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Full Length Research Paper

Evaluation of price linkages within the supply chain of rice markets in Cross River State, Nigeria

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This paper evaluates price linkages within the supply chain of rice markets in Cross River State using weekly prices in three urban markets located in major rice producing areas of the State. The Johansen cointegration test indicated one cointegrating vector both at the 1 and 5% levels of significance. The results of the study indicate that the supply chain (farmgate-assembler-wholesaler-retailer) in Cross River is integrated. Though the price changes may vary in the short run between the different levels (farmgate-assembler-wholesaler-retailer), they were expected to move together as a system in the long run. The study recommends that facilitative policies that will enhance the provision of infrastructures such as good roads, market structures and efficient market information network systems should be formulated and implemented. Also, the government should provide price regulatory services to enhance market integration and reduce market exploitation by intermediaries especially in the short run.

Key words: Cointegration, supply chain, price linkages, rice markets.

INTRODUCTION

Market integration of agricultural products has retained importance in developing countries due to its potential application to policy making (Heman and Fateh, 2005). The extent of integration gives the government a direction on how to formulate policies of providing infrastructure and regulatory services to avoid market exploitation. Price behaviour along supply chains is an important indicator of overall market performance. Markets that are not integrated may convey inaccurate price information distorting the marketing decisions of rice producers and contributing to inefficient product movements. More so, rice has been cultivated consumed and marketed by women and men worldwide for more than 10,000 years (Kenmore, 2003) longer than any other crop. The total area under rice cultivation is globally estimated to be 150,000,000 ha with annual production averaging 500,000,000 metric tons (Tsuboi, 2005). This represents 29% of the total output of grain crops worldwide, (Xu and Guofang, 2003). FAO (2001) asserts that in Nigeria, the demand for rice has been increasing at a much faster rate than in any other African country, since the mid 1970s. The average Nigerian consumes 24.8 kg of rice per year which represents 9% of total caloric intake.

This increase in consumption according to Akande (2004), Ogundele and Okoruwa (2006) and Daramola (2005) is largely due to urbanization, population growth, increased income levels, and the fact that rice is easy to prepare when compared to other traditional cereals, thereby reducing the chore of food preparation and fitting more easily in the urban lifestyles of the rich and poor alike. Rice is produced in all the agro ecological zones of Nigeria. Production is primarily by small-scale producers, with average farm sizes of 1 to 2 ha. According to Daramola (2005), there are three major rice production systems in Nigeria namely upland rain-fed, lowland rain-fed and irrigated. Rice cultivation is widespread within the country extending from the northern to southern zones with most rice grown in the eastern (Enugu, Cross River and Ebonyi States) and middle belt (Benue, Kaduna, Niger and Taraba States) of the country. In Nigeria, the enterprise provides employment for more than 80% of their inhabitants in various activities along the production/ distribution chains from cultivation to consumption. Also, marketing is a cardinal determinant of the frequency and intensity of product distribution. Ihene (1996) opines that rice marketing covers the performance of all business

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activities in the flow of paddy and milled rice, from the point of mutual production until they are in the hands of the ultimate consumers. This must be at the right time, in the right place and as convenient as possible, at a profit margin that will keep the marketer in operation.

Rice marketing involves various intermediaries between the producers and the consumers who facilitate exchange among trading partners to move rice to consumers. These intermediaries function in environment constrained by low investments in marketing and market infrastructure, shortage of food supply and the limited progression toward more visible market arrangements. However, there is need for price information to flow accurately within the supply chain. Markets that are not integrated may convey inaccurate price information, distorting the marketing decisions of rice producers and contributing to inefficient product movements. Therefore, it is important to analyse price integration within the different levels within the marketing system. The objective of this paper is therefore to empirically evaluate the price linkages within the supply chain of rice markets in Cross River State, using weekly prices in three urban markets located in major rice producing areas of the State. The specific objectives are to:

1. Assess the level of price stationarity;
2. Test for cointegration of the price series.

METHODOLOGY

Study area

Cross River State is located within the tropical rainforest belt of Nigeria. It lies between latitude 4° 28' and 6° 55' north of the equator and longitude 7° 50' and 9° 28' east of the Greenwich meridian. It shares common boundaries with the Republic of Cameroon in the east, Benue State in the North, Ebonyi and Abia States in the West, Akwa Ibom State in the Southwest and the Atlantic Ocean in the South. It has a total landmass of about 23,000 km^2. At least five distinct ecological zones are represented in the State ranging from mangrove and swamp forest towards the coast, tropical rain forests further inland, and savannah woodlands in the Northern parts of the State. The highlands of Obudu Plateau offer montane type vegetation. The favourable climate of tropical, humid, dry and wet seasons gives rise to rich agricultural lands, thus encouraging both perennial and annual crop cultivation. The population of the State in 2001 stood at 2,526,542 giving a population density of 110 persons / km^2. The gender distribution of the population is 1,263,915 (50.03%) males and 1,262627 (49.97%) females. Cross River State has two distinct wet and dry seasons occurring in April to November, and December to March respectively. The varied ecological zones of the State makes it rich in a variety of crops such as rice, rubber, cocoa, cashew, yam, cocoyam, plantain, banana, groundnut and assorted vegetables.

Sampling procedure

The study adopted a multistage sampling method. In the first stage, Cross River State was purposively selected. Secondly, three markets comprising one urban and two rural markets were chosen. This was based on the fact that the rural markets are located within communities were intensive rice cultivation is done. Thus, a total of three markets were purposively selected and used for the study. The markets selected were Watt market, Ofudua rice market and Yala rice market. The sampling frame which comprised all the registered members of the different rice associations in the selected markets were obtained from the presidents of the different rice associations. These lists were further upgraded to remove names of participants who had left the trade either by death or relocation. Using the simple random technique, assemblers, wholesalers and retailers were selected. At least 50% of the traders' population at each level was selected. The sizes were guided by the homogeneity in the population and the time and resources available to the researcher (Ndiyo, 2005). The assemblers were selected at the processing markets within the rice markets. It was ensured that assemblers chosen, performed only assembling functions. Data on farmers' price, rice assemblers' price, wholesalers' price and retailers' price were collected from 100 respondents comprising 15 assemblers, 40 wholesalers and 45 retailers for a period of 44 weeks starting from March, 2007 to January, 2008 using questionnaires and price data forms.

Analytical technique

The use of ordinary least square (OLS) to estimate price integration has the shortcoming of assuming that data series are stationary though most agricultural time series data tend to be non stationary and also the inability of the technique to give the short and long run adjustments, thus using OLS with non stationary data may result to spurious regression (Granger and Newbold, 1974). To avoid these problems, co-integration analysis is used to check for the relationship among prices in different levels. When a long-run linear relation exists among different price series, these series are said to be co-integrated. In addition, to make a clear distinction between short-run and long-run integration, the study uses an error correction model (ECM). This allows the researcher to derive the speed of price transmission from one level to another. In this study, we apply the Johansen procedure to test for long run and short run price integration. The approach adopted is to estimate a vector auto-regressive model (VAR) in which market prices of rice at a level are explained by its own lagged prices and lagged prices on other market levels. The price series used for this test were time series collected for a period of 44 weeks.

A prerequisite for undertaking cointegration tests is to verify that the series is nonstationary and to ascertain the variables' integration order. The most commonly used test for determining whether a series is nonstationary is the augmented Dickey-Fuller (ADF) unit root test. In this test, a null hypothesis is imposed that the data are non-stationary (that is contain a unit root) against the alternative hypothesis of being a stationary variable. Differencing a non stationary variable generally results in a stationary variable. If a series is differenced d times before it becomes stationary, thus containing d unit roots, it is said to be integrated of order d and is denoted as being $I(d)$. Variables that are stationary in their levels, that is $I(0)$ should be discarded from cointegration analysis. In most cases it is not strictly necessary for all the variables in question to have the same order of integration (Harris, 1995). Another important implication of cointegration and the error correction representation is that cointegration between two variables implies the existence of causality (in the Granger sense) between them in at least one direction (Granger, 1988). Cointegration itself cannot be used to make inferences about the direction of causation between the variables, and thus causality tests are necessary. Granger (1969) proposed an empirical definition of causality based only on its forecasting content: if x_t causes y_t then y_{t+1} is better forecast if the information in x_t is used, since there will be a smaller

Table 1. Augmented Dickey Fuller (ADF) test on price series.

Price	No. of observation	Unit root on price levels		Unit of root on first difference	
		ADF with constant	ADF with constant and trend	ADF with constant	ADF with constant and trend
LNASPI	44	-1.6559	-4.2811	-5.4097*	-7.2629*
LNFGPI	44	-1.3284	-2.4777	-7.0410*	-6.9946*
LNRLPI	44	-0.7185	-1.7047	-7.0409*	-7.5677*
LNWSPI	44	-1.1916	-2.9765	-75239*	-7.5677*

Estimated from field survey (2007/2008); * indicates significance at 1%; LNASP1 = natural log for average assemblers' selling price of rice sold in three markets selected from Cross River State; LNWSP1 = natural log for average wholesalers' selling price of rice sold in three markets selected from Cross River State; LNRLP1 = natural log for average retail selling price of rice sold in three markets selected from Cross River State; LNFGP1 = natural log for average buying price purchased by assemblers' in three markets selected from Cross River State. This price was used to represent the farm gate price; ADF = Augmented Dickey Fuller.

variance of forecast error. More so, if two markets are integrated, the price in one market, p_1, would commonly be found to Granger-cause the price in the other market, p_2 and/or vice versa. Therefore, Granger causality provides additional evidence as to whether, and in which direction, price integration and transmission is occurring between two price series or market levels. In line with this, this study will therefore carry out a Granger causality test to make inferences about the direction of causation between the price series under study.

Mathematically, the cointegration test is specified as follows:

$$X_t = A_1 X_{t-1} + A_2 X_{t-2} + A_{p-1} X_{t-(p-1)} + A_p X_{t-p} + \varepsilon_t \quad (1)$$

Where: t = 1,2….n refers to the weeks of prices considered; p = an a prori unknown integer, whose value is determined in the estimation process; X_t is an nx1 vector of variables (X_{1t} ,X_{2t}…………X_{nt}) (prices at n market levels); A_t is an (nxn) matrix of coefficients; ε_t is an (nx1) vector of error terms; n is the number of prices included in the analysis.

With $\Delta X_t = X_t - X_{t-1}$ Equation (1) can be put in a more suitable form as:

$$\Delta X_t = \sum \Pi_i \Delta X_{t-i} + \Pi X_{t-1} + \varepsilon_t \quad (2)$$

Where Π and $\prod_i$ are defined as:

$$\Pi = \sum_{i-1}^{p} A_i - 1 \text{ and } \prod_i = \sum_{j=i+1}^{p} A_j$$

The Johansen approach defines two matrices α and β, both of dimension nxr, where r is the rank of $\prod$ such that $\prod \beta$. The matrix β is the matrix of cointegrating relations and the matrix α is the matrix of weights with which each cointegrating vector enters the n equations of the vector error correction model (VECM). α can be viewed as the matrix of the speed of adjustment parameters. The Johansen procedure allows for a wide range of hypothesis testing on the coefficients α and β, using likelihood ratio test (Johansen, 1990).

RESULTS AND DISCUSSION

Testing for stationarity in the price series

A unit roots analysis of each of the time series of the chosen variables were undertaken to ascertain the order of integration or test for the stationarity of the prices. This is to ensure that the variables are not integrated of order greater than one. Different test such as the Phillip-Perron and augumented Dickey Fuller (ADF) could be used. This study used the ADF unit root test. The results are presented in Table 1. Using the ADF test, the results presented in Table 1 indicate that the price series were stationary at first difference 1(1). This result implied that inclusion of first differences as variables in the model, instead of normal price series, will eliminate the stochastic trend to which the nominal series are exposed.

Testing for cointegration in the price series

The Johansen cointegration test indicated one cointegrating vector both at the 1 and 5% levels of significance (Table 2). This result implied that the supply chain in Cross River is integrated. Though the price changes may vary in the short run between the different levels, they were expected to move together as a system in the long run. This result gave the opportunity to estimate the movement of prices in the long and short run, using a vector error correction mechanism (Table 3). The long and short run equations were selected using the Schwarz criterion and Akaike information criterion (AIC). The results revealed that the prices (wholsaler, assembler, retailer and farmgate) were significantly integrated in the long run (Table 3). The short run dynamics revealed that 55% of the deviations from the long run equilibrium corrected per week .This is explained

Table 2. Johansen cointegration test for prices in three markets.

Null hypothesis	Alternative	Test value	95% critical value	99% critical value
Trace test				
r = 0	r > 0	72.20*	47.21	54.46
r < 1	r > 1	18.33	29.68	35.65
r < 2	r > 2	6.97	15.41	20.04
r < 3	r > 3	2.84	3.76	6.65
Max test				
r = 0	r > 0	53.86*	27.07	32.24
r < 1	r > 1	11.36	20.97	25.52
r < 2	r > 2	4.13	14.07	18.63
r < 3	r > 3	2.84	3.76	6.65

Estimated from field survey (2007/2008); * indicates significance at 5%; r = rank or the number of cointegrating equations.

Table 3. Estimates for the short and long run price integration in three selected markets

Variable	Dependent variable LNFGP1					
	Short run estimates			Long run estimates		
	Coefficient	Standard error	t-statistic	Coefficient	Standard error	t-statistic
ECM(-1)	-0.5509	0.092	-5.9880*			
D(LNFGP1(-1))	-0.177	0.0898	-1.9716**			
D(LNASP1(-1))	0.2096	0.117	1.791			
D(LNWSP1(-1))	-0.20644	0.101	-2.6164*			
D(LNRLP1(-1))	-0.3372	0.1044	-3.2298*			
LNASP1				1.7535	0.2222	-7.8926*
LNWSP1				0.3394	0.4113	0.8251
LNRLP1				0.5409	0.2756	1.9629**
R^2	0.6482					
ADJUSTED R^2	0.6182					
F-Statistic	22,597					
Log likelihood	292.1225					
Akaike AIC	-2.7972					
Schwarz SC	-2.6165					

*Indicates significance at 1% and ** at 5%; LNASP1 = natural log for average assemblers' selling price of rice sold in three markets selected from Cross River State; LNWSP1 = natural log for average wholesalers' selling price of rice sold in three markets selected from Cross River State; LNRLP1 = natural log for average retail selling price of rice sold in three markets selected from Cross River State; LNFGP1 = natural log for average buying price purchased by assemblers' in three markets selected from Cross River State, this price is used to represent the farm gate price; D(LNASP1(-1)) = first difference of the natural log for average assemblers' selling price of rice sold in three markets in Cross River State; D(LNWSP1(-1)) = first difference of the natural log for average wholesalers' selling price of rice sold in three markets in Cross River State; D(LNRLP1(-1)) = first difference of the natural log for average retail selling price of rice sold in three markets in Cross River State; D(LNFGP1(-1)) = First difference of the natural log for average buying price purchased by assemblers' three markets in Cross River State, this price is used to represent the farm gate price; R^2 = coefficient of determination.

by the coefficient of the error correction mechanism (ecm(-1)). The coefficient of the error correction term (ecm(-1)) is also significant at 1% and carries the expected negative sign. The significance of the error correction mechanism (ECM) supports cointegration in the price series and suggests the existence of long-run steady state of equilibrium between the prices. The significant coefficients (t-statistics) indicated that in the long-run the different identified levels (farmgate-assembler-wholesaler-retailer) within the marketing system of rice in Cross River were highly co-integrated with the farm gate level. The implication is that since rice is a major staple crop produced within the study area, the price formation process in these areas highly depends on the farmgate prices.

CONCLUSIONS AND RECOMMENDATIONS

The study concludes that the supply chain of rice in Cross River State, Nigeria is significantly integrated in the long run. The short run dynamics revealed that 55% of the deviations from the long run equilibrium are corrected per week. This implies that facilitative policies that will enhance the provision of infrastructures such as good roads, market structures and efficient market information network systems are necessary. Also, the government should provide price regulatory services to enhance market integration and reduce market exploitation by intermediaries especially in the short run.

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