in Imo state was 4.437479. This implies that an increase in price of cowpea in the destination market (Imo State) leads to an increase in price of cowpea in the source market (Gombe State). The net regression coefficient of 4.437479 implies that a unit increase in price of cowpea in the destination market (Imo state) leads to an elastic increase in the price of cowpea at the source market (Gombe State) by ₦ 4.437479. The findings corroborate the work of Mayaka, (2013) who reported that Eldoret and Kitale markets were co-integrated at 5 percent level ofsignificance. A unit change in prices of beans in Nldoret market leads to a proportionate change in the price of beans in Kitale market.

ARDL Bound test for long run relationship between the source market Gombe and the destination markets (Abia, Imo and Enugu).

The long run relationship between the source market (Gombe) and the destination markets (Abia, Imo and Enugu) States are presented in Table: 6.

The result of the bound test from Table 6: shows that there existed a long run relationship since the computed F- statistic is greater than both lower and the upper bound values at all levels of significance tested. The study therefore rejected the null hypothesis of there is no long run relationship between price in the source market (Gombe State)

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and destination markets (Abia, Enugu and Imo States) and concluded that there existed a long run relationship in the price of cowpea among the markets.

Table:6 ARDL Bound Test for Long Run Relationship Between the Source Market and the Destination markets

F-Bounds Test		Null Hypothesis: No levels relationship		
Test Statistic	Value	Significance.	I(0)	I(1)
F-statistic	13.634	10%	2.72	3.77
K	3	5%	3.23	4.35
		2.5%	3.69	4.89
		1%	4.29	5.61
t-Bounds Test		Null Hypothesis: No levels relationship		
Test Statistic	Value	Significance.	I(0)	I(1)
t-statistic	-8.5272	10%	-2.57	-3.46
		5%	-2.86	-3.78
		2.5%	-3.13	-4.05
		1%	-3.43	-4.37

Source: Computed from NBS, January 2016-February 2018 (data on cowpea Gombe, Abia , Enugu and Imo states)

Test for long, short run and error correction mechanism (ECM) estimate of market integration between source market (Gombe State) and destination markets (Abia, Imo and Enugu States)

The result of the estimate of long, short run and error correction mechanism of the source market (Gombe) and the destination market Abia Imo and Enugu states is presented in Table:7

Table:7 shows the Autoregressive Distributed Lag (ARDL) result of the long run estimate of price of cowpea at source market (Gombe State) and prices of cowpea at destination markets of (Enugu and Imo States). The R^2 value of 0.878192implies that 87.8 % of total variation in prices of cowpea in the source market (Gombe state) was accounted for by changes in prices at the destination markets, Abia, Enugu and Imo State and vice versa. The F-statistics value was 8.651585 and was significant at 1% level. This implies the goodness of fit of the model. The destination market prices that showed significant long relationship with source market (Gombe state) were Abia, Enugu and Imo States.

Table 7: Long, short run and error correction mechanism (ECM) estimate of market integration between source markets and destination markets

Variable	Coefficient	Std. Error	t-Statistic
Long Run			
LOG(ABIA)	7.644	1.657	4.613895***
LOG(ENUGU)	-9.412	2.201	-4.276180***
LOG(IMO)	3.807	1.533	2.482449**
C	-6.007	2.919	-2.057759*
Short Run			
DLOG(ABIA)	5.899	1.569	3.759436***
DLOG(ABIA(-1))	3.044	1.696	1.795
DLOG(ABIA(-2))	-7.558	1.696	-4.455785***
DLOG(ENUGU)	0.502	1.606	0.312
DLOG(ENUGU(-1))	-1.483	1.618	-0.917
DLOG(ENUGU(-2))	12.279	2.629	4.670905***
DLOG(IMO)	-0.614	0.202	-3.035417**
DLOG(IMO(-1))	0.834	0.225	3.712132***
DLOG(IMO(-2))	-6.610	1.932	-3.421000***
CointEq(-1)	-0.673	0.101	-6.668632***
R-squared	0.878		
Adjusted R-squared	0.777		
F-statistic	8.652		
Durbin-Watson stat	1.665		
Breusch-Godfrey Serial Correlation LM Test	0.393		
Heteroskedasticity Test: Breusch-Pagan-Godfrey	2.093		

Source: Computed from NBS, January 2016-February 2018 (data on cowpea Gombe, Abia, Enugu and Imo States)

The coefficient of cowpea prices of Abia State had a positive sign and was significant at 1% level. This implies that there existed a long run relationship between the price of cowpea at source market prices (Gombe State) and Abia State. This implies that a unit increase in the price of cowpea in the destination market (Abia State), leads to an increase in price of cowpea at the source market (Gombe State). The regression coefficient of7.643828 implies that a unit naira increase in the price of cowpea at the destination market leads to ₦7.643828 increase in the price of cowpea in the source market (Gombe state). The findings are in agreement with Demise *et al*., (2017) who reported that a unit change in the price of coffee in the destination market leads to an increase in the source market.

The coefficient of Enugu State had a negative sign and was significant at 1% level. This implies that there existed a long run relationship between the price of cowpea at source market prices (Gombe State) and Enugu State, that is a unit increase in the price of cowpea in the destination market (Enugu State), leads to a decrease in price of cowpea at the source market (Gombe State). The regression coefficient of-9.411825 implies that a unit naira increase in price of cowpea in the destination market (Enugu State) leads to an elastic decrease in the price of cowpea at the source market Gombe state by ₦9.411825. The increase in price of cowpea in the destination market (Enugu state) leads to a decrease in the demand for cowpea in the destination market which transcends to decrease in the demand of cowpea in the source market of Gombe hence the decrease in the price of cowpea at source market (Gombe State). This could be attributed to the fact that Enugu state is said to have other substitute commodities to cowpea. The findings are in agreement with the work ofVigila*et al*.,(2017) who reported that there was a long run relationship between Gujarat market potato price and the potato price in Tamil Nadu market.

Similarly, the coefficient of Imo State prices had a positive sign and was significant at 5 %. This implies that there existed a long run relationship between the prices of cowpea at Gombe and Imo States. However, a unit increase in price of cowpea in Imo leads to an increase in the price of cowpea in (Gombe State). The regression coefficient of 3.806831 implies that a unit naira increase in the price of cowpea at the destination market leads to an elastic increase by ₦3.80683 in the price of cowpea at the source market (Gombe State). The findings are in agreement with Demise *et al*., (2017) who reported that a unit change in the price of coffee in the destination market leads to an increase in the source market.

Table 4.16 also shows the short run estimate of price of cowpea at source market (Gombe State) and prices of cowpea at destination markets of Abia, Enugu and Imo States. The destination market price shows that there existed a short runrelationship between source market and the destination markets of Abia, Enugu and Imo states.

The coefficient of cowpea prices of Abia State at level had a positive sign and was significant at 1% level, while Abia price at lag 2 had a negative sign but was significant at 1% level. The net effect of the lag prices was -1.65923. This implies that there existed a short run relationship or equilibrium condition between the price of cowpea at source market prices (Gombe State) and Abia State. This implies that a unit increase in the price of cowpea in the destination market (Abia State), leads to a decrease in the price of cowpea at the source market (Gombe State). The net regression coefficient of -1.65923 implies that a unit naira increase in the price of cowpea at the destination market leads to ₦ 1.65923decrease in the price of cowpea in source market (Gombe State). Hossain and Verbeke, (2010) work corroborates this finding that 1% increase in rice prices inChittagong leads to decreases in prices of rice in Rajsha region by 0.2%; thatChittagong is a rice-importing and Rajshahi a rice-producingregion. The gains of price increases do not transfer from Chittagong toRajshahi. The gains were captured by marketing agencies, not by farmers.Due to the long distance between Chittagong and Rajshahi, pricesignals were not transmitted accurately and correctly.

The coefficient of Enugu State at lag 2 had a positive sign and was significant at 1% level. This implies that there existed a short run relationship or equilibrium condition between the price of cowpea at source market prices (Gombe State) and Enugu State. This implies that a unit increase in the price of cowpea in the destination market (Enugu State), leads to an increase in the price of cowpea at the source market (Gombe State) at the short run. The regression coefficient of 12.279145 implies that a unit naira increase in the price of cowpea at the destination market leads to ₦ 12.279145 increase in the price of cowpea in source market (Gombe State). The finding is in agreement with the work of Ekananda and Suryanto (2018) who reported that a unit change in the world soybean prices have a positive and significant effect both in the short-term and long run increase in domestic soybean prices by 0.086%.

The coefficient of Imo State cowpea prices at level and lag 2 were negatively signed and were significant at 5% and 1 % levels respectively, while price at lag 1(one) had a positive sign. The net effect of lags of price was -6.39034. This implies that there existed a short run relationship between the prices of cowpea at Gombe and Imo State. However, a unit increase in price of cowpea in Imo state causes a reduction in the price of cowpea in Gombe State at the short run. The net regression coefficient of -6.39034 implies that a unit naira increase in the price of cowpea at the destination market leads to ₦6.39034 decrease in the price of cowpea in source market (Gombe State). The finding is in consonance with the work of Hossain and Verbeke, (2010) that corroborate the findings that 1% increase in rice prices inChittagong leads to a decrease in prices of rice in Rajsha region by 0.2%. That is Chittagong is a rice-importing and Rajshahi a rice-producingregion. The gains of price increases do not transfer from Chittagong toRajshahi but accrued to the marketing agencies alone.

The Error Correction Mechanism estimate had a negative sign and was significant at 1%. Thisimplies the speed of adjustment or the rate of feedback or shock of prices that are transmitted or transferred to another market that are spatiallyseparated from one another. Similarly, the ECM coefficient was significant and negative implying co-integration of the model and the convergence of the price to equilibrium. The ECM value was -0.672566 which implied that, the rate of adjustment of price is 67.3 percent suggesting a fast rate of adjustment of the two markets to equilibrium. This further suggest that it will take exactly 8 months and 5 days for prices disequilibrium between the source market of Gombe State and the destination markets of Enugu and Imo States to adjust to equilibrium in the long run.

Breusch-Godfrey Serial Correlation LM was conducted to test for serial correlation of variables, the test showed that they were not significant hence we concluded that variables were not serially correlated. More so the heteroskedasticity test was also carried out using the Breusch-Pagan-Godfrey test. The test result showed that independent variables were not correlated witherror term. This implies that the error term is independent of the exogenous variables.

Table 8: Residual and stability diagnostics

Ramsey RESET test	LM	HET	JB
0.6354 (0.5037)	0.3931 (1.2964)	2.0928 (1.5193)	0.0785 (0.9374)

Diagnostic Tests

To estimate the goodness of fit of the ARDL model, residual diagnostics and stability diagnostics were carried out. Residual diagnostics was conducted using the Jacque-bera normality test (JB), Breusch-Godfrey Serial correlation LM test, and Breusch-Pagan-Godfrey heteroscedasticity test (HET) while stability diagnostics was conducted using Ramsey RESET test and CUSUM of squares test (see Table 8). These tests show that the model used in this study is not miss-specified and that the model is of good fit. Results show that for residual tests, the

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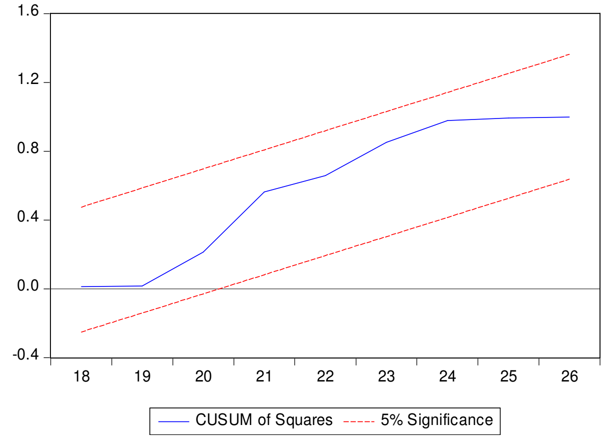
coefficients of Breusch-Godfrey Serial correlation LM test (LM), Breusch-Pagan-Godfrey heteroscedasticity test (HET), and Jacque-bera normality test (JB) were not statistically significant. Therefore, the null hypothesis cannot be rejected at 5% level of significance for serial correlation, heteroscedasticity and Jacque-Bera normality tests. This implies that no serial correlation exists, no heteroscedasticity exists and residuals are normally distributed. Results also show that for model stability tests, the coefficient of Ramsey RESET test was not statistically significant. Also, the CUSUM of squares tests show the stability of the model. The CUSUM of square test detects changes in the conditional model parameters whether or not the variance of the regression error is included in the set of parameter shift especially towards the end of the sample. The CUSUM of squares stability test show that the lines fall within the acceptance region at 5% level of significance. Therefore, the null hypothesis cannot be rejected at 5% level of significance for stability test. This confirms the stability of the estimated parameters in the period under review. Therefore, the study concluded that there existed a log run relationship between the prices of cowpea in the source market (Gombe state) and destination markets Abia, Enugu and Imo states.

CUSUM of squares test of stability of the time series

The cusum of square test detects changes in the conditional model parameters whether or not the variance of the regression error is included in the set of parameter shift especially towards the end of the sample.

The stability of the time series set used for the study was established using the Cusum test as presented in figure 1

CUSUM Squares testof stability of the time series



Source: Computed from NBS, January 2016-February 2018 (data on cowpea Gombe, Abia , Enugu and Imo States)

Figure :1 *CUSUM square of stability test*

The result of the Cusum of squares test that detects the stability of the model when the blue line is within the bound of the red line also proved that the model was stable. Therefore, the study concluded that there existed a log run relationship between the prices of cowpea in the source market (Gombe State) and destination markets Abia, Enugu and Imo States.

Conclusion

Spatial market integration of cowpea in Nigeria was approached through co-integration and Vector Error Correction Model using the (ARDL). The co-integration test showed there is a long run relationship between the producing and consuming states considered. From the value of the vector error correction model, 67.3isa fast adjustment process of cowpea prices in the States considered which show a long run relationship. It is evident that price movement within cowpea market in Nigeria is efficientand there was free flow of trade between source and destination markets. This served as a means of livelihood to the marketers (employment creation) hence reduction of poverty among the marketers. It shows that there is efficient distribution of cowpea products according to comparative advantage which is a major source of economic growth.This is consistent with the objectives of AFCFTA which ensures economic growth and reduction of poverty among the regions involved in the trade partners.In addition, government can formulate policies of providing infrastructure and information regulatory services to avoid market exploitation, as this will facilitate market integration between the production and consumption States.

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