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PRICE TRANSMISSION IN DOMESTIC AGRICULTURAL MARKETS: EVIDENCE FROM SELECTED CASSAVA MARKETS IN GHANA

Henry De-Graft Acquah, John Andoh Micah, Rebecca Owusu
Department of Agricultural Economics and Extension, University of Cape Coast, Ghana

ABSTRACT

This study analyses market integration and price transmission in selected agricultural markets in Ghana. The Johansen co-integration procedure, Granger Causality test and autoregressive distributed lag model were applied to analyse the data. The results revealed that the price series were integrated of order one, however, we did not find evidence of co- integration of the price series. Moreover, the market studied did not Granger Cause one another. Conclusively, the results suggest the existence of poor price transmission and poorly integrated cassava markets. We therefore suggest that policy makers take a critical look at the factors that influence spatial price transmission.

Keywords: Market integration, Johansen's multiple co integration, Price transmission,, Granger causality, Autoregressive distributed lag

INTRODUCTION

Cassava (Manihot esculenta Crantz) is one of the world's most important food crops. Throughout the tropics, the plant's root and leaves serve as an essential source of nutrition. About 600 million people in Africa, Asia and Latin America depend on the cassava crop for their food and incomes (International Fund for Agricultural Development [IFAD], 2004).

In Africa, cassava production has more than tripled since 1961 from 33 million tonnes per year to 101 million tonnes (Sagoe, 2006), making it a major food crop of Ghana's agricultural economy. It contributes about 22% of the Agricultural Gross Domestic Product (Nti & Sackitey, 2010) and is usually referred to as the 'food security crop' and as such, an assured way of attaining some of the Millennium Development Goals (MDG's) in particular, the eradication of extreme poverty and hunger. However, there is little emphasis on how price transmission takes place in the domestic cassava markets and the degree of integration which have implication for food security. The integration of markets can be considered either as: the existence of physical trade between markets, the difference in prices between two markets being equal to the cost of transporting goods between the markets, or the prices in the markets moving together over time (World Food Programme [WFP], 2007). Integrated markets are important avenues of raising the income level of farmers and promoting the economic development of a country. In the state of well integrated markets, farmers allocate their resources according to their comparative advantage and invest in modern farm inputs to obtain enhanced productivity and production, food becomes available and affordable thereby improving the food security status of households. Integrated markets further imply efficient functioning of market forces and as such, price changes in a location are consistently translated to price changes in other locations; marketing agents in different markets interact. The phenomenon ensures the flow of food from surplus to deficit areas and import flow from port and border areas into the hinterlands, a scenario that arises due to the incentives high prices in deficit areas provide to traders who transport food from surplus to deficit areas. As a consequence, prices decline in deficit areas and rise in surplus areas thereby improving the lot of producers and consumers.

The geographical separation of markets is of special importance in agriculture, as often, agricultural produce are bulky and/or perishable, and the place of consumption may be different from that of production, which implies possibly expensive transport costs (Sexton, Cling & Carmon, 1991). Spatial market integration signifies the time lapse for the exogenous shocks to transform and reach the various geographically separated markets. The shorter the time lapse, the better, since longer time lapse leads to the conveyance of an inaccurate price signal that might distort producers' marketing decisions. In such situations, there is the exploitation of the market by market actors who benefit at the expense of producers and consumers thereby contributing to inefficient product movement (Goodwin & Schroeder, 1991).

Although the many excellent attributes of cassava have been recognised for several decades in Ghana, there have been limited government interventions to guide the development of the crop until very recently (IFAD, 2005). According to the paper, even in the early 1980s when government started to address the agricultural sector more seriously, policy still favoured the cereals - maize and rice, in the form of guaranteed minimum prices, subsides on fertilizers and agro-chemicals. However, after the very severe drought during 1982/83 when the superiority of cassava over the cereals was glaringly demonstrated, government started taking action through a series of bilateral and World Bank agreements in agricultural development as a vehicle for economic growth. The agricultural development policies filtered down through root crops to cassava even then, emphasis has been on its productivity rather than marketing. Where marketing issues have been tackled, integration has scarcely been factored. Therefore this paper seeks to analyse market integration and price transmission in the cassava markets aimed at initiating a discourse in relation to cassava marketing specifically, market integration and price transmission.

THEORETICAL AND CONCEPTUAL ISSUES

The evaluation of market integration has usually been undertaken by analysing price interactions. Different methods report on distinct aspects of these linkages and thus alternative empirical definitions exist. However, non stationarity of prices has led to the widespread use of cointegration (Gopal, Raveendaran, & Rajan, 2009). Conforti (2004) studied agricultural markets aimed at establishing price transmission among selected markets using the Autoregressive Distributed Lag Model. He found out that most of the price series were integrated of order one but concluded that there is less firm evidence of price transmission among cassava markets. In addition, Ghafoor, Mustafa, Mushtaq & Abedulla (2009) studied mango markets in Pakistan and found out that the series were integrated of order one.

Market integration is usually measured by the transmission of prices among markets. Taking for instance x_t and y_t to be a pair of price data measured at regular time intervals such as weekly over a period t=1,2,….,T. If this sequence of data is plotted as x and y with time varying points on the plot, the result will be as shown on figure 1.

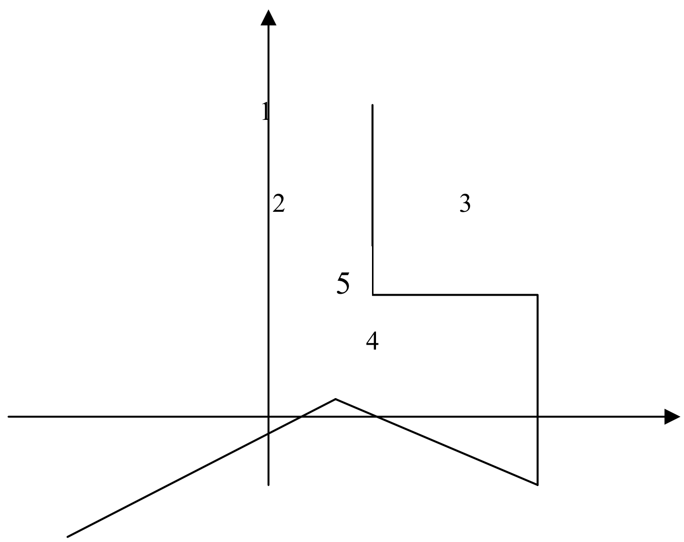

Figure 1: An illustration of Market Integration I

Where point 4 is ($x_{4,}$ y_4). There may be some reasons for the economy to prefer these points to lie near some line rather than elsewhere. These may include effective government policy or the working of the market. Taking for example, the price of cassava at different parts of the country: Let P_{kt} be the price of cassava in Kumasi and P_{tt} , the price in Techiman. If these prices are different, it would be possible to make profit by purchasing cassava in one region, transporting them to the other region and selling there. The operation of the markets would tend to increase prices in the region where the extra purchases occur and lower prices where they are sold. Once the difference between these prices is small, further profits cannot be made because of transportation costs, risks among other factors.

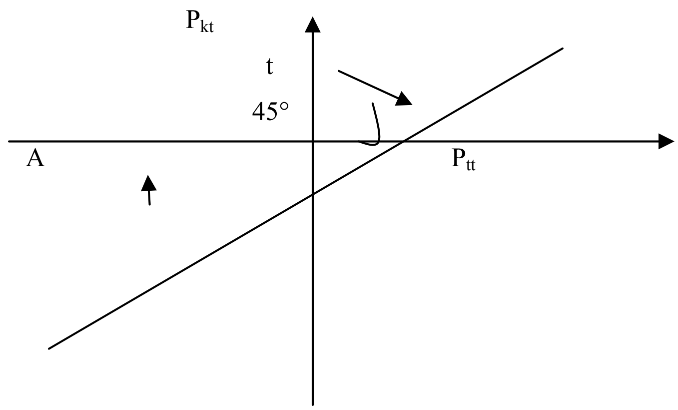

Figure 2: An illustration of Market Integration II

The 45° line, A, acts as an attractor with some mechanism existing such that if the prices drift away from A, there will be a tendency to get back near it. Because of uncertainties, sticky prices, contracts, the mechanism may not immediately bring the prices exactly to the attractor. At any particular time, shocks to the economy may take away from the line but there will be an overall tendency to drift towards it. If the economy lies on A, a shock will take it away. If there is an extended period with no exogenous shocks, the economy will definitely go back to the line and remain there, thus line A can be thought of as equilibrium of the centre of gravity type.

MATERIALS AND METHODS

Data Needs and Sources

The study aimed at estimating price transmission and market integration among selected cassava markets in Ghana. The testing was done for weekly prices of six domestic markets in Ghana namely; Koforidua, Mankessim, Accra, Techiman, Kumasi and Tamale for the period August 2008 to April 2010. The selection of these markets was based on the geographical locations, quantity of cassava produced and the availability of data. The price data was obtained from Statistics, Research and Information Directorate of the Ministry of Food and Agriculture, Ghana.

Data Processing and Analysis

Stationarity

Data processing commenced with visual inspection of the data and this was followed by a test for stationarity. Testing for Stationarity is a prerequisite since econometric relation between the time series has the presence of trend components (Davidson and Mackinnon, 1993). The Augmented Dicky Fuller (ADF) test was conducted. The ADF test considered the null hypothesis that the series have a unit root i.e. is non – stationary. The test was applied by running a regression of the following form:

$$\Delta Y_t = B\beta_i + \gamma Y_{t-1} + \alpha_i \sum \Delta Y_{t-1} + \varepsilon_t \qquad 1.1$$

Johansen's Multiple Cointegration Framework

Testing for cointegration implies testing stationarity of the residual term Z_{ti}. The dependent variables Y_{ti} (i= 1, 2, 3,...6) are prices of different cassava markets (i=1, 2, 3...,6) and the independent variables X_{ti} (i=1, 2, 3...,6) are prices of other cassava markets.

For instance, the cointegration equation for Techiman cassava market with the other five cassava market prices is represented as:

$$\text{Techiman} = \beta_1 + \beta_2 \text{Kumasi} + \beta_3 \text{Mankessim} + \beta_4 \text{Koforidua} + \beta_5 \text{Accra} + \beta_6 \text{Tamale} + Z_t \quad 1.2$$

Thus, the Johansen's multiple cointegration equation was run in the form of the equation 1.2.

Granger Causality

Autoregressive lag k was assumed and used to determine the Granger Causality using the maximum likelihood method.

$$X_t = a_1 + \sum_{i=1}^{p} a_{i1} X_{t-i} + \sum_{j=1}^{p} b_{j1} Y_{t-j} + u_{1t} \quad 1.3$$

$$Y_t = a_2 + \sum_{i=1}^{p} a_{i2} X_{t-i} + \sum_{j=1}^{p} b_{j2} Y_{t-j} + u_{2t}$$

F test was then carried out to test the null hypothesis of no Granger causality.

Price Transmission Determination

Autoregressive Distributed Lag (ADL)

ADL involves running a regression of independent variables and their lags as well as that of the dependent variable and its lags. This is an alternative test in the absence of cointegration. Since the price series were of a unit root and were not integrated, their first difference was used to run the regression in the form:

$$\Delta y_t = \alpha + \beta_1 \Delta y_t + \beta_2 \Delta y_{t-1} + w_0 \Delta X_t + w_1 \Delta X_{t-1} + \varepsilon_t \quad 1.4$$

RESULTS AND DISCUSSION

Unit Root

The starting point for cointegration analysis is to find out whether the price series have a unit root or not. Table 1 presents the results of the unit root tests of the price series both at levels and first difference. This was conducted to determine if the price series were integrated of order one I(1) or otherwise. This is very important in time series analysis. In furtherance of this, the Augmented Dickey- Fuller (ADF) test was used. The null hypothesis was that the variables observed has a unit root against the alternative that they do not. The model indicates that the null cannot be rejected for all price series as the absolute value of the ADF statistics are well below the 95% critical value of the statistics except Accra for which the null was accepted at 99%. Thus, it is concluded that the price series are non stationary.

Table 1: Unit Root Test of price levels using ADF

H_o: I (1); H_1 : I (0)

Variables	Non-trended model	Trended model
Koforidua	-1.27	-2.29
Mankessim	-1.82	-2.39
Kumasi	-1.27	-2.29
Techiman	0.75	-0.79
Accra	-2.94	-2.91
Tamale	-1.09	-2.31
Unit Root test of First Difference		
Variables	Non-trended model	Trended model
Koforidua	-7.29	-7.25
Mankessim	-9.81	-9.79
Kumasi	-7.79	-7.79
Techiman	-6.25	-6.52
Accra	-7.79	-7.77
Tamale	-10.28	-10.28
Critical values at 90%, 95% and 99% confidence level	-2.58 -2.89 -3.51	-3.15 -3.47 -4.07

Critical values at 90%, 95% and 99% confidence level for non trended model are -2.58, -2.89 -3.52 and trended model are -3.15, -3.47, -4.07 respectively

Source: Authors' calculation

In order to test the level or number of unit roots in the data, a unit root test of first difference was conducted that showed the number of unit roots equal to 1 since the data becomes stationary after the first difference as absolute values of the ADF statistics are now greater than 90%, 95% and 99% critical value of the test statistic. This agrees with Conforti (2004) who also found out that the prices of most of the crops had a unit root, implying that they were integrated of the order one, I(1) with their first difference remaining stationary or integrated of the order zero, I (0). In addition, it conforms to Ghafoor et al. (2009) who conjectured that the price series of major mango markets in Pakistan had a unit root, is stationary or I(1) and their first difference were I (0). With most of the studies showing non stationarity in the price series and stationarity in their first differences, one could conclude that the price series of most of the major markets of commodities exhibits non stationarity. This phenomenon can be attributed to the nature of the data, which is a time series.

When the price series were ascertained to have a unit root, the study proceeded with the Johansen's Multiple Cointegration test. The results are presented in Table 2.

Table 2: Results of Johansen's Multiple Cointegration Tests for different Domestic Cassava Markets

Domestic market	Eigen values	Likelihood Ratio (LR)	Ho: rank=	Trace Test	Probability	VAR order
Koforidua	0.33749	-1030.380	0	89.222	0.128	1
Mankessim	0.21865	-1020.264	1	55.461	0.403	1
Kumasi	0.19631	-1011.304	2	35.228	0.441	1
Techiman	0.12147	-1005.994	3	17.308	0.626	1
Accra	0.067253	-1003.140	4	6.6888	0.620	1
Tamale	0.11878	-1002.650	5	0.9784	0.322	1

Source: Authors' calculation

The first null hypothesis (H_0=0) states that there is no cointegration in the price series. Thus, if the probability value is not less than 0.100, then the eigenvalue is not significant implying the null of no cointegration is accepted. The results from Table 2 reveal that the price series are not cointegrated, signifying no long run relationship among the price series of the markets, although the markets are individually integrated, I (1).

The study result reveals that there is no interaction among the markets. Prices in markets moving together over time or co-moving indicate that the markets are integrated, implying a proper functioning and efficient market. The lack of integration of these markets may convey inaccurate price signal that might distort producers marketing decisions and contribute to inefficient product movement (Goodwin & Schroeder, 1991).

The causal relationship of the price series was examined using Granger causality test at 2 lags. This analysis was necessitated by the statement of Gujarati (2004) that although regression deals with the dependence of one variable on other variables, it does not necessarily imply causation. The results are presented in the Table 3.

Table 3: Pair wise Granger Causality of the Price Series

Null Hypothesis:	Observation	F-Statistic	Probability
Tamale does not Granger Cause Techiman	81	0.45190	0.63812
Techiman does not Granger Cause Tamale	81	1.72707	0.18471
Mankessim does not Granger Cause Techiman	81	1.63133	0.20245
Techiman does not Granger Cause Mankessim	81	0.67935	0.51000
Kumasi does not Granger Cause Techiman	81	0.67062	0.51439
Techiman does not Granger Cause Kumasi	81	1.31910	0.27343
Koforidua does not Granger Cause Techiman			
Techiman does not Granger Cause Koforidua	81	2.02295	0.13933
Accra does not Granger Cause Techiman	81	2.31749	0.10545
	81	0.47470	0.62390
Techiman does not Granger Cause Accra	81	0.71792	0.49104

Reference market: Techiman, Sig. Level: ***1%, **5% and *10%

Source: Authors' construct

According to the result obtained from the Granger causality test in Table 3, Techiman market price does not Granger cause the other markets prices and in the same vein, the other markets prices do not Granger cause Techiman market price. Thus, the null hypothesis is accepted for all. The markets are therefore independent and autonomous implying the markets are not incorporating the price information from one another. This thus suggests that the cassava markets are inefficient.

Evidence of Price Transmission

In the absence of evidence of cointegration of the price series, the Error Correction Model (ECM) could not be applied to analyse the price transmission of the market. Subsequently we apply the Autoregressive Distributed Lag (ADL) model which takes into consideration the fact that the data are not cointegrated. The results are presented in Table 4.

Table 4: Autoregressive Distributed Lag Results of the Price Series

ADL	Coefficients	S(e)	t-value	P value
Without Trend				
ΔTechiman_1	0.0757	0.120	0.630	0.531
Constant	0.209	0.175	1.20	0.235
ΔKoforidua	0.0206	0.085	0.242	0.809
ΔKoforidua_1	-0.072	0.086	-0.834	0.407
ΔMankessim	0.0199	0.090	0.220	0.872
ΔMankessim_1	0.083	0.091	0.915	0.364
ΔKumasi	0.234	0.095	2.45	0.017
ΔKumasi_1	0.138	0.096	1.44	0.156
ΔAccra	0.023	0.080	0.281	0.780
ΔAccra_1	0.079	0.078	1.01	0.318
ΔTamale	-0.067	0.060	-1.11	0.272
ΔTamale_1	-0.052	0.061	-0.853	0.397
With Trend				
ΔTechiman_1	0.0388592	0.1214	0.320	0.750
Constant	-0.300218	0.3765	-0.797	0.428
ΔKoforidua	0.0197609	0.08417	0.235	0.815
ΔKoforidua_1	-0.0745476	0.08553	-0.872	0.387
ΔMankessim	0.0164013	0.08962	0.183	0.855
ΔMankessim_1	0.0749548	0.09034	0.830	0.410
ΔKumasi	0.217489	0.09499	2.29	0.025
ΔKumasi_1	0.133403	0.09509	1.40	0.165
ΔAccra	0.240036	0.08003	0.300	0.765
ΔAccra_1	0.0862232	0.07761	1.11	0.271
ΔTamale	-0.0715021	0.05963	-1.20	0.235
ΔTamale_1	-0.6601104	0.06077	-0.989	0.326
Trend	0.0116918	0.007676	1.52	0.133

Source: Authors' construct

Reference market-Techiman

Lag length was selected using the Akaike Information Criteria.

From Table 4, both with and without trend, there is a positive and negative correlation, although weak between Techiman and its previous price, current price of Koforidua, Mankessim, Kumasi, Accra -both current and previous, and the previous price of Koforidua and Tamale-both current and previous, respectively. However, only the p-value of current Kumasi prices (ΔKumasi) is significant, implying that only the current prices of Kumasi explain the current prices of Techiman at 5 percent level of significance. The previous values of all the markets however, were insignificant indicating that the past values of Techiman market itself and that of the other markets do not explain the current prices of cassava in Techiman market. This reveals the dynamism of the cassava markets. At any point in time, pricing of the produce depends on the prevailing market situation.

ADL Equation for the Non Trended Model:

ΔTechiman = 0.2098 + 0.07333ΔTechiman_1 + 0.01608ΔKoforidua - 0.07087ΔKoforidua_1 + 0.0151ΔMankessim + 0.08035ΔMankessim_1 + 0.2305ΔKumasi + 0.139ΔKumasi_1 + 0.02694ΔAccra + 0.08049ΔAccra_1 - 0.06579ΔTamale - 0.05281ΔTamale_1

CONCLUSIONS

Although cassava has been touted as a food security crop and an assured way of attaining some of the Millennium Development Goals (MDG's) particularly eradication of extreme poverty and hunger, there have been very little emphasis on the spatial price transmission of the domestic cassava markets. Price transmission and market integration which plays an important role in raising the income level of farmers and promoting economic development of a country is worth studying. Since integrated markets imply efficient functioning of market forces and as such, price changes in one location are transmitted to other locations, there is a flow of food from surplus to deficit areas.

The paper sought to analyse price transmission and market integration using cointegration techniques. The objectives were to test for the order of integration of the selected cassava markets, analyse whether the markets are cointegrated or not, test for Granger Causality and examine the evidence of price transmission. The results revealed that the price series of the cassava markets in Ghana are integrated of order one implying that the cassava market prices fluctuate and therefore have a unit root. However, the Johansens' multiple Cointegration analysis revealed that the market prices are not cointegrated. We therefore find no evidence of cointegration among the market prices implying no long run relationship among the markets. Additionally, there is no causality between Techiman as reference market and the other markets, suggesting that the cassava markets in Ghana are independent. The lack of cointegration indicates that there is poor price transmission among the selected cassava markets in Ghana. The evidence indicates that there may be inefficiencies in the cassava markets in Ghana that needs to be addressed. It is suggested that the sources of inefficiencies which are dependent on the transportation system, usefulness of the commodity, credit accessibility, storage facilities and appropriate policies to encourage private businesses to invest in storage facilities, building up of strong pricing system for the cassava industry should be considered by policy makers since these are the factors that influence spatial price transmission.

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ABOUT THE AUTHORS:

Henry De-Graft Acquah, John Andoh Micah and Rebecca Owusu are affiliated with the Department of Agricultural Economics and Extension at University of Cape Coast in Ghana.