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# Price Growth Rates, Co–integration and Price Leadership among Local Rice Market in the Six Geopolitical Zones of Nigeria

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***Authors' contributions***

*This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.*

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## ABSTRACT

The study of market integration is important in determining the co movement of prices and the transmission of price signals and the information across spatially separated markets. This study describes growth rates in retail prices, examines long- run price equilibrium in local rice markets, determines markets that exhibit leadership position in price formation and transmission of spatial separated markets integration of the different pairs of markets in Nigeria for both local rice varieties and imported rice varieties. Examining the extent of interregional market integration, both spatial and across marketing stages will provide insights on the speed of trader responses in moving this vital commodity from surplus to deficit areas, especially in the face of high demand.

The data used for the analysis were collected from National Bureau of Statistics, Abuja, from January 2001 to December 2010 (120 months) per state. Eighteen spatially separated (urban) markets across six geopolitical zones in Nigeria were selected based on their development. Augmented Dickey Fuller (ADF), Johansen Co integration technique, Granger Causality test and Vector Error Correction Model (VECM) were the analytical techniques employed.

The results of the local rice markets growth rates were highest in Bayelsa (86.15%) in 2003,

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followed by Lagos (72.01%) in 2005 and Bauchi (45.83%) in 2007. The empirical results revealed that price series variables became stationary after first differences. The results of Johansen Co-integration analysis revealed that 71.90% of the local rice markets showed long- run price equilibrium despite the divergence in prices. The results of Johansen multiple co integration also affirmed the co integration results among local rice markets. The results of Granger causality tests were both uni- directional and bi- directional, indicating the markets that show leadership position in price formation and transmission from one market to the other. The results of VECM revealed moderate short-run price equilibrium in the local rice markets.

In conclusion, the price signal were transmitted across spatially separated markets for locally planted rice, thus indicating integration of local rice markets across the six geopolitical zones in Nigeria. Therefore, adequate investment in local rice varieties will remove the drain in the nation's foreign exchange.

*Keywords: Local rice; spatial; integration; co–integration; Nigeria.*

## 1. INTRODUCTION

### 1.1 Rice Importance, Production, Consumption and Importation in Nigeria

Rice (*Oryza sativa*) is an important annual crop grown in all ecological and dietary zones of Nigeria. Traditionally, it has been an important basic food commodity for certain populations in sub Saharan Africa and West Africa in particular. The food sub sector of Nigeria agriculture parades a large array of staple crops, made possible by diversity of agro ecological production system. Out of the staple crops Nigeria, rice consumption since the mid 1970s has risen tremendously at about 10% per annum due to changing consumer preferences [1]. Over the years, greater percentage of rice output in Nigeria has been from the rural smallholder farmers. It has been observed that Nigeria was virtually self sufficient in rice enterprise up to the 1970s (WARDA, 2004).

Basic food commodities usually play an essential role in economic development as their availability and cost impinge directly on food security, expenditures and income of households, particularly amongst the poorer segments of population both rural and urban [2]. Rice is consumed regularly in Nigeria's urban and rural areas and is an important food security crop. It is primarily a cash crop for those farmers who produce it (selling nearly 80 percent of total production and directly consuming only 20 percent) and it generates more income for Nigerian farmers than any other cash crop in the country. The total industry, between imports and domestic production is valued at about $5 billion, with nearly $4 billion accruing inside Nigeria. Rice is a normal food and it has changed from being a luxury to being a necessity and thus become a staple food in Nigerian economy and its importance increases as economy growth continues (Erhabor and Ojogbo, 2011).

Rice is produced in at least thirty five (35) of Nigeria's thirty seven (37) states covering three (3) major ecological zones; rain-fed upland, rain-fed lowland and irrigated. Among these, lowland rice has the highest priority for reducing production costs being the ecology that represents the social opportunity costs of producing rice in the limited viable alternatives. The upland and irrigated rice ecology have an approximately equal share in the overall production. Irrigated rice should be second in priority as it presents an easier to target area being smaller and diffuse and having had past land development investments with potential high spill over from other regions ( Erenstein, 2004). The challenge for the development of the Nigerian rice sector is to bring the cost of domestic rice down to substitute imported rice for improved rice without having to impose significant losses to the Nigerian economy. The need to improve both the cost and quality aspect of Nigerian rice is imperative. Indeed reducing the cost of Nigerian rice will be insufficient to close the self sufficiency gap. The number of rice consumers who will substitute local rice for imported rice in response to lower domestic rice prices will be limited in view of the quality differential in local rice of current standards being an imperfect substitute for imported rice. Alternatively, improving domestic rice quality alone will be insufficient as the traditional costs will only augment the price in uncompetitiveness of domestic rice.

The main objective of the study is to analyze the spatial integration of rice markets in Nigeria. The

specific objectives were meant to (i) to describe the growth rates in retail prices of local rice; (ii) determine the long run spatial price equilibrium in local rice markets in the study area; (iii) examine if there is granger causality among local rice markets; (iv) determine the short run equilibrium response to changes in prices in the local rice markets.

Examining the extent of interregional market integration, both spatial and across marketing stages will provide insights on the speed of trader responses in moving this vital commodity from surplus to deficit areas, especially in the face of high demand. Since rice is an important contributor to the food security situation of households in Nigeria as it constitutes the most preferred food commodity and it is grown by many farmers at the local level. However, an efficient rice supply over space should favour the sharing of risk across regions by smoothening idiosyncratic price variations. The spatial price behavior in regional rice markets is an indicator of overall market performance. Nigerian's annual rice demand is estimated at 5million tonnes out of which only about 2.2 million tonnes is produced locally. The annual rice supply gap of 2.8million tonnes (or 5 percent of demand) is bridged by importation ([3], [4]; Kasali et al. 2010 and [5]). However, if there is integration in the prices of local rice varieties that cut across the six geopolitical zones in the country, that will give a signal of the steps to be taken to make the local rice varieties come up higher to supply the need of the growing population and to meet the taste of Nigerians both at the rural and urban areas.

Therefore, this study is an attempt to investigate the existence as well as the extent of spatial market integration among the different regional local rice markets across Nigeria. This study employed various time series econometric techniques to empirically test the integration of all possible pair- wise combinations subdivisions of the local rice markets in the six regional markets in Nigeria.

## 1.2 Literature Review

In the past three decades, rice has steadily increased in demand and its growing importance is evident given its important place in the strategic food security planning policies of many countries [6]. Adesina [7] recently revealed that the country spends over ₦356billion on yearly importation of rice out of which about ₦1billion is used per day. In West Africa sub region, Nigeria has witnessed a well established growing demand for rice as propelled by rising per capita consumption and consequently the insufficient domestic production had to be complemented with enormous import both in quantity and value at various times (Erenstein et al. 2004; [3]). However, various regimes of government have considered the enormous importation as an avoidable drain on the country's foreign exchange earnings in view of the abundant natural endowments for expanded production in Nigeria [8]. This has prompted Nigerian government to actively interfered in Nigerian rice economy over the last thirty years. As a response to the prevailing rice supply deficit situation in Nigeria, successive governments intervened in the rice sector by increasing tarrifs so that local production could be encouraged. This was expected to widen the home market for the nation's local rice. However, policy has not been consistent, it has included oscillating import tariffs and import restrictions. For example, from 1986 to the mid 1990s imports were illegal. In 1995 imports were allowed at a 100% tariff. In 1996 the tariff was reduced to 50% but increased to 85% in 2001. These erratic policy reflects the dilemma of securing cheap rice for consumers and a fair price for producers. However, these various policy measures has not increased domestic rice production sufficiently enough to meet the increased demand [2].

In Nigeria, the demand for rice has been on the increase since the mid 1970s (Daramola, 2005). During 1960s, Nigeria had the lowest per capita annual consumption of rice in the West Africa sub region with an annual average of 3kg. Since then Nigeria's per capita consumption levels have grown significantly at 7.3 percent per annum. Consequently, per capita consumption during the 1980s increased to an annual average of 18 kg and reached 22 kg between 1995 – 2000 as shown in Table 1 by Okoruwa and Ogundele [9] in Bamidele et al. [10].

Of the individual rice importing countries, none has brought in a greater quantity of rice between 2002 - 2007 than Nigeria into their countries. Nigeria's share of global rice imports is matched only by the Phillipines, with both representing 5.6% of world trade in rice. Also, at 7.9miliion metric tons of rice imports over the past years, Nigeria comes first leading the Phillipines by just over 20,000MT per year during this period. The production and consumption levels of rice in the sub Saharan region remain substantial. The region is projected to import 6.7million tonnes in 2006, down 10% from 2005 which was a record

**Table 1. Comparison of rice trends between Nigeria and the rest of West Africa**

| Indicator | Mean (1961–75) | Mean (1976–82) | Mean (1983–85) | Mean (95–2000) |
|---|---|---|---|---|
| **Nigeria** | | | | |
| Production in metric tonnes | 332800 | 806222 | 2306794 | 3189833 |
| Imported in metric tonnes | 2036 | 420756 | 334975 | 525307 |
| Self-reliance ratio | 99% | 54% | 77% | 79% |
| Total consumption in metric tonnes | 178199 | 833640 | 1599609 | 2248113 |
| Per capita consumption | 3.0 | 12.0 | 18.0 | 22.0 |
| **West African without Nigeria** | | | | |
| Production in metric tonnes | 1779376 | 2344073 | 2822635 | 4041384 |
| Imported in metric tonnes | 416183 | 894073 | 1760884 | 2107146 |
| Self-reliance ratio | 65% | 56% | 42% | 50% |
| Total consumption in metric tonnes | 1178753 | 1950821 | 2973885 | 3985721 |
| Per capita consumption | 21.0 | 27.0 | 30.0 | 34.0 |

*Source: Okorowa and Ogundele, [9]*

performance [11]. Apart from Nigeria and South Africa, the region mainly imports low quality rice. Nigeria accounts for 20% of sub Saharan Africa's rice imports, South Africa accounts for 11% imports into the region, mainly high quality parboiled rice from India and Thailand. Senegal also accounts for 11% of imports mainly broken rice with imports rising substantially after 1995 as consumption growth has outpaced production. Ghana also has 5% of rice importation in the region. USDA/FAS (2007) also revealed other principal world importer of rice between 2002 and 2007 given their world share of importation. The importation in Indonesia is 6.6% while milled production was 4.5%, Phillipines had importation of 6.3% with 5.6% milled production. Nigeria among others 5.9% with milled production of 5.6%, Iran also had 4.2% imports while its milled production stands at 3.7%.

However, various regimes of government in Nigeria have considered the enormous importation as an avoidable drain on the country's foreign exchange earnings in view of the abundant natural endowments for expanded production in Nigeria [8]. This has prompted Nigerian government to actively interfered in Nigerian rice economy over the last thirty years in order to develop rice sector. These include the pre-ban, ban and post-ban periods. The pre-ban period is the era prior to the introduction of absolute quantitative restriction on rice imports (i.e., 1971-1985). This epoch can be classified into two, the pre-crisis (1971-1980) and the crisis period (1981-1985). The pre-crisis period was characterized by liberal policies on rice imports though ad hoc policies were put in place during times of interim shortages. This corresponds to the launching of various programs and projects aiming at developing the rice production in order to meet up with the escalating demand of rice by the growing populace.

These programmes include the Federal Rice Research Station (FRRS) at Badeggi in 1970 and the National Cereal Research Institute (NCRI) in 1974. National Seed Service (NSS) was also established in 1975 with the assistance of Food and Agriculture Organization (FAO). Operation Feed the Nation (OFN) was also designed as a strategy to bring about self-sufficiency in domestic food supply in 1976. The River Basin Development Authorities (RBDA) was conceived in 1970 and became operational in 1974 with the aim of increasing food production. Also, Agricultural Development Projects (ADP) was also established to increase food production through small farmers. The National Grain Production Programme (NGPP), the Structural Adjustment Programmes (SAP) and the Presidential Initiative on Increased Rice Production, Processing and Export. The last mentioned programme, aimed at addressing the ever widening demand – supply gap for rice and stimulating surplus rice harvest for export [10].

Inspite of government numerous programmes and policies on rice, the demand - supply gap for rice still persist. The high demand for rice bring about increase rate of rice importation. Rice importation was very insignificant in 1960s and early 1970s, however, there was a phenomenal rise in imports in 1977 as the quantity of rice imported in this year alone (45 thousand tons) was more than the combined quantity of rice imported during 1961-1975 period. However, the rice import begins to decline in 1981 as a result of some policy measures put in place to check the importation of the commodity. Then, the quantity imported on an annual basis was over

300 thousand tons. Imports dropped significantly from 1985 when a ban was placed on rice importation. Although, rice importation began to rise again in 1991, major importation did not begin until after the lifting of the ban in 1995 (Erenstein et al. 2004).

There are debates concerning the appropriate role of government in the market place and there is need to find solution to the effects of agricultural policies on agricultural markets. This has motivated the need to develop various methods which are desirable to analyze market efficiency. The government intervention in setting prices, incomes and market is always controversial. For Economists, government intervention may be justified if it does not enhance distortions into the market and moreover, remedies the existing market imperfections. In order to deduce whether the policy proves to improve market functioning or results in even more inefficiency, one way to throw more light on these long standing issues is to analyze market performance by studying market integration.

### 1.3 Market Integration and Importance

Market integration refers to a situation in which prices of commodity in separated markets move together, thereby offering smooth transmission of price signal and information (Reddy, 2006; Intodia, 2005). There are three types of market integration, which are classified as inter - temporal, vertical and spatial integration. Inter temporal market integration relates to the arbitrage process across periods in terms of regional market performance. Vertical market integration is concerned with stages in marketing and processing channels. Spatial market integration refers to co movements of prices and more generally, to the smooth transmission of price signals and information across spatially separated markets. Spatial price behavior in regional rice markets is an important indicator of overall market performance. Regional prices move over time because of various shocks. If in the long run they exhibit a constant linear relationship, then we say that they are co integrated. In general, the presence of co integration between two series is indicative of inter dependence. In other word, co integration indicates non segregation between two series. The study of market integration is important in determining the co movement of prices and the transmission of price signals and the information across spatially separated markets.

Co-integration analysis is a useful tool to give an answer about existence of a relationship between two econometric time series (Luu, 2003). Markets that are not integrated may convey inaccurate price information, distorting the marketing decision of rice producers and contributing to inefficient product movements. Therefore, an important part of market performance analysis focuses on rice market integration between different market places.

In Nigeria, the attainment of inter regional equity is of vital importance , if Nigeria is going to attain its marketing and pricing policy objectives .This will imply that there is presence of a well integrated marketing systems. Agricultural policy objectives in Nigeria have centred on increasing agricultural production with a view to achieving self sufficiency in food and raw materials for industries as well as improvement of the socio economic welfare of rural farmers. However, the marketing and pricing have been to ensure stable renumerative incomes for farmers. The reforms that followed the adoption of a Structural Adjustment Program (SAP in 1986 led to the liberalization (abolition of marketing boards in 1986) of marketing of cash/ export crops while the foodstuffs markets were ordered by farmers' and traders' decisions to produce and sell; rather than the liberalization policies. These policies have only been able to supply imported foodstuffs thus posing a serious threat to domestic foodstuffs (Okoh and Egbon, 2005) including escalating rice importation into the country.

Traders usually cover narrow market boundaries as a result of factors that contribute to market segregation. These include high cost of transportation which is as a result of bad roads and road networks. Also, inadequate price information about other markets which is as a result of poor information transmission channels, inefficient communication systems and absence of official (government) price communication [12]. Furthermore, the incidence of individualized price formation processing resulting from haggling is another factor and the lack of product homogeneity and lack of standardized measuring units. Also, the presence of market association also limit the access of poor farmers to the urban areas, because of discrimination from rich wholesaler. These factors may results in the overlapping of market service areas covered by the traders. Prices of agricultural product serve as market signals of the relative abundance or scarcity of such product. They also serve as

incentives that direct the allocation of economic resources and thus, determining the structure and rate of economic growth [13]. Prices are key signals in the resource allocation process that take place through markets. The ability of free markets to allocate resources in a way suitable to allow the whole economy to reach an optimal equilibrium is a fundamental result of the economy theory. Moreover, free market via price adjustment allow the economy to reach a new optimal mechanism at domestic level and in case of free trade between countries at international level. The liberalization of agricultural markets implies accepting potentially substantial variation in prices across time, space and product form. According to Tschirley [14], this variation in agricultural product prices are necessary. In developed and developing countries such as Nigeria, the information on agricultural commodity products are important to both producers and consumers. Since prices vary throughout the year, there is need for understanding the trend of such variations which is essential for good planning by the producers, consumers and policy makers. For instance, an average household after the price increase spends as high as 75% of their income on food compared with an average of 65% before food crisis [15]. In Nigeria, the prices of agricultural commodities are not stable and this is a regular phenomenon in markets across the nation (Akpan, 2007). However, the variability in commodity prices could be detrimental to the marketing system and the economy at large. Variation in prices may be due to fluctuation in cyclical income among sellers and consumers, natural shocks such as flood, pests, diseases, inappropriate response of farmers to price signals, ect. ([16], Adebusuyi, 2004).

There are several factors that affect the degree of market integration and generate discontinuities in the price response to exogenous shocks [17]; D' Angelo and Cordano, 2005). The first one is the presence of high transaction costs relative to the price differential between two regions, which determines the existence of autarkic markets. The second factor is the presence of barriers to entry, risk aversion and information failures. This may turn the arbitrage process into a less smooth process than assumed by traditional models of market integration. A commonly mentioned source of asymmetry in the price response to shocks is the market power. For instance, the oligopolistic intermediaries in a commodity market may react collusively faster to shocks that reduce their profit margins, generating asymmetries in the transmission of those shocks to other segments of the market (Issa, 2008). As a result, an increase in the central market prices would be spread to the other markets in a faster way than a decrease in such prices. The existence of imperfect competition is relevant segments of the markets, that is, high price differentials between markets that cannot be attributed to transaction costs. For example, the presence of search costs on imperfect regional commodity markets is considered as a source of asymmetry or discontinuities in the prices adjustment process that occurs as a response to exogenous shocks [18]. In many regions, some firms can exercise local market power, due to the absence of other firms located in spatial proximity that could compete with them. The consumers that face these dominant firms face high search costs to get all the information about prices offered by other firms. Also, short run fluctuations in agricultural commodity prices occur between production seasons (Cashin and Pottila, 2000). During the period of harvest, prices become high due to reduced production and seasonal changes [19,20]. In Nigeria, the prices of agricultural commodities are not stable and this is a regular phenomenon in markets across the nation (Akpan, 2007). However, the variability in commodity prices could be detrimental to the marketing system and economy at large.

Estimates indicate that over nine (9) percents of domestic rice production comes from resource poor and weakly organized smallholders (Federal Ministry of Agriculture and Water Resources), a key fact when considering the wide ranging constraints that continue to impede significant progress in Nigeria's farm-level productivity and international competitiveness in rice. More than half of all Nigerians live on less than 1dollar per day, and the poverty incidence exceeds 60 percents in rural areas where people overwhelmingly depend on agricultural activities for their livelihoods. Consequently, agricultural incentives that elevate production capacity are of the utmost importance for fostering broad based economic growth, poverty reduction and improved food security. In 2008, Nigeria rice production was estimated at approximately 2 million MT of milled rice and imported about 3 million MT, including the estimated 800,000 MT that is suspected to enter the country illegally in an annual basis (USDA, 2007). Although, Nigeria's rice trade policy has been and continues to be heavily *protectionist*, ranging from outright import bans in 1980s to the 32.5

percent tariff / levy combination that is applied to rice imports. Currently, it has had little effect in stimulating local production to a level of significant import substitution. However, the domestic production has never been able to meet the demand of the growing masses leading to considerable imports. FAOSTAT (2008) stated that Nigeria is the largest importer of rice in African continent and the second largest importer in the world. Akinbode et al. (2011) also stated that in Nigeria about three million Nigerains consumed over four and half million tonnes of rice per annum and this calls for an urgent solution especially in the price and cost of importing rice from other nations of the world. Thus, the need to bring integration in the price of rice across the nation so as to make the locally produced rice compete with the imported rice in terms of quality, acceptability, and taste. Also, the need to continually move the surplus rice from production areas to deficit consumption areas in most economical manner possible has been an ever present challenge to the stakeholders of rice economy since the beginning of rice trading in the country.

## 1.4 Theoretical Framework on Spatial Market Integration

The conventional demand supply theory explains that the actual price of a commodity in a given market (rice market in this case) at a given point in time is higher than the equilibrium price when the product is ‘‘deficit’’ (i.e. excess demand where the demand is greater than domestic supply) and the price of which is lower than equilibrium when it is ‘‘surplus’’ (i.e. excess supply where the domestic supply is greater than demand). Consequently, there exists an opportunity for trade between these two types of markets (i.e. from surplus to deficit regional market) and ultimately these two markets become integrated by adjusting into a single price. In geographically separated markets for a homogenous commodity, prices are integrated if goods and information flow freely among them. As a result, prices are linked and arbitrage of activities will not allow prices to differ by an amount greater than the transfer costs. Where the spread of price between a pair of markets are larger than unit transfer cost, profitable opportunities are not being exploited, in which case these market are not efficiently connected.

In integrated markets however, price changes in one region are reflected in the other region’s prices. In an interregional set for a homogenous agricultural commodity such as rice, two regional markets belonging to this set up are said to be spatially integrated, whenever the following conditions are satisfied: when trade takes place between them, the nominal price at the receiving market is equal to the nominal price at the exporting market plus the transporting and other incidental costs required in moving unit amount of commodity between them. Early empirical studies of market integration used static price correlation to test for spatial market integration in agricultural markets ([21]; Faruk, 1970 and Lele, 1970). This involves the estimation of bivariate correlation or regression coefficient between the time series of spot prices for homogenous commodity at different spots prices for a homogenous commodity at different markets. In these analyses, a statistically significant coefficient implies that the two markets are integrated. However, there are short comings with this model. It was criticized for masking other effects like inflation and seasonality. It also assumes instantaneous price adjustment and cannot capture the dynamic nature of a marketing system (Theytens, 1986; [22] and Sexton et al, 1991). It might overestimate a lack of market integration if a lag in market information produces a lag in the price response between markets [23]. It also tests only a pair of markets at a time and cannot evaluate the entire marketing system (Delgado, 1986). In order to overcome these weakness of price correlation tests, various alternative methods have been developed (Delgado, 1986; Ravillion, 1986; Engle and Granger, 1987 and Johnsen; 1988).

Baulch [17] identified four econometric approaches that can be employed in measuring spatial market integration. The Law of One Price LOP), the Ravallion Model, the Granger causality technique and Econometric analysis. Richardson (1978) postulated that the LOP is the test of the market in period t and involves the regression; If the joint test $\beta = 0$ and $\beta = 1$ is not rejected, the two prices are not satisfactory different , hence the LOP holds. The model is estimated using the original price series or series in natural logarithms. The former applies an absoluteprice differences the mentioned hypothesis. Ravillion (1986) extended the LOP model of Richardon by assuming that price adjustment between markets take time and through an Error Correction Model ( ECM) showed that a nested test for short run integration is equivalent to a test of LOP. The Granger causality approach (Gupta and Mueller, 1982); Alexander and Wyeth, 1994) on the other

hand improved on the Ravallion model and employed a single equation ECM to test for causality between prices.

The econometric cointegration technique (Palaskas and Harris- White, 1993); Alexander and Wyeth (1994); Praash and Taylor (1970) establishing spatial market integration based on the first step of Engle and Granger (1987), two step procedure that is estimating the regression, A test of long run spatial integration is equivalent to testing the presence of unit root (s) in the residual series at $U_t$. The theoretical basis of such procedure is the fact that if linear combination of two non stationary, that is, 1 (1) series, is stationary then the two time series variables are said to be co integrated (Engle and Granger , 1987) and a long run equilibrium relationship exist between the two series.

The literature has pointed out some indicators such as the simple correlation coefficients between city pairs, co- integration coefficients (which capture the existence of a long run linear relation between prices) and the parameters representing the speed of adjustment of prices from different regional markets to their equilibrium. Simple bi variant correlation coefficients are interpreted as a measure of how closely price movements of a commodity at different markets are linked. However, this method can neither measure the direction of price integration between two markets, nor can it account for trade reversals, which are common where infrastructure is poor [23].

## 2. MATERIALS AND METHODOLOGY

### 2.1 Study Area and Scope

The study area for this work is Nigeria. Nigeria has six geographical zones, that is, North East (NE), North-North (NN), North-West (NW), South East (SE), South-West (SW) and South-South (SS) zones.

### 2.2 Source of Data Collected

The data for this study were derived from secondary source. The National Bureau of Statistics (NBS) which is the successor agency of the Federal Office of Statistics (FOS) merged with the National Data Bank (NDS). The agency is charged with the responsibility of providing the nation with comprehensive, timely and reliable statistical information in all spheres of human endeavour. The monthly rice retail prices data for this study were derived from the National Bureau of Statistics from January 1997 to 2010 December. However, the available data between 1997 and 2000 were not comprehensive enough for this study because there were several missing data among them.

### 2.3 Sample Size and Frame

The monthly retail prices of local rice varieties data from January 2001 to December 2010 (120 months) per state from eighteen spatially separated state capital (urban) markets across the six geographical zones of Nigeria were collected. Three states were purposely selected from each region on the basis of economic and infrastructural development. Thus, while one state is economically and infrastructurally advanced, the The markets considered were Lagos (Lag), Osun and Ekiti States (South West), Rivers, Bayelsa (Baye) and Akwa Ibom (Akwa) States (South South), Abia, Anambra (Ana) and Ebonyi (Ebon) States (South East), Abuja (FCT), Plateau (Plat) and Kogi States (North Central), Bauchi (Bau), Adamawa (Ada), and Yobe States (North East), Kano (Kan), Sokoto (Sok ) and Zamfara (Zam) States (North West).

### 2.4 Market Integration Test

#### 2.4.1 Test for order of econometric integration (unit root test)

In order to investigate the market integration, the study first examined each price series for evidence of non stationarity in order to confirm that co integration approach is the appropriate tool (Fossati et al, 2007). Augmented Dickey Fuller was used to ensure that serial correlation is absent using the Akaike's information criterion. In testing for unit root, the main technique involved in the empirical methodology used in the study is Ordinary Least Square (OLS) regression. An implicit requirement of any regression based model is that all time series variables to be used should exhibit the property of stationarity. A variable is said to be stationary if it has time invariant mean and variance and the covariance between two time periods depends only on the lag between the periods and not on the length of the estimation period (Gujarati, 2003). When OLS regressions may result in the spurious or non sensical outcomes. Hence, as a matter of course, all time series based analyses must include prior testing for the stationarity of the variables involved. Most econometric time

series are non stationary in nature and must undergo appropriate transformation before they can achieve stationarity. The most frequent transformation used in the practice is the process called integration (or differencing). A stationary series is said to be integrated of order zero or 1(1), that is, they generally become stationary only after taking their first differencing. In general, if a non stationary series has to be differenced is said to be integrated of order d, 1(d). A stationary series is one with a mean value which will not vary with the sampling period. In contrast, non-stationary series will exhibit a time varying mean (Juselius 2006). Augmented Dickey Fuller statistic used in the test is a negative number, the more negative it is, the stronger the rejection of the hypothesis, that is, there is a unit root at some level of confidence ( Wikipedia, 2009). Before examining integration relationships between or among variables, it is essential to test for unit root, and identify the order of stationarity, denoted as I(0) or I(1). This is necessary to avoid spurious and misleading regression estimates.

The framework of ADF methods is based on analysis of the following model;

$$\Delta\rho_t = \alpha + \beta\rho_{t-1} + \gamma T + \sum_{k=1}^{n} \delta_k \Delta\rho_{t-k} + \mu_t \quad (1)$$

Here, $\rho_t$ is the rice price series being investigated for stationarity, Δ is first difference operator, T is time trend variable, represents zero-mean, serially uncorrelated, random disturbances, k is the lag lengths; α, β, γ and $\delta_k$ are the coefficient vectors. Unit root tests were conducted on the parameters to determine whether or not each of the series is more closely identified as being I(1) or I(0) process. Test statistics is the t statistics for β. The test of the null hypothesis of equation (1) shows the existence of a unit root when β = 1 against alternative hypothesis of no unit root when β ≠ 1. The null hypothesis of non-stationarity is rejected when the absolute value of the test statistics is greater than the critical value. When $\rho_t$ is non-stationary, it is then examined whether or not the first difference of is stationary (i.e. to test $\Delta\rho_t$-$\Delta\rho_{t-1}$~I(1) by repeating the above procedure until the data were transformed to induce stationarity.

### 2.4.2 Testing for johansen co-integration (trace and maximal eigenvalue tests)

Johansen procedure is the most recent method used in co integration analysis and it is based on maximal likelihood estimates of all the co integrating vectors in a given set of variables**.** This provides two likelihood ratio tests for the number of co integration vectors. This technique is important when testing for co integration between more than two variables.

If two series are individually stationary at same order, the Johansen and Juselius (1990) and Juselius (2006) model can be used to estimate the long run co-integrating vector from a Vector Auto regression (VAR) model of the form:

$$\Delta p_t = \alpha + \sum_{i=1}^{k-1} \Gamma i \ \Delta p_{t-1} + \Pi p_{t-1} + \mu_t \ \text{.....(2)}$$

Where $p_t$ is a nx1vector containing the series of interest (rice price series) at time (t) is the first difference operator. $\Gamma i \ and \ \Pi \ are$ n x n matrix of parameters on the *i*th and *k*th lag of $p_t$ $\Gamma i = \left(\sum_{i=1}^{k} A_i\right) - I_g$, $\Pi = \left(\sum_{i=1}^{k} A_i\right) - I_g$, Ig is the identity matrix of dimension g, α is constant term, is nx1 white noise vector. Throughout, p is restricted to be (at most) integrated of order one, denoted I (1), where I(j) variable requires *j*th differencing to make it stationary. Equation (2) tests the co-integrating relationship between stationary series. Johansen and Juselius (1990) and Juselius (2006) derived two maximum likelihood statistics for testing the rank of $\Pi$, and for identifying possible co-integration as shown in the equation below:

$$\lambda_{trace}(r) = -T\sum_{i=r+1}^{m} In(1-\lambda_i) \text{.....} \quad (3)$$

$$\lambda_{\max}(r, r+1) = -TIn(1-\lambda_{r+1}) \text{.....(4)}$$

Where r is the co-integration number of pair-wise vector, $\lambda_i$ is ith eigenvalue's value of matrix $\Pi$. $T$ is the number of usable observations after the lag adjustment and λ is the estimated values of the ordered eigen values obtained from the estimated matrix. The first step is based on the trace of the stochastic matrix while the second step is based on maximal eigen value. The $\lambda_{trace}$ is not a dependent test, but a series of tests corresponding to different r -value. The $\lambda_{\max}$ test each eigen value separately. The null hypothesis of the two statistical tests is that there is existence of r co-integration relations while the alternative hypothesis is that there is existence of

more than r co-integration relations. This model was used to test for integration between pair-wise price series of local rice in the six zonal markets in Nigeria.

### 2.4.3 Test for granger-causality

After undertaking co-integration analysis of the long run linkages of the various market pairs, and having identified the market pair that are linked, an analysis of statistical causation was conducted. The Granger causality reflects the direction of influence between series (prices of local and imported rice). When two series have the same order of econometric integration and are co integrated, test for causality can be carried out owing to the fact that at least one Granger – causality relationship exists in a group of co integrated series (Granger, 1988; Alexander and Wyeth, 1994, France, 1994, Chirwa, 2001; [24]). The implication is that the evidence of co integration indicates the existence of causality. However, when the co integration residuals are ignored this will lead to incorrect model specification (Mafimisebi, 2012). If prices in market i Granger causes price in market j and if j also Granger causes i, then prices are said to be determined by a simultaneous feedback mechanism (SFM). This phenomenon is called bi- directional causality. Also, if the Granger causality runs once, it is said to be uni- directional causality. Also, the market that Granger causes the other is referred to as the exogenous market (Mafimisebi, 2010).

$$\Delta p_{jt} = \alpha_0 + \sum_{t-1}^{n} \beta_1 \Delta p_{(t-1)} + \sum_{t-1}^{n} \beta_j \Delta p_{(t-1)j} + \delta\, ECT_{t-1} + \mu_1 .(5)$$

$$\Delta p_{jt} = \phi_0 + \sum_{t-1}^{n} \delta_j \Delta p_{(t-1)j} + \sum_{t-1}^{n} \delta_t \Delta p_{(t-1)t} + \lambda\, ECT_{t-1} + \varepsilon_1 .(6)$$

Where:
Δ is the difference operator, $P_{jt}$ is the price series in the leading market (i=1), $P_{ij}$ is the price series in other markets (j = 2 … 18) $\mu_1$ and $\varepsilon_t$ are white noise error terms, $ECT_{t-1}$ is the error correction term (adjustment vector) derived from the long run co-integrating relationship, while n is the optimal lag length orders of the variables which are determined by using the general – to – specific modeling procedure (Hendry and Ericsson, 1999). The null hypotheses are; $P_{it}$ will Granger – cause $P_{jt}$ if $\mu_1 \neq 0$. Similarly, $P_{jt}$ will Granger - cause $P_{it}$ if $\varepsilon_t \neq 0$. To implement the Granger causality test, F – statistics are calculated under the null hypothesis that all the coefficients of $\mu_1$ and $\varepsilon_t = 0$.

### 2.4.4 Vector error correction model (VECM)

Vector Error Correction Model describes the dynamic equilibrium relationship of short run (SR) and long run (LR) in a system of equation. Although, there could be long run inter market equilibrium, but there could be deviation in the short run equilibrium (Aryani and Yulius, 2012). VECM can also be described as a combination of SR and LR relationship between prices of different prices of different markets. It captures the short -run disequilibrium situation as well as the long run equilibrium adjustments between prices Nagubadi, et al. (2001) in Anwar (2005). VECM results in changes in the LR equilibrium relationship and deviation of prices in the short run period. Deviation from equilibrium as reflected by VECM coefficient will bring changes in the balance between the co integrating variables. The coefficient of error correction term (ECT) in the VECM is a measure of the adjustment speed toward LR equilibrium relationship between markets (Enders, 1995). The large coefficient indicates the speed of adjustment toward the LR equilibrium and vice versa (Aryani and Yulius, 2012).

The ECM is expressed as follows:

$$\Delta P_{it} = y_1 + y_2\, \Delta P_{jt} - \pi V_{it-1} + V_{ij} ..... \quad (7)$$

Where $y_2$ is the impact multipler (the short run effect) that measures the immediate impact that a change in $p_{it}$ will have on a change in $p_{it,}$ π is the feedback effect or the adjustment effect that shows how much of the disequilibrium is being corrected, that is the extent to which any disequilibrium in the previous period affects adjustment in $p_{it}$ period. Hence,

$\widehat{V}_{t-1} - \widehat{P}_{it} - \widehat{P}_1 - \widehat{P}_2 P_{jt-1,}$ therefore from this equation we also have $P_2$ being the long run response.

## 3. RESULTS AND DISCUSSION

The results of the analysis of the price series of local rice are reported in this section. These include the results of unit roots tests, pair wise co integration, multiple co– integration, tests for markets that exhibit leadership position in price formation and transmission and short run equilibrium in prices in the study are.

### 3.1 Augmented Dickey Fuller Unit Root Tests of Local Rice Price Series

The results of the stationarity (unit root) tests conducted for the price variables are reported in Table 2. The properties of each price time series were analyzed first in order to investigate the market integration. The study first examined each price series for evidence of non- stationarity in order to confirm that co integration approach is the appropriate tool (Fossati et al, 2007). Augmented Dickey Fuller was used to ensure that serial correlation is absent using the Akaike's information criterion. The ADF estimation is based on ordinary least square (OLS). All the price series of rice accepted the null hypothesis at their levels at 5% level of significance for all rice price data. The series were first differenced since further tests showed that non - stationarity was the case and the test was re conducted. When all the price series were differenced once, the results of the unit root test indicated that the null hypothesis of non - stationarity was rejected in favour of the alternative hypothesis by all the price series. This implies that all the price series were generated by similar stochastic processes and also they exhibit the possibility of moving together on the long run (Chirwa, 2001; [24]; Mafimisebi; 2007).

The result is supported by previous findings which shows that food commodities price series in Nigeria and elsewhere are mostly stationary after first differencing ([25]; Chirwa, 2001; Mafimisebi, 2008; Okoroafor et al, 2010; and [26]). This is probably due to the possession of series of trends arising from price inflation and cyclical variations from season leading to mean non – stationarity in food price series (Mafimisebi, 2008). The results also implies that the average variance and co variance at any lag are still constant at anytime [27]. Another implication of stationarity of variables is that if there is a disturbance in such variables, they will revert back to equilibrium level at the same rate. This confirms the fact that stationarity of variables prevent spurious regression, thus, it enhances proceeding to co integration tests.

### 3.2 Results of Long Run Price Equilibrium (Co integration) Test for Local Rice Markets

The results in Table 3 showed that one hundred and ten (110) market pairs co integrate with one another at 5% level of significance as shown by their maximum eigen and trace test statistics which are greater than their critical values. The results show that in respective of the differences

**Table 2. Augmented dickey fuller unit root test of local rice price series in Nigeria**

| Variable | ADF stat. 1(0) | P-values | ADF statistic (1) | P-value | Order unit |
|---|---|---|---|---|---|
| Abia | -2.1608(NS) | 0.2218 | -9.7929(S) | 0.000 | 1 |
| Ada | -1.4633( NS) | 0.5487 | -9.8193(S) | 0.000 | 1 |
| Akwa | -1.5193( NS) | 0.5205 | -10.9270(S) | 0.000 | 1 |
| Ana | -1.9036( NS) | 0.3297 | -13.8193(S) | 0.000 | 1 |
| Bau | -1.9987( NS) | 0.2872 | -15.2211(S) | 0.000 | 1 |
| Baye | -1.7987(NS) | 0.3796 | -11.3862(S) | 0.000 | 1 |
| Ebon | -1.6398(NS ) | 0.4591 | -10.7996(S) | 0.000 | 1 |
| Ekiti | -1.6343( NS) | 0.4619 | -10.8114(S) | 0.000 | 1 |
| FCT | -1.8052( NS) | 0.3764 | -15.0992(S) | 0.000 | 1 |
| Kan | -1.7939( NS) | 0.3820 | -12.5465(S) | 0.000 | 1 |
| Kogi | -1.6686( NS) | 0.4445 | -13.4145(S) | 0.000 | 1 |
| Lag | -1.4727( NS) | 0.5441 | -17.5849(S) | 0.000 | 1 |
| Osun | -1.6599( NS) | 0.4489 | -10.7884(S) | 0.000 | 1 |
| Plat | -1.4970( NS) | 0.5318 | -11.1607(S) | 0.000 | 1 |
| Rivers | -2.0383( NS) | 0.2703 | -10.0294(S) | 0.000 | 1 |
| Sok | -1.2375( NS) | 0.6565 | -12.9032(S) | 0.000 | 1 |
| Yobe | -1.4228( NS) | 0.5689 | -11.0251(S) | 0.000 | 1 |
| Zam | -1.6938( NS) | 0.4318 | -15.3076(S) | 0.000 | 1 |

*Source: Compiled from result of stationary test*

*Notes :*

1. *Critical values are -2.8859 and -2.8861 at the 95% confidence level and first difference series respectively*
2. *If the absolute value of ADF is lower than 5% critical ADF statistics, the null hypothesis of non stationarity is rejected.*
3. *NS means Non Stationarity while S means Stationarity*

in the value of the test statistics, the results of the maximal eigen value and trace value with respect to the number of co-integrating vectors that attained full rank were the same. In local rice market pairs, this implies that (one hundred and ten)110 local rice market pair were co integrated of order (1) in the six geopolitical zones of Nigeria. It can also be deduced that 71.90% of the local rice markets have their prices moved together in the long run despite the divergence in prices in between them in the long run. However, the remaining market pairs that show segregation in the local rice markets (28.10%) may be due to bad roads within the regional markets, there could be poor communication channels, market distortion, etc. Since the test statistics were greater than the critical values , the null hypothesis of no co integration in the market pairs is rejected in favour of the alternative for both the maximal eigen value and trace statistics . The results of the local rice market integration in Nigeria is supported by the findings of Mafimisebi et al. [28] which highlighted high degree of market integration of local rice market in the southwest states which is one of the six zones in this study. However, empirically the results in this study do not show wide differences when the samples of rice markets were taken across the six geographical zones in Nigeria.

**Table 3. Pair –wise co integration test for 1(1) market pair (local price)**

| Market pairs $P_1$-$P_2$ | | Maximum eigen value test statistics | Trace test statistics | Market pairs $P_1$-$P_2$ | | Maximum eigen value test statistics | Trace test statistics |
|---|---|---|---|---|---|---|---|
| 1. | Lag-Osun | 28.9423* | 31.3468* | 21. | Osun-Ada | 22.5770* | 25.4129* |
| 2. | Lag-Ekiti | 21.339* | 23.4842* | 22. | Osun-Yobe | 18.4713* | 20.9638* |
| 3. | Lag-Rivers | 28.3103* | 30.1852* | 23. | Osun-Kan | 19.4735* | 21.8189* |
| 4. | Lag-Baye | 35.9888* | 37.9401* | 24. | Osun-Sok | 19.2207* | 21.4794* |
| 5. | Lag-Akwa | 27.6091* | 29.2776* | 25. | Osun-Zam | 19.2222* | 21.5832* |
| 6. | Lag-Ana | 31.1585* | 33.6052* | 26. | Ekiti-Rivers | 20.2130* | 22.7907* |
| 7. | Lag-Abia | 38.5388* | 40.5219* | 27. | Ekiti-Bay | 35.7893* | 38.2602* |
| 8. | Lag-Ebon | 28.9336* | 30.8968* | 28. | Ekiti-Akwa | 24.1135* | 26.0008* |
| 9. | Lag-Kogi | 16.5933* | 18.9883* | 29. | Ekiti-Ana | 18.99387* | 22.2188* |
| 10. | Lag-Ada | 19.8191* | 22.1611* | 30. | Ekiti-Abia | 32.0042* | 34.3096* |
| 11. | Lag-Yob | 14.5343* | 16.4196* | 31. | Ekiti-Ebon | 28.6252* | 31.0401* |
| 12. | Lag-Zam | 12.9328* | 15.1016* | 32. | Ekiti-Bau | 14.4157* | 16.6565* |
| 13. | Osun-Ekiti | 23.5262* | 26.1133* | 33. | Ekiti-Ada | 17.8018* | 20.1519* |
| 14. | Osun-Rivers | 21.9094* | 24.6703* | 34. | Ekiti-Yob | 14.3013* | 16.1889* |
| 15. | Osun-Baye | 33.5113* | 36.1967* | 35. | Ekiti-Sok | 17.7192* | 19.4994* |
| 16. | Osun-Akwa | 18.3242* | 21.239* | 36. | Ekiti-Zam | 15.1442* | 17.4427* |
| 17. | Osun-Ana | 29.0252* | 31.7615* | 37. | Ekiti-Baye | 26.2567* | 31.3838* |
| 18. | Osun-Abia | 22.7761* | 25.6691* | 38. | Rivers-Bay | 26.2567* | 31.3838* |
| 19. | Osun-Kogi | 19.6431* | 22.2692* | 39. | Rivers-Akwa | 39.1808* | 43.3536* |
| 20. | Osun-Bau | 33.5113* | 36.1967* | 40. | Rivers-Ana | 33.8627* | 37.2050* |
| 41. | Rivers-Abi | 27.4186* | 31.0262* | 65. | Ana-Sok | 16.8921* | 19.3593* |
| 42. | Rivers-Ebon | 16.4384* | 19.9949* | 66. | Ana-Zam | 14.6616* | 17.2793* |
| 43. | Rivers-Kogi | 18.6689* | 21.4899* | 67. | Abia-Ebon | 24.3119* | 27.3988* |
| 44. | Rivers-Ada | 14.3935* | 18.7179* | 68. | Abia-Kogi | 15.25999* | 18.0079* |
| 45. | Rivers-Sok | 16.6338* | 19.2621* | 69. | Ebon-Kogi | 19.5848** | 22.2648* |
| 46. | Baye-Akwa | 22.5143* | 26.1704* | 70. | Ebon-Ban | 17.4851* | 20.5080* |
| 47. | Baye-Abia | 30.0258* | 33.2973* | 71. | Ebon-Ada | 21.2975* | 25.2649* |
| 48. | Baye-Ebon | 32.3626* | 35.3300* | 72. | Ebon-Yor | 19.7389* | 22.24681* |
| 49. | Baye-FCT | 21.0894* | 23.5720* | 73. | Ebon-Kan | 19.6812* | 22.5672* |
| 50. | Baye-Plat | 16.3630* | 19.2595* | 74. | Ebon-Sok | 16.9762* | 19.6583* |
| 51. | Baye-Kogi | 27.0070* | 29.5713* | 75. | Ebon-Zam | 16.2452* | 18.9995* |
| 52. | Baye-Ban | 19.6593* | 22.7248* | 76. | FCT-Plat | 26.8231* | 29.1096* |
| 53. | Baye-Ada | 17.1211* | 21.0259* | 77. | FCT-Ban | 18.7485* | 21.2466* |
| 54. | Baye-Yob | 22.5905* | 25.1024* | 78. | FCT-Ada | 30.2482* | 32.9811* |
| 55. | Baye-Kan | 21.5434* | 23.9505* | 79. | FCT-Yor | 22.6135* | 25.0520* |
| 56. | Baye-Sok | 20.8357* | 23.431* | 80. | FCT-Kan | 15.6479* | 18.0822* |
| 57. | Baye-Zam | 19.4832* | 22.3961* | 81. | FCT-Sok | 17.6679* | 20.1741* |
| 58. | Akwa-Ana | 25.7419* | 29.0457* | 82. | FCT-Zam | 24.7801* | 27.0893* |

| Market pairs $P_1$-$P_2$ | | Maximum eigen value test statistics | Trace test statistics | Market pairs $P_1$-$P_2$ | | Maximum eigen value test statistics | Trace test statistics |
|---|---|---|---|---|---|---|---|
| 59. | Akwa-Abia | 31.0707* | 34.1867* | 83. | Plat-Kogi | 15.8594* | 18.4349* |
| 60. | Akwa-Ebon | 17.7302* | 20.9399* | 84. | Plat-Ban | 23.5594* | 25.9838* |
| 61. | Akwa-Kogi | 15.1586* | 18.3382* | 85. | Plat-Ada | 34.0596* | 36.8618* |
| 62. | Ana-Ebon | 21.7164* | 24.8513* | 86. | Plat-Yor | 26.4020* | 28.7323* |
| 63. | Ana-Kogi | 16.0124* | 18.8099* | 87. | Plat-Kan | 31.6634* | 33.9411* |
| 64. | Ana-Kan | 14.8618* | 17.4763* | 88. | Plat-Sok | 37.0120* | 39.9262* |
| 89. | Plat-Zam | 30.6689* | 32.9451* | 100. | Bau-Zam | 37.1455* | 60.2724* |
| 90. | Kogi-Bau | 21.9897* | 24.5097* | 101. | Ada-Yob | 34.8444* | 38.1891* |
| 91. | Kogi-Ada | 22.9113* | 25.6945* | 102. | Ada-Kan | 48.6956* | 51.3881* |
| 92. | Kogi-Yobe | 20.9101* | 23.3043* | 103. | Ada-Sok | 41.5046* | 44.1383* |
| 93. | Kogi-Kan | 22.8078* | 25.0918* | 104. | Ada-Zam | 57.3593* | 60.2724* |
| 94. | Kogi-Sok | 33.3393* | 35.5817* | 105. | Yob-Kan | 26.3561* | 28.7284* |
| 95. | Kogi-Zam | 17.1622* | 19.5817* | 106. | Yob-Sok | 31.8201* | 34.1108* |
| 96. | Bau-Ada | 30.0606* | 34.1197* | 107. | Yob-Zam | 28.5201* | 31.1076* |
| 97. | Bau-Yob | 32.2401* | 35.1953* | 108. | Kan-Sok | 37.2481* | 39.7198* |
| 98. | Bau-Kan | 48.3956* | 51.3881* | 109. | Kan-Zam | 36.0265* | 38.4315* |
| 99. | Bau-Sok | 41.5046* | 44.1383* | 110. | Sok-Zam | 24.1795* | 26.7029* |

*Source: Compiled from result of cointegration test*

*Note:*
*(1) Only the 110 markets link with significant parameters are shown*
*(2) ** means significant at 5% level*
*(3) Critical values for trace and maximal eigen value tests are 15.495 and 14.265 at 95% respectively*

### 3.3 Multiple Co integration Result of Local Rice Market

Also, Table 4 shows the results of trace statistics and maximum eigen value for local rice price series. The results reveal that the rank of co integrating vectors $\pi$ can be set to three (3) (for both the trace statistics and maximum eigen value at 5% significant level). It can be deduced that if we select $r \geq 3$ then the trace and maximum eigen value tests are smaller than 95% critical value ($26.41 < 29.80$, $10.49 < 15.50$ and $1.89 < 3.84$ for trace test, while $15.93 < 21.13$, $8.6 < 14.26$ and $1.86 < 3.84$ for maximum eigen value test). The meaning of this according to Johansen procedure is that there are three (3) linear combination that exist among the price variables over the entire study time. This further confirms the findings of pair wise co integration tests reported earlier. The overall economic implication of the result is that in Nigeria the local rice markets exhibit moderate long run price equilibrium.

### 3.4 Results of Granger Causality of Local Rice Markets

The results also identified markets that exhibit leadership position(s) in the formation and transmission of local rice pricing as shown in Table 5. The result showed 10 market links in the local rice pricing are bi directional, Akwa Ibom (Akwa) – Rivers, Rivers-Akwa Ibom (Akwa), Bayelsea (Baye) - Akwa Ibom, Akwa Ibom-Bayelsea (Baye), Plateau - Abuja( (FCT), FCT-Plateau (Plat), Bauchi- Yobe, Yobe-Bauchi (Bau), Yobe – Adamawa (Ada), Adamawa - Yobe and they exhibited bi- directional (two way) causality. Akwa - Ibom Granger caused Rivers at 1% level of significance in the first market link, Rivers Granger caused Akwa Ibom at 5% level of significance in the second market link. Thus, Rivers proved stronger than Akwa Ibom in the first two market links. In the third and fourth market link Bayelsea proved stronger than Akwa Ibom at 1% level of significance. Also, the fifth and sixth market links shows that Plateau Granger caused FCT at 5% level of significance while FCT Granger caused Plateau at 1% level of significant, proving stronger than Plateau. However, in the seventh and eighth market links, Yobe and Bauchi marched strength with strength as they exhibited exogeneity at same level of significance (1%). The ninth and tenth market links, Yobe and Adamawa matched strength for strength as they Granger caused each other at 1% level of significance. The remaining eleven (11) market links showed uni-directional (one-way) Granger causality in which there is no significant causality from other market. Therefore, the leading markets occupying leadership positions in local rice pricing were Osun, Lagos, Bayelsa, Akwa Ibom, Rivers, Anambra, Ebonyi, Plateau, FCT, Kano, Bauchi, Adamawa and Zamfara.

**Table 4. Multiple co–integration result of local rice**

| Null hypothesis | Trace tests value | 95% critical value | P value | Maximum eigen test value | 95% critical value | P value |
|---|---|---|---|---|---|---|
| r = 0 | 175.96 | 95.73 | 0.000*** | 68.00 | 40.08 | 0.0003*** |
| r ≤ 1 | 107.96 | 69.82 | 0.000*** | 45.37 | 33.88 | 0.0014** |
| r ≤ 2 | 62.59 | 47.86 | 0.0012** | 36.18 | 27.58 | 0.0031* |
| r ≤ 3 | 26.41 | 29.80 | 0.1169 | 15.93 | 21.13 | 0.2292 |
| r ≤ 4 | 10.49 | 15.50 | 0.2452 | 8.60 | 14.26 | 0.3213 |
| r ≤ 5 | 1.89 | 3.84 | 0.1692 | 1.89 | 3.84 | 0.1692 |

*(1) Trace test and maximum eigen value test indicate 3 co -integrating equation(s) at the 0.05%;*
*(2) **Mackinnon Naug – Michelis (1999) P – values*
*(3) r = Rank of co integrating vector*

**Table 5. Pair wise granger causality test (local rice markets)**

| | Null Hypothesis | F-Statistics | Probability | Direction |
|---|---|---|---|---|
| 1. | Akwa ↔ Rivers | 3.8333* | 0.0245 | Bi-directional |
| 2. | Rivers ↔ Akwa | 9.5574** | 0.0002 | Bi- directional |
| 3. | Baye ↔ Akwa | 7.5286** | 0.007 | Bi-directional |
| 4. | Akwa ↔ Baye | 4.3794* | 0.0386 | Bi-directional |
| 5. | Plat ↔ FCT | 3.8452* | 0.0242 | Bi- directional |
| 6. | FCT ↔ Plat | 5.6921** | 0.0044 | Bi-directional |
| 7. | Yobe ↔ Bau | 10.9826** | 4.40 E-05 | Bi-directional |
| 8. | Bau ↔ Yobe | 3.2232* | 0.0435 | Bi- directional |
| 9. | Yobe ↔ Ada | 4.6414** | 0.0116 | Bi-directional |
| 10. | Ada ↔ Yobe | 10.7708** | 5.20E-05 | Bi-directional |
| 11. | Osun → Lag | 10.4389** | 6.90E-05 | Uni-directional |
| 12. | Lag → Ekiti | 9.7208** | 0.0001 | Uni-directional |
| 13. | Osun → Ekiti | 10.31179** | 7.70E-05 | Uni-directional |
| 14. | Baye → Rivers | 8.2011** | 0.0005 | Uni-directional |
| 15. | Ana → Abia | 6.9740** | 0.0014 | Uni-directional |
| 16. | Ana → Ebon | 4.3851** | 0.0147 | Uni-directional |
| 17. | Ebon → Abia | 4.1525* | 0.0182 | Uni-directional |
| 18. | Kan → Sok | 12.4765** | 1.30E-05 | Uni-directional |
| 19. | Kogi → Plat | 3.0393* | 0.0518 | Uni-directional |
| 20. | Kan → Zam | 11.9151** | 2.00E-o5 | Uni-directional |
| 21. | Zam → Sok | 5.3277** | 0.0062 | Uni-directional |

*Source: Compiled from the Result of Granger-Causality test*
*(*, **) means significant at 5% and 1% level; ↔ Indicates direction of causality (bi-directional) ; → Indicates direction of causality (uni-directional)*

### 3.5 Vector Error Correction Measures for Local Rice Market

In Table 6, the local rice markets VECM estimates showed that North East States and South West States show strongest reaction to others with adjustment coefficients 0.584096 (58%) and -0.37546 (38%) respectively. Also, in the second co- integrating equation, South West States and North Central States show strongest reaction to others with adjustment coefficients of 2.92206 (29%) and 2.66200 (27%) respectively, while others react with negative coefficients. In addition, the third co integrating equation shows that North East States and North Central States show the strongest reaction to others with adjustment coefficients of -0.467021 (47%) and -0.470646 (47%) respectively. This implies that the local rice markets in Nigeria are moderately integrated in the short run.

## 4. SUMMARY OF THE STUDY

The study used monthly retail price data for the period of January 2001 to December 2010 for six regional markets in Nigeria. This study has assessed the time series properties of the available regional retail price series for local rice markets. This indicates that the series were stationary after the first differencing for local rice

**Table 6. Vector error correction test for local rice**

| Error correction | D(SW) | D(SS) | D(SE) | D(NC) | D(NW) | D(NE) |
|---|---|---|---|---|---|---|
| Coint Eq 1 | -0.375460 | 0.109760 | 0.230719 | 0.210072 | 0.506344 | 0.584096 |
| | (0.10023) | (0.15651) | (0.11818) | (0.13092) | (0.17332) | (0.12606) |
| | [-3.74587] | [0.70129] | [1.95223] | [1.60461] | [2.92150] | [4.63338] |
| Coint Eq 2 | 0.202200 | -0.233498 | 0.153780 | 0.240595 | -0.251453 | -0.194462 |
| | (0.06920) | (0.10805) | (0.08159) | (0.09038) | (0.11965) | (0.08703) |
| | [2.92206] | [-2.16100] | [1.88481] | [2.66200] | [-2.10154] | [-2.23443] |
| Coint Eq 3 | 0.223805 | 0.109170 | -0.408208 | -0.470646 | -0.310099 | -0.467021 |
| | (0.11899) | (0.18580) | (0.14030) | (0.15542) | (0.20575) | (0.14966) |
| | [1.88083] | [0.58755] | [-2.90952] | [-3.02822] | [-1.50714] | [-3.12062] |
| D(SW(-1)) | -0.293560 | 0.260382 | -0.116805 | -0.196358 | -0.642496 | -0.276964 |
| | (0.11049) | (0.17252) | (0.13027) | (0.14431) | (0.19105) | (0.13896) |
| | [-2.65697] | [1.50926] | [-0.89662] | [-1.36066] | [-3.36304] | [-1.99314] |
| D(SS(-1)) | -0.258761 | -0.364530 | -0.207389 | -0.267462 | -0.05471 | 0.117599 |
| | (0.07492) | (0.11699) | (0.08834) | (0.09786) | (0.12955) | (0.09423) |
| | [-3.45370] | [-3.11590] | [-2.34764] | [-2.73314] | [-0.42236] | [1.24800] |
| D(SE(1)) | -0.88700 | 0.212948 | 0.023842 | 0.590589 | 0.367980 | 0.304462 |
| | (0.12784) | (0.19962) | (0.15073) | (0.16698) | (0.22105) | (0.16079) |
| | [-0.69383] | [1.06676] | [0.158171] | [3.53694] | [1.66466] | [1.89359] |
| D(NC(1)) | 0.145106 | -0.542403 | -0.129229 | -0.29322 | -0.064264 | -0.283433 |
| | (0.10262) | (0.16023) | (0.12099) | (0.13403) | (0.17744) | (0.12906) |
| | [1.41406] | [-3.38506] | [-1.06807] | [-2.08400] | [-0.36218] | [-2.196121] |
| D(NW(1)) | -0.023759 | 0.114554 | -0.010050 | -0.128841 | 0.177140 | -0.110026 |
| | (0.07340) | (0.11461) | 0.08654 | (0.09586) | (0.12599) | (0.09231) |
| | [-0.32372] | [0.99955] | [-0.11613] | [-0.11613] | [-1.39578] | [-1.19193] |
| D(NE(1)) | -0.237858 | 0.143008 | 0.121629 | -0.103092 | -0.127901 | -0.033503 |
| | (0.10754) | (0.16791) | (0.12679) | (0.12135) | (0.16065) | (0.11685) |
| | [0.01952] | [0.85167] | [0.95928] | [-0.84954] | [-0.79615] | [-0.28672] |
| C | 1.220332 | 0.347143 | 0.783672 | 0.953758 | 0.940443 | 0.757686 |
| | (0.55542) | (0.86728) | (0.65488) | (0.72545) | (0.96040) | (0.69855) |
| | [2.19713] | [0.40027] | [1.19666] | [1.31471] | [0.97922] | [1.08466] |
| R –squared | 0.421505 | 0.377929 | 0.2742258 | 0.295047 | 0.311450 | 0.332402 |
| F-statistic | 4.906065 | 4.090731 | 2.544533 | 2.818137 | 3.045675 | 3.352583 |

*Source: Compiled from Vector Error Correction Test Results.*

*Note: D: First difference operator; Adjusted Coefficient in first Row; Standard Error Value in ( ); t – Statistics Value in [ ]; SW: South West; SE: South East; SS: South South; NC: North Central; NW: North West; NW: North East*

retail prices. This shows that all the price series were generated by similar stochastic process and they have a stable long-run relationship. The co integration analysis results using Johansen's maximal Eigen value and trace tests show that local rice markets were well integrated in Nigeria. This shows that shock in the prices are easily transmitted to local rice markets across the nation. This was affirmed by the results of Johansen multiple co integration analysis.

The Granger causality tests indicated that there were ten market links that exhibited bi-directional (two ways) causality in the local rice markets while twelve market links showed uni-directional (one way) Granger causality in which there is no significant causality from other markets. In the short run, local rice pricing is moderately integrated.

## 5. CONCLUSION

The study explored spatial market integration for local rice monthly retail prices in Nigeria, for the period of January 2001 to December 2010, using the Johansen Co – integration, Granger causality tests and Vector Error Correction Model. The results suggest that local rice price series were well integrated in the six geopolitical zones of Nigeria on the long- run and moderately co-integrated on the short -run. Results suggest that prices in these regions were highly integrated, irrespective of whether they were surplus or deficit markets. However, in the segregated market pairs, what the study uncovered is simply the lack of statistical alignment of prices in these regional pairs. In other words, there exist no long- run equilibrium relationship of the prices in the identified market pairs and that the price

transmission mechanism is flawed. The reasons for such market segregation were not pursued in this study since the available data were not sufficient to do such analysis. The results of the market integration analysis obtained by employing the error correction model (ECM) shows that price signal is transmitted in the short run between the markets in the six geopolitical zones in Nigeria. The results of the Granger causality tests conducted on all regional market pairs identified what the theory predicts that at least a unidirectional causality exists in the integrated market pairs. Interestingly, market information in deficit regions were apparently being used in the price formation at the rice producing regions. In some deficit – surplus regional pairs, significant feedback causality was also noted (bi--directional causality). However, this higher degree of spatial market integration of rice in Nigeria might contribute to economic development or a by-product of development process (Gloria and Steven, 2001).

## 6. RECOMMENDATIONS

Based on the findings of this study, the following recommendations are highlighted towards an effective functioning of rice markets in Nigeria, especially, the local rice varieties:

- There is need to establish a system of formal price equality for rice markets in Nigeria;
- Market related infrastructure should be put in place to increase the efficiency of the market which in turn may have positive effect in the pricing of local rice;
- Government of Nigeria should create a trade mark for local rice varieties to attract home based consumption and subsequent exportation;
- Lastly, government should institute food policy reforms in the supply regions.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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