SPATIAL PRICE ANALYSIS OF TOMATOES IN NIGERIA

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ABSTRACT

The study examined market integration in tomato markets in selected producing and consuming states in Nigeria. Secondary data on tomato prices spanning 2003 –2006 were sourced from National Bureau of Statistics. The data were analyzed using Augmented Dicker Fuller (ADF) and Granger Causality tests*. Results indicated that the maximum tomato price was recorded in Ekiti in November, 2006 while the minimum price was recorded in Kano state in August, 2006. The results also revealed that prices of tomato were not stationary in their level form but become stationary at the first difference level. Seven tomato markets rejected their respective null hypothesis of no granger causality. None of the markets exhibited bi -directional granger causality or simultaneous feedback relationships Seven markets exhibited uni -directional granger causality. The results also indicated that Ekiti and Katsina states occupy the leadership position in tomato price formation and transmission. We recommend there should be efficient flow of information and good access road and infrastructural development among the states to improve market performance.*

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KEYWORDS: Tomatoes, Market integration, Nigeria.

INTRODUCTION

Spatial market integration refers to co-movements or the long-run relationship among prices (Ghafoor et al, 2009). It is also the smooth transmission of price signals and information across spatially separated markets (Golleti, et al 1995). Spatial price analysis of markets improves understanding of price signals, direction of change and the transmission of same from food production centers to consumption zones.

Vegetables, including tomatoes, are highly perishable in nature due to their large water content. Efficient agricultural marketing is essential for the satisfaction of producers and consumers, as well as production and consumption. Agricultural marketing assumes greater importance in an economy when excess production from farms are disposed of in order to earn income with which farmers can purchase goods and services not produced by them (Adekanye, 1998).

In most Nigerian markets, price determination is accomplished by haggling. Commodities are not standardized and measures are not uniform. Farmers are affected by price volatility and hence may fail to specialize to gain a comparative advantage and gains from trade will not be realized (Chirwa, 2000). Favorable pricing stimulates more production; hence the co-movement and transmission of price signals and information across spatially separated markets are equally important in determining marketing performance (Yusuf *et al* 2006). Several studies address agricultural marketing margin and pricing efficiency on staple foods and animal products (Mafimisebi 2002). Few marketing studies have been conducted on horticultural crops. This study fills this gap in the literature.

This study examines trends in tomato prices in the selected states in Nigeria. We test for co integration of the price series in order to measure relationships in the price series and also determine the causal relationship between and among the price series. This will add to the body of literature on market integration, indicating the extent of price transmission in tomato markets in different producing and consuming states within Nigeria. The remainder of the paper is organized as follows: Literature Review, Data and Methodology, Results and Concluding Comments.

LITERATURE REVIEW

Bakucs and Ferto, 2005 examined marketing margins and price transmission in the Hungarian port meat market using cointegration analysis. They found that producer and retail pork meat prices are cointegrated. They concluded that price transmission in the Hungarian pork market is symmetric. Dawson and Dey, 2002 tested for the law of one Price in Rice Market Integration in Bangladesh. They proposed an integrated empirical framework which tests for long-run spatial market integration between price pairs using a dynamic vector autoregressive model and cointegration. Hypotheses tests of market integration, perfect market integration, and causality are conducted sequentially. Data on monthly prices from rice markets in Bangladesh since trade liberalization in 1992 were utilized. Results show that rice markets are perfectly integrated and that Dhaka dominates near markets but is dominated by more distant markets.

Uchezuba (2005) measured market integration for apples in the South African FPMs to determine the existence of long-run price relationships and spatial market linkages. Standard autoregressive (AR) and threshold autoregressive (TAR) error correction models were compared to determine whether transaction cost has significant effects in measuring market integration. The investigation revealed a statistically significant decline in real prices in six of eight markets investigated. Nkang *et al*, 2007 examined price transmission and integration of cocoa and palm oil markets in Cross River State, Nigeria using standard econometric techniques. Results indicated that cocoa markets are fully integrated in the long run, with price transmission elasticity of approximately 1.0 indicating that the law of one price holds in the markets. The study concluded that producers of cocoa and palm oil benefited from spatial arbitrage as suggested by the perfect integration of the market and the fulfillment of the law of one price.

Dittoh (2006) examined the Market integration of dry season vegetables in Nigeria. The objective is to obtain indices of marketing inefficiency through the market integration approach. Weekly price data for pepper (*tatashe*) and tomatoes were collected from eight locations in Nigeria, four producing areas, two production/consuming areas, and two consuming areas, for 34 weeks (November 1991 to June 1992). The data were analyzed using a Ravallion-type model. The results indicated that there is little, and a low degree of, integration of pepper and tomato markets in the study area as a whole. Some market integration however exists between major producing and major consuming areas. The results also indicated that good access roads are important for markets to be integrated. He concluded that a major determinant of market integration in the study area was information flows between producing and consuming areas and those assemblers of the produce, primary wholesalers, and transporters are currently the major sources of the information.

DATA AND METHODOLOGY

The study covers 2003 to 2006 using monthly prices (48 months). Secondary data on prices of fresh tomatoes on state basis were collected from National Bureau of Statistics on a monthly basis. The study covered Lagos, Oyo, Ekiti, Kaduna, Kano and Katsina states using the prices of fresh tomatoes. The selection of the states was based on the fact that Kano, Kaduna and Katsina are producing areas whereas Lagos, Oyo and Ekiti state are consuming points. The choice of tomato is due to its daily variation in prices and its importance in diet of households. The study made use of a combination of analytical tools. These include trend analysis, cointegration and Granger causality procedures. The first step in carrying out a time series analysis according to Masliah (2002), is to check for stationarity of the variables or price series. A price series is stationary if its mean and variance are constant over time. Non stationary stochastic series have varying mean or time varying variance. The price series in this study were first tested for stationarity. The purpose was to overcome the problems of spurious regression. The Augmented Dickey Fuller (ADF) was adopted to test for stationarity. This involves running a regression of the form:

$$\Delta P_{it} = \partial P_{t-1} + \sum_{i=1}^{P} \beta_1 \Delta P_{t-1} + \ell_{it} \quad (1)$$

Where Δ = first difference operator, ∂ = 0, implies the existence of a unit root in $P_{i\,t}$ or that the price series is non-stationary, i = commodity price series, i.e. tomatoes, t = time indicator, e_{it} is the error term. The process is considered stationary if $/\partial\ / < 1$, thus testing for stationarity is equivalent with testing for unit roots (∂ <1). Therefore:

H_o: ∂ = 0 indicates the price series is non stationary or existence of unit root
H_1: ∂ < 0 indicates the price series is stationary

Johansen Tests were carried out using a linear deterministic trend in order to know the number of co-integrating vectors. The Johansen testing procedures have the advantage that they allow for the existence of more than one co integrating relationship (vector) and the speed of adjustment towards the long-term equilibrium is easily determined (Bakucs and Ferto, 2005). The model is:

$$\Delta X_t = \mu_t + \sum_{i-1}^{k} \Gamma X_{t-1} + \Pi X_{t-k} + \varepsilon_t \quad (2)$$

where X_t = an n x 1 vector containing the series of interest (tomatoes spatial price series), Γ and Π = matrices of parameters, K = number of lags, that should be adequately large to capture the short-run dynamics of the underlying VAR and to produce normally distributed white noise residuals, ε_t = vector of white noise errors. The Johansen test provides insight into the number of estimation equations to be fitted. The presence of one cointegration relationship is necessary for the analysis of the long run relationship of the prices to be plausible.

The Granger causality test determines the direction of causality. When two price series are co-integrated and stationary, one may use the granger causality test. One granger causal relationship must exist in a group of co integrated series (Chirwa, 2000). When Granger causality runs one way (uni-directional), the market, which Granger-causes the other is tagged the exogenous market. Exogeneity can be weak or strong. Hendry (1986) observed that weak exogeneity occurs when the marginal distribution of $P_{i\,(t-1)}$ and $P_{j(t-1)}$ was significant, while strong exogeneity occurs when there is no significant Granger-causality from the other variable. It could also be bi-directional which indicates that both series influence each other (X causes Y, and Y also causes X). The Granger model used in this study can be represented by:

$$\Delta P_{it} = \sum_{i=1}^{m} a_i \Delta P_{j(t-1)} + \sum_{j=1}^{n} a_j \Delta P_{j(t-1)} + \ell_t \quad (3)$$

Where m and n are the numbers of lags determined by a suitable information criterion. Rejection of the null hypothesis indicates that prices in market j Granger-cause prices in market i.

H_o: price of tomato in one market does not determine (granger cause) the other market.
H_1: price of tomato in one market determine the other market (not granger cause)

RESULTS

The maximum price of fresh tomato ever attained in Lagos state was N121/kg in August 2005 (Figure 1). The minimum price was N46.16kg recorded in September 2003. The maximum price of tomato ever attained in Oyo state was N104.97/kg in 2005 (Figure. 2). The peak price ever attained in Lagos and Oyo state was 116.90/Kg (July 2005) and 106.95/kg (March 2006) respectively (Figure 1 and 2). In the same vein, the highest price ever attained at Kano, Kaduna and Katsina were 112.47/kg (July, 2005), 100/kg (March, 2005) and 114.62/kg (August, 2003) respectively. The maximum price attained for tomato in the study area was N145.52/kg occurred in Ekiti state in November, 2006 (Figure 3), whereas the minimum price of N27.06/kg occurred in Kano state in August, 2006 (Figure 4). Figure 5 and 6 show the 2005 price of tomato in other states varied from N27.57/kg to N116.9/kg depicting seasonal variations.

Figure 1: Monthly Retail Price of Tomatoes in Lagos state

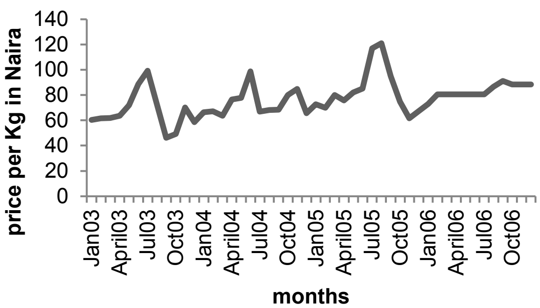


Figure 2: Monthly Retail Price of Tomatoes in Oyo State

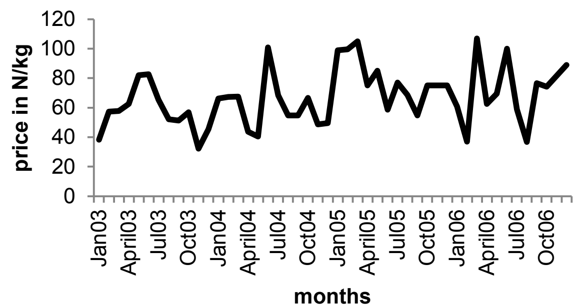


Figure 3: Monthly Retail Price of Tomatoes in Ekiti State

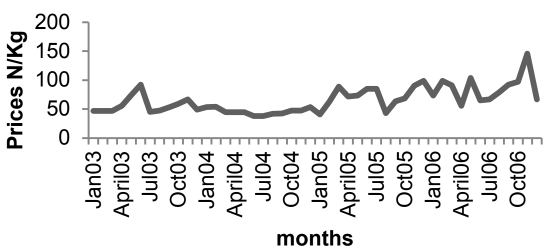


Figure 4: Monthly Retail Price of Tomatoes in Kano State

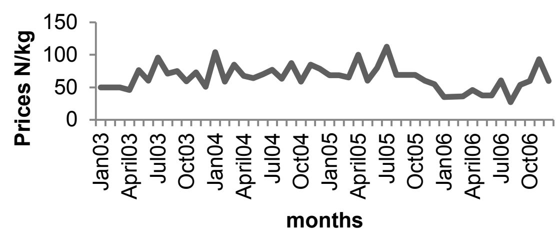


Figure 5: Monthly Retail Price of Tomatoes in Katsina State

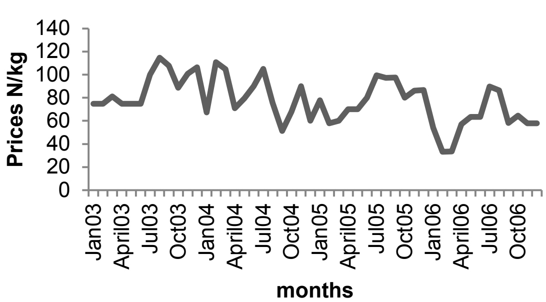
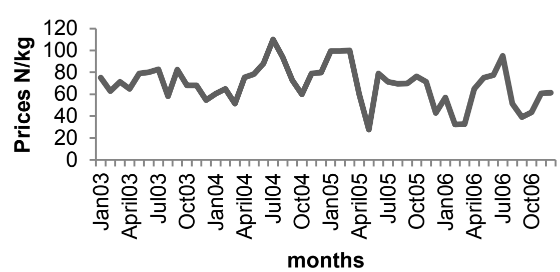


Figure 6: Monthly Retail Price of Tomatoes in Kaduna State



The price of tomato was not stable across seasons and states. The peak price was always in the second and third quarters of the year while the least price was observed in the first quarter of the year. The reason for the price variation can be attributed to the economic principle of supply and demand. The second and third quarters coincide with the period of high rainfall. Tomato does not grow well during this period and therefore the supply will be greatly reduced in the markets. Thus, these quarters of the year are regarded as off season and the resultant effect is the high prices of tomato fruit. The first and fourth quarters are the harvesting season for tomatoes justifying low prices.

The result in Table 1 shows the stationarity test for tomato using ADF procedure. The results indicate that all variables are not stationary in their level form. Therefore, the null hypotheses of non-stationary series were accepted for all the variables in their level form. The null hypotheses were however rejected for the first differences. This agrees with the findings of Alexander and Wyeth (1994), Chirwa (2000), Yusuf *et al* (2006) that commodity prices are stationary at the order of first difference. Thus, the test of cointegration could be applied, as all the tomato price data series were integrated of the same order, i.e. I (1) and did not have unit root.

Table 1: Stationarity Test of Tomato in Nigeria

Market	ADF(Level form)	Remark	ADF (first difference)	Remarks
Lagos	-3.268	Non stationary	-6.337	Stationary
Oyo	-5.542	Non stationary	-8.171	Stationary
Ekiti	-2.318	Non stationary	-7.337	Stationary
Kaduna	-3.935	Non stationary	-7.823	Stationary
Kano	-2.459	Non stationary	-14.440	Stationary
Katsina	-3.432	Non stationary	-7.229	Stationary

This table shows the stationarity test for tomato using ADF procedure. The results indicate that all the variables are not stationary in their level form.

In Table 2, the maximum Eigen value test shows that out of the 30 tomato market pairs investigated only 3 are co integrated at 10% level of significance. The trace test shows all the 30 tomato market pairs are co integrated at the 5% level of significance. Therefore using the trace statistics, it can be inferred that the entire tomato markets investigated are co integrated of the order (1, 1). This is the proportion of tomato market pairs which prices are tied together in the long run.

Thirty tomato market links were investigated for evidence of granger causality (Table 3). Seven tomato market links rejected their respective null hypothesis of no granger causality. From the results of the analysis, none of the market links exhibited bi directional granger causality or simultaneous feedback relationships. Seven market links exhibited unidirectional granger causality. These are Ekiti-Lagos, Ekiti-Oyo, Oyo-Kaduna, Katsina-Oyo, Katsina-Ekiti, Ekiti-Kaduna, and Kano-Katsina. Ekiti market has a strong exogeneity over Oyo and Kaduna markets but exhibits weak exogeneity over Lagos market. Similarly, Oyo market exhibits a strong exogeneity over Kaduna. Katsina exhibits strong exogeneity over Oyo markets and Kano exhibits weak exogeneity over the Ekiti market. Weak exogenity was also observed in the Kano/Katstina markets. It can therefore be said that Ekiti and Katsina tomato markets are in the leadership position in tomato price formation and transmission among the tomato markets investigated. Furthermore, from the result of the analysis, few of the markets are spatially linked by trade. Therefore, there is low market integration between producing and consuming states. This implies that price changes in one market are not manifested to an identical price response in the other market (Goletti et al, 1995, Barrett, 1996). There is also inadequate free flow of goods between markets and the markets are not linked by efficient arbitrage.

Table 2: Cointegration Test for Tomato in Nigeria

Spatial Market pairs	Maximum Eigen value Test			Trace Test		
	Hypotheses			Hypotheses		
	Null	Alternative	Test statistics	Null	Alternative	Test
Ekiti – kad	r=0	r=1	0.4057	r=0	r=1	28.409**
	r<1	r=2	0.0926*	r<1	r=2	4.469**
Ekiti-kano	r=0	r=1	0.2217	r=0	r=1	15.593**
	r<1	r=2	0.0845*	r<1	r=2	4.062**
Ekiti-Kats	r=0	r=1	0.2413	r=0	r=1	18.023**
	r<1	r=2	0.1091	r<1	r=2	5.317**
Ekiti-Lagos	r=0	r=1	0.3066	r=0	r=1	20.851**
	r<1	r=2	0.0833*	r<1	r=2	4.004**
Ekiti-Oyo	r=0	r=1	0.3794	r=0	r=1	27.766**
	r<1	r=2	0.1188	r<1	r=2	5.819**
Kad-kano	r=0	r=1	0.2795	r=0	r=1	21.166**
	r<1	r=2	0.1238	r<1	r=2	6.082**
Kad-Katsina	r=0	r=1	0.2518	r=0	r=1	22.790**
	r<1	r=2	0.1855	r<1	r=2	9.440**
Kad-Lagos	r=0	r=1	0.2881	r=0	r=1	28.571**
	r<1	r=2	0.2451	r<1	r=2	12.939**
Kad –Oyo	r=0	r=1	0.3306	r=0	r=1	30.165**
	r<1	r=2	0.2246	r<1	r=2	11.701**
Kano-Katsin	r=0	r=1	0.2625	r=0	r=1	20.386**
	r<1	r=2	0.1294	r<1	r=2	6.378**
Kano-Lagos	r=0	r=1	0.2704	r=0	r=1	20.304**
	r<1	r=2	0.1184	r<1	r=2	5.797**
Kano-Oyo	r=0	r=1	0.3337	r=0	r=1	24.495**
	r<1	r=2	0.1187	r<1	r=2	5.816**
Kats- Lagos	r=0	r=1	0.2909	r=0	r=1	22.612**
	r<1	r=2	0.1373	r<1	r=2	6.797**
Kats-Oyo	r=0	r=1	0.4258	r=0	r=1	33.455**
	r<1	r=2	0.1584	r<1	r=2	7.933**
Lagos-Oyo	r=0	r=1	0.4298	r=0	r=1	37.435**
	r<1	r=2	0.2226	r<1	r=2	11.586**

*The table shows that out of the 30 tomato market pairs investigated only 3 are cointegrated at the 10% level of significance. The trace test shows all 30 tomato market pairs are cointegrated at the 5% level of significance. **sig at 5% * sig at 10%. Note: r= number of cointegrating vectors.*

CONCLUSION

The study examined price transmission in tomatoes markets in Nigeria. The study covers the time period 2003 to 2006. Secondary data on prices of fresh tomatoes on a state basis were collected from National Bureau of Statistics on a monthly basis. The study covered Lagos, Oyo, Ekiti, Kaduna, Kano and Katsina states using the prices of fresh tomatoes. The study made use of a combination of analytical tools including trend analysis, cointegration and Granger causality procedures.

The price of tomato was not stable across seasons and states. The peak price occurred in the second and third quarters of the year while the lowest price was observed in the first and fourth quarter of the year. The entire tomato markets investigated are co integrated of the same order. Seven tomato market links rejected their respective null hypothesis of no granger causality. None of the market links exhibited bi directional granger causality or simultaneous feedback relationship. Seven market links exhibited unidirectional granger causality. The major limitation of the study is that data could not be obtained from 2007 and later periods. Based on the study findings, there is need for a policy that will keep the prices of tomato constant throughout the year. The following are recommended: preservation of tomato at harvest; provision of processing plants; upgrading of markets/marketing facilities; and market information centers should be established to facilitate adequate communication and flow of information between markets. There is need for similar studies on other horticultural crops that have a perishable nature.

Table 3: Granger Causality Test for Tomato Markets in Nigeria

Null Hypothesis	Observations	F-Statistic	Probability
OYO does not Granger Cause LAGOS	46	0.9095	0.4106
Lagos does not granger cause Oyo		0.7203	0.4926
EKITI does not Granger Cause LAGOS	46	2.8110	0.0717*
Lagosdoes not Granger Cause Ekiti		1.4450	0.2475
KANO does not Granger Cause LAGOS	46	0.3372	0.7157
Lagos does not Granger Cause Kano		0.1605	0.8522
KADUNA does not Granger Cause LAGOS	46	0.4989	0.6108
Lagos does not Granger Cause Kaduna		0.1675	0.8463
KATSINA does not Granger Cause LAGOS	46	1.860	0.1685
Lagos does not granger cause Katsina		1.471	0.2414
EKITI does not Granger Cause OYO	46	4.875	0.0126*
Oyo does not Granger cause Ekiti		1.399	0.2583
KANO does not Granger Cause OYO	46	0.3725	0.6913
Oyo does not Granger Cause Kano		0.7387	0.4839
KADUNA does not Granger Cause OYO	46	0.0505	0.9508
Oyo does not Granger cause Kaduna		5.415	0.0081**
KATSINA does not Granger Cause OYO	46	4.044	0.0249**
OYO does not Granger Cause KATSINA		0.9849	0.3821
KANO does not Granger Cause EKITI	46	2.691	0.0797*
EKITI does not Granger Cause KANO		0.0916	0.9126
KADUNA does not Granger Cause EKITI	46	0.6308	0.5372
EKITI does not Granger Cause KADUNA		3.459	0.0408*
KATSINA does not Granger Cause EKITI	46	0.7150	0.4951
EKITI does not Granger Cause KATSINA		0.4017	0.6717
KADUNA does not Granger Cause KANO	46	0.3731	0.6908
KANO does not Granger Cause KADUNA		1.455	0.2452
KATSINA does not Granger Cause KANO	46	0.1831	0.8333
KANO does not Granger Cause KATSINA		2.671	0.0812*
KATSINA does not Granger Cause KADUNA	46	0.0247	0.9756
KADUNA does not Granger Cause KATSINA		0.5079	0.6055

*The table shows that seven tomato market links rejected their respective null hypothesis of no granger causality. Also, from the table none of the market links exhibited bi directional granger causality or simultaneous feedback relationship. *significant at 10%, ** Sig at 5%.*

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