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Full Length Research Paper

Efficiency of the plantain marketing system in Ghana: A co-integration analysis

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The study assesses the efficiency of the plantain marketing system in Ghana using monthly wholesale prices in GHS/10 kg covering the period 2004 to 2009. The integration among the plantain markets was tested with the Johansen multivariate co-integration analysis and error correction model. The markets chosen for the study are Accra market as a central consumption market; Kumasi market, Sunyani market and Koforidua market as assembling markets; Goaso market, Begoro market and Obogo market as producing markets. These markets were chosen based on the volume of production and trade in the areas. The findings of the market integration analysis indicate that arbitrage in the plantain marketing system is working since there are both long and short run relationship between Accra market (central consumption market) and the three assembling and three producing markets. However, the speed with which prices are transmitted between Accra market (consumption market) and the other markets (plantain production and assembling markets) is relatively weak at 27.7%, compared to perfect adjustment of 100% threshold. This implies that there is the need for further integration especially in the short run. Improvement in market information systems and expansion especially into producing areas, as well as accurate, timely, and availability of information on plantain prices may be useful in the efficient distribution of plantain from surplus to deficit markets.

Key words: Plantain marketing system, Johansen multivariate co-integration, error correction model, Ghana.

INTRODUCTION

Plantain is a basic food product contributing to the food security of millions of people in the developing world, and constitutes a source of employment and income for the rural population (Nkendah and Nzouessin, 2006). Plantain is grown in 52 countries with world production of 33 million metric tonnes (FAO, 2006). Eight African countries are named among the top ten world producers of plantain, with Ghana producing 2,930,000 metric tonnes and ranked as the third world producer (FAOSTAT, 2007). It contributes about 770 Kcal/Kg and its supply of micronutrients such as iron and zinc is well established (Babatunde et al., 2007).

Plantain is the third most important food crop after yam and cassava in terms of volume of production and contributes 13.1% to the Agricultural Gross Domestic Product in Ghana (FAO, 2006). About 8,348,865 ha of land area is used to cultivate plantain in Ghana, producing an annual average of 2.0 million tonnes of fruits, of which more than 95% is sold on the local market and the rest exported (SRID-MoFA, 2006). Six of the ten administrative regions of Ghana, namely Ashanti, Eastern, Brong-Ahafo, Western, Central and Volta regions, are designated as plantain producing regions (Banful, 1998). Recently, it has become an important export commodity in the international market (ISSER, 2007) and Ghana obtained the highest international price with an average of US$ 1.53 per kg for the period 1995 to 1998 (Martinez and Saavedra, 2001).

If agricultural growth is to be realized, developing countries have to ensure effective and efficient marketing and distribution systems. Economic integration results in more efficient use of resources increase in trade, productivity and overall production (Ismet et al., 1998). Efficiency of markets depends, among other things, on the number of traders, the level of competition among

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them and on the amount and costs of information at their disposal (Federico, 2007). Food crop marketing in Ghana is dominated by the private sector which handles more than 95 percent of the products marketed (MoFA, 1987). This includes itinerant traders, market based traders and food contractors. An efficient farm marketing system is an important means for raising the income levels of farmers and for promoting the economic development of a country (Tamimi, 1999). The study uses integration of plantain markets to measure the efficiency of the plantain market system in Ghana. This approach is based on the concept originally developed by Bressler and King (1970) that an efficient commodity market will establish prices that are interrelated spatially by transaction and transfer costs and inter-temporally by storage costs. If a market is integrated, there will be a relatively low spatial and inter-temporal variation in prices implying that commodity market prices will be functionally related (Onyuma et al., 2006).

The plantain business is faced with a lot of marketing problems which determine whether production can be expanded or not (Adetunji and Adesiyan, 2008). The relative attention given to plantain is focused on the technical and productive viability of plantain in Ghana, while little is done on its marketing (Ekboir et al., 2002; Owusu-Benoah et al., 2007). Agricultural production problems can be overcome through introducing new technology and efficient marketing systems (Adetunji and Adesiyan, 2008). According to Codjoe (2007) the area under production of plantain has been increasing over the years and Dankyi et al. (2007), also revealed that farmers are aware of the various production technologies, however low farm-gate pricing with traders determining prices has been a major hindrance to production and marketing. It is however obvious that increased production without corresponding well-developed and efficient marketing system may amount to wastage of resources (Adetunji and Adesiyan, 2008). Hence, investigating the spatial integration of producing and consuming plantain markets is useful in ascertaining the efficiency of plantain marketing in Ghana. The investigation provides a probable means of enhancing the efficiency of the marketing system for plantain.

The objective of the study is to examine the efficiency of the plantain marketing system in Ghana by measuring price transmission and market integration for plantain (False horn) in some selected regional and district markets in Ghana. There is little disagreement on the benefits of a well-integrated market system. In general, producer marketing decisions are based on market price information, and poorly integrated markets may convey inaccurate price information, leading to inefficient product movements (Goodwin and Schroeder, 1991). Linkages to marketing centres have been found to contribute significantly to rural household's escape from poverty (Krishna, 2004; Krishna et al., 2004). Market integration ensures that a regional balance occurs among food deficit, surplus and non-cash crop producing regions (Delgado, 1986). Moreover, how long an initially localized scarcity can be expected to persist depends entirely on knowledge of how well the region is connected by arbitrage to other regions (Ravallion, 1986). Improving marketing efficiency is a way to increase social welfare by generating income for the local producers and chain actors and by promoting its sustained use. The paper contributes towards identification of the degree and level of spatial market integration of the plantain market in Ghana, adds to the literature on the efficiency of the plantain marketing system, and provides guidance for policy aimed at enhancing economic activity in the plantain marketing system.

METHODOLOGY

Theoretical framework

This research adopts market integration as a measure of marketing efficiency. Barret and Li (2002) defined market integration as tradability or contestability between markets. Market integration can be interpreted as the extent to which price shocks are transmitted between spatially separate markets (Goodwin and Piggott, 2001). This study assesses market integration and price transmission for plantain across some selected markets in Ghana using the Johansen multivariate co-integration procedure and the error correction model.

The goal of market integration analysis is to determine marketing efficiency which is basically the extent and speed of price transmission between spatially separated markets (Goleti et al., 1995). It is built on the premise that if a pair of markets is integrated, a price change in one of them will be reflected in a price change in the other. The demand for and price of a given unit of plantain in a market would have a dominant effect on the plantain trade and by extension, price formulation in other trading markets. This would be an indicator for marketing efficiency since price differences between the given markets would reflect only transportation costs including normal profit (Delgado, 1986). The more integrated a market is the more efficient it is.

Estimation of plantain market integration: Johansen co-integration test procedure

Unit root test

When investigating for 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). The number of lags in the Augmented Dickey Fuller (ADF) equation is chosen to ensure that serial correlation is absent using the Akaike's information criterion. The ADF equation estimated by OLS is based on a model with a constant as follows:

$$D(P_t) = \alpha + \delta P_{t-1} + \beta_i \sum_{i=1}^{m} D(P_{t-1}) + \varepsilon_t \qquad (1)$$

Where D is the differencing operator; P_t is the price variable of interest and ε_t is a white noise process; the unit root test is:

Null Hypothesis: H_0: $\delta = 0$ (P_t is non-stationary or has a unit root)
Alternate Hypothesis: H_1: $\delta \neq 0$ (P_t is stationary or has no unit root).

If the null hypothesis which states that the price series is non-stationary is not rejected, then in literature it has been suggested to difference the variable of interest to stabilize its mean. If a variable is found to have a unit root, the difference of the variable is included in the model. The procedure requires that the non-stationary variable be differenced sequentially until it attains stationarity. Since the price series were not stationary in levels (integrated of order zero), they were differenced once to attain stationarity.

Testing for lag length

A test for a suitable lag length to be included in the co-integration test was performed, because the results of co-integration tests can be quite sensitive to this (Hafer and Sheehan, 1991: Hai et al., 2004). The number of lags is selected by applying three different multivariate lag selection criteria: the Akaike information criterion (AIC), the Hannan-Quin information criterion (HQIC), and the Schwarz's Bayesian information criterion (SBIC). A vector auto-regression (VAR) on the differenced series was conducted and lag length of the model with the least AIC, HQIC and SBIC values chosen as the appropriate lag length to be included in the co-integration test. The test started with a lag length of 12 and then shortened till the least values of the AIC, HQIC and SBIC were obtained.

Johansen multivariate co-integration test

Following Ekpe (2005), the test of long-run market integration was done with the Johansen multivariate co-integration analysis. Johansen maximum likelihood estimation uses a rank test to define the number of co-integrating vectors *r* that can be found in a data. The rank is determined by estimating the *p*-dimensional VAR (k) model given in Equation (2):

$$P_t = \eta + \sum_{i=1}^{k} A_i P_{t-1} + \varepsilon_t \qquad (2)$$

Where t = 1, 2,... refers to the months from January 2004 to December, 2009; P_t is a $n \times 1$ vector of the logarithmic prices at time t ($P_t = P_{1t}, P_{2t},\ldots,P_{nt}$); A_i are $n \times n$ matrices of parameters; η is an $n \times 1$ vector of intercept terms; ε_t is a $n\times 1$ vector of error terms, k is the lag length and ε_t is the vector of error terms assumed to be *NID*(0,Ω).

On the basis of the Granger representation theorem, when the price series are integrated of order one, I(1), the VAR model can be re-parameterized into vector error correction model (VECM):

$$\Delta P_t = \eta + \sum_{i=1}^{k} \Pi_i \Delta P_{t-1} + \Pi P_{t-1} + \varepsilon_t \qquad (3)$$

Where $\prod$ and $\prod_i$ are defined by:

$$\Pi_i = -\sum_{j=i+1}^{k} A_j \qquad (4)$$

$$\Pi = \sum_{i=1}^{k} A_i - 1 \qquad (5)$$

Where $\prod_i$ and $\prod$ are ($n\times n$) matrices; $\prod$ has a reduced rank $r = n - s$; and ε_t is a ($n\times 1$) error vector. According to Silvapulle and Jayasuriya (1994), there are three possible cases for the rank of $\prod$.

a. Rank $\prod$ is equal to n, that is r = n ($\prod$ is unrestricted).
b. Rank $\prod$ is equal to zero.
c. Rank $\prod$ lies between zero and n, that is, $0 < r > n$.

If case (a) holds, then ordinary least squares estimate of the levels of models 2 and 3 are directly related by models 4 and 5. If case (b) holds, then model 3 is appropriate and Equation 2 is over-parameterized and its estimates are inefficient. Between these two extremes are the vector error correction models that come under case (iii). In estimating the number of co-integrating equations present in the system, the rank of $\prod$ in Equation 3 was determined using the trace statistic (Johansen, 1991; 1988) results of the Johansen co-integration test available in EVIEWS 5. If $\prod$ = 0, then no co-integration relationship exists; if the rank of $\prod$ is equal to r < n, then there are r co-integrating relationships and s = (*n* - *r*) common trends. The extent of an integrated market requires that s = 1, that is perfect integration. If there is more than one common trend, then some prices could be generated by the first common trend and some by *s* combination of the first and other trends. According to Gonzalez-Rivera and Helfand (2001), such markets could not be said to be integrated because the long run movements in prices would be governed by different components.

The error correction model (ECM)

The error correction model is used to test the short-run integration restrictions and the speed of integration. Johansen defines two matrices α and β, such that $\prod = \alpha\beta'$, where both α and β are ($n \times r$) matrices. This implies that; $\prod P_{t-1} = \alpha\beta' P_{t-1}$. The error correction term which gives the short-run disequilibrium is X, hence $= \beta' P_{t-1}$. The matrix α is the weights with which each co-integrating vector enters the *n* equations of the vector error correction model (VECM), and β is the matrix of co-integrating relations. α is also the matrix of the speed of adjustment coefficients.

Substituting for $\prod P_{t-1} = \alpha X$ in Equation 3 implies:

$$\Delta P_t = \eta + \sum_{i=1}^{k} \Pi_i \Delta P_{t-1} + \alpha X + \varepsilon_t \qquad (6)$$

Where X is an $(n\text{-}s)\times 1$ vector of error correcting term given by the estimated residual from equation (2) and α is the speed of price adjustment to equilibrium level. A dummy variable was introduced into equation (6) for year 2007 where there was a shock in the plantain marketing system. Hence:

$$\Delta P_t = \eta + \sum_{i=1}^{k} \Pi_i \Delta P_{t-1} + \delta D_{2007} + \alpha X + \varepsilon_t \qquad (7)$$

The long-run co-integration of the plantain price series was determined by analyzing the normalised co-integrating coefficients (β). In estimating the co-integrating coefficients (β), the Johansen co-integration test as implemented in EVIEWS was used.

Wald test for market integration

The type and degree of market integration is determined by the statistical significance of the estimated parameters based on the results of the set of hypothesis using the F-statistic of the Wald tests restrictions. The following restrictions were tested on the OLS estimation of the regression Equation (2):

Long-Run Market Integration

H_o: Plantain market prices are integrated in the long-run, that is $\sum_{i=1}^{k} A_i = 1$.

H_A: Plantain market prices are not integrated in the long-run, that is, $\sum_{i=1}^{k} A_i \neq 1$.

Table 1. Results of unit root test in levels and first differences.

Market price	Levels (intercept only)		First differences (intercept only)		Order of integration
	ADF	P-values	ADF	P-value	
Accra	-2.1140	0.0846	-6.6830	0.0000	1
Goaso	-2.8890	0.0910	-9.4910	0.0000	1
Begoro	-3.5510	0.6800	-9.6220	0.0000	1
Obogu	-1.6240	0.5239	-14.0130	0.0000	1
Kumasi	-0.8280	0.8620	-12.2000	0.0000	1
Sunyani	-2.5250	0.4250	-6.5870	0.0000	1
Koforidua	-2.7330	0.4160	-7.2410	0.0000	1

MacKinnon critical value for the prices in levels at 5% is -2.9130. MacKinnon critical value for the prices in first differences at 5% is -2.9140.

b) Short –Run Market Integration

H_o: A price change in a market is immediately transmitted to the other market, that is, $A_{i0} = 1$.
H_A: A price change in a market is not immediately transmitted to the other market, that is, $A_{i0} \neq 1$.

The null hypothesis is not rejected if the probability value of the F statistic test is less or equal to 0.10, but rejected if the probability value is greater than 0.10 (i.e. 10 percent critical level).

Description of variables and sources of data

Markets are said to be integrated if a process of arbitrage connects them. This will be reflected in the price series of commodities in spatially separated markets (Van Campenhout, 2005). Thus, the analysis of this study is entirely based on secondary price data collected from the Information Management System Units of seven District Agricultural Development Units in Ghana.

Average monthly wholesale prices for 10 kg of plantain from January 2004 to December 2009 (72 observations) in four regional and three district markets in Ghana were used in the study. Prices of plantain (and some other agricultural commodities) are collected by the various District Agricultural Development Units throughout the country on weekly basis. Based on the weekly data, monthly price series are computed by taking averages. It is worth considering the appropriateness of using monthly series in testing spatial market integration. For instance, Hai et al. (2004) argues that average monthly data are inappropriate when analyzing rice market integration in the Mekong River Delta of Niger because these prices do not reflect the daily prices on which traders make their arbitrage decisions. However, weekly price series have several long periods in which prices are constant in almost every market. Such constancy of prices will invalidate a statistical analysis which is based on an assumption of independent and identically distributed innovations that follow a continuous distribution. Moreover, the use of weekly data is problematic due to the need to interpolate numerous missing values. For these reasons this study analyzes monthly data instead of the weekly data.

In addition, the consumer price index (with 2002 as base year) was used to convert nominal price data into real values. This is justified because through this conversion, correlation by inflation can be excluded (Fafchamps and Gavian, 1995).

The seven (7) markets were purposely selected based on the production and volume of plantain traded. They include one consuming market; Agbogbloshie (Greater Accra); three assembling markets; Kumasi (Ashanti Region), Koforidua (Eastern Region) and Sunyani (Brong –Ahafo Region); and three producing markets; Obogu (Asante Akyem- South in the Ashanti Region), Begoro (Fanteakwa District in the Eastern Region) and Goaso (Asunafo North District in the Brong –Ahafo Region). Based on the trade relations between the markets, spatial integration between these seven markets is assessed.

RESULTS AND DISCUSSION

Unit root test

In order to ascertain whether the variables were stationary or not, the ADF unit root test was applied on the levels and first differences of the prices series. The results presented in Table 1 indicate that the real wholesale price series for the seven markets are integrated in order one, that is, I (1). The unit root test (with an intercept) shows that none of price series is stationary at the level at the 5 percent significance level. To make them stationary, their first differences were taken. When all the price series were differenced once, the results of the unit root test indicate that the null hypothesis of a unit root can be rejected at the 5% significance level.

The lag selection-order criterion was used to select the appropriate lag length to be included in the cointegration model. Table 2 presents the results of the lag selection-order for the various information criteria. On the basis of the Akaike's information criterion (AIC), Hannan-Quin information criterion (HQIC) and Schwarz's Bayesian information criterion (SBIC), one month of lag was selected for the model.

Johansen multivariate results for co-integration

To examine the hypothesis that there are *r* co-integrating vectors, the trace test was performed. Table 3 reports the results for the Johansen trace statistic (λ_{trace}) test based on the smallest value of the AIC and SBIC values. Comparing the trace statistic with the corresponding

Table 2. Lag selection-order criteria.

Lag	AIC	HQIC	SBIC
0	3.6838	3.7731	3.9086
1	1.0924*	1.8069*	2.8912*
2	1.2026	2.5423	4.5754

*AIC, HQIC and SBIC values are smallest at 1% significant level.

Table 3. Results of Johansen co-integration tests.

Null hypothesis	Alternative hypothesis	λ_{trace} value	5% critical value
r = 0	r > 0	157.9151*	124.24
r ≤ 1	r > 1	92.8623	94.15
r ≤ 2	r > 2	48.9786	68.52
r ≤ 3	r > 3	30.689	47.21
r ≤ 4	r > 4	15.4227	29.79

*If value of λ_{trace} exceeds the critical value, we reject the null hypothesis and accept the alternative of more co-integrating vectors.

critical values, it can be seen that the null hypothesis of no co-integrating relationship can be rejected at the 5% significance level for the plantain wholesale market real prices. In carrying out the co-integration test, the deterministic trend was used because of the characteristics of the line plots of the plantain prices in the various selected markets. The trace test statistics reported in Table 3 indicates that at least a stationarity relationship exists among the seven plantain wholesale markets. The paper discusses the price relationship between a central market (consuming, but non-producing market) and other markets (assembling and producing markets) for plantain.

The co-integration results for wholesale real price in Accra (the central market) are presented in Table 4. The explanatory variables jointly explain the variation in the Accra wholesale price with the F-statistic significant at the 1% level. The coefficient of determination (R^2) of approximately 83% means that the variables in the model explain 83% of the variations in current wholesale real price in Accra. The coefficients of the current and previous month wholesale real prices in Kumasi and Obogu markets are insignificant. The coefficients of the other markets wholesale real prices are significant.

From Table 4, the coefficient of previous month wholesale real price for Accra shows a positive sign, meaning that a higher wholesale real price in Accra in the previous month would reflect in a higher wholesale price in Accra in the current month. Also, the current plantain wholesale real prices in Sunyani and Goaso have positive and significant effects on the current wholesale real price for plantain in Accra. Thus, within the same month, higher (lower) wholesale real prices in the Sunyani and Goaso markets will result in higher (lower) real prices in the Accra market. On the other hand, lower previous month wholesale real prices in both Sunyani and Goaso would reflect in higher current month wholesale real prices in Accra.

On the contrary, current wholesale real prices in Koforidua and Begoro have negative and significant effects on the current wholesale real prices in Accra. This means that higher (lower) current wholesale prices in Koforidua and Begoro would reflect in lower (higher) wholesale real prices for Accra market in the current month. The coefficients of previous month wholesale real prices in Koforidua and Begoro markets show positive signs, indicating that lower (higher) wholesale real prices in Koforidua and Begoro in the previous month would reflect in lower (higher) wholesale real prices in Accra during the current month.

The significant coefficients in the co-integration model indicate that in the long-run most of the plantain markets are highly co-integrated with the wholesale real price in Accra (central market). In particular, the wholesale real prices for Koforidua and Begoro, assembling and producing markets, respectively, in the Eastern region and Sunyani and Goaso, assembling and producing markets, respectively, in the Brong-Ahafo region are spatially integrated with the wholesale real price in Accra (the central consuming market), while the wholesale real prices in Kumasi and Obogu assembling and producing markets respectively in the Ashanti region are not spatially integrated with the wholesale real price in Accra (the central consuming market).

But the directional effects of the integration between Accra market and the markets in the Eastern region are different from (opposite to) the directional effects of the integration between Accra market and the markets in the Brong-Ahafo region. Thus, while the current wholesale real prices in Sunyani and Goaso have positive effects on

Table 4. Co-integration regression results.

Variable	Coefficient	Std. error	t-Statistic	P-value
Accra wholesale real price (-1)	0.5590***	0.1027	5.4500	0.0000
Kumasi wholesale real price	0.0517	0.0966	0.5300	0.5930
Kumasi wholesale real price (-1)	0.0678	0.0711	0.9500	0.3440
Sunyani wholesale real price	0.2837**	0.1133	2.5000	0.0150
Sunyani wholesale real price (-1)	-0.3006**	0.1164	-2.5800	0.0120
Koforidua wholesale real price	-0.6112***	0.1496	-4.0900	0.0000
Koforidua wholesale real price (-1)	0.6112***	0.1551	3.9400	0.0000
Goaso wholesale real price	0.2852**	0.1348	2.1200	0.0340
Goaso wholesale real price (-1)	-0.2852**	0.1292	-2.2100	0.0270
Begoro wholesale real price	-0.2781*	0.1426	-1.9500	0.0510
Begoro wholesale real price (-1)	0.2781**	0.1376	2.0200	0.0430
Obogu wholesale real price	-0.0470	0.0573	-0.8200	0.4120
Obogu wholesale real price (-1)	0.0470	0.0629	0.7500	0.4550
C	0.1902***	0.0648	2.9300	0.0050
R-squared	0.83144	F-statistic		21.6200
Adjusted R-squared	0.79303	Prob (F-statistic)		0.0000

Source: Authors' computation based on data from MoFA, 2010. *** indicates significance at the 1 percent level, ** indicates significance at the 5 percent level and * indicates significance at the 10 percent level. Dependent Variable: Accra Wholesale Price. Included observations: 71 after adjustment.

the current wholesale real price in Accra, the current wholesale real prices in Koforidua and Begoro have negative effects on the current wholesale real price in Accra. On the other hand, while the previous month wholesale real prices in Sunyani and Goaso have negative effects on the current wholesale real price in Accra, the previous month wholesale real prices in Koforidua and Begoro have positive effects on the current wholesale real price in Accra. The reasons for these mixed results are not very clear, but the negative effects do not meet prior expectations.

The implication is that the positive response of the wholesale real price in Accra market to the wholesale real prices for plantain in the Sunyani and Goaso markets (Borng-Ahafo region) is prompt, while its positive response to the wholesale real prices in Koforidua and Begoro markets (in the Eastern region) lags by about a month. On the other hand, the negative response of the wholesale real price in Accra market to the wholesale real prices for plantain in the Sunyani and Goaso markets (Borng-Ahafo region) lags by about a month, while its negative response to the wholesale real prices in Koforidua and Begoro markets (in the Eastern region) is prompt. The differences in these effects could be due to differences in trade volume/levels and information flow among the different regions.

Error correlation model

The vector error correction model (VECM) was constructed in order to analyze the short-run dynamics of the effects of plantain prices in other selected markets on plantain prices in Accra, having established that a long-run relationship exists between the variables. The results of the error correction model capture short run relationships. The result of the estimated error correction model which expresses the first difference of the Accra wholesale price of plantain as a function of the first difference of the explanatory variables is presented in Table 5. The empirical results suggest good explanatory power of the model as indicated by the R^2 statistics as well as the F-statistics for the overall regression. The F-statistic of 21.73 indicates the joint significance of current and previous plantain prices in Kumasi, Sunyani, Koforidua, Goaso, Begoro and Obogu and previous prices in Accra in explaining about 68.82% of the variation in the plantain wholesale prices in Accra in the short period.

The adjustment coefficient of the lagged of the first

Table 5. Error correction model results.

Variable	Coefficient	Std. error	t-Statistic	Prob.
1st diff Accra wholesale real price (-1)	0.6543	0.0930	7.0585	0.0000
1st diff Kumasi wholesale real price	0.3117	0.4023	0.7748	0.1529
1st diff Kumasi wholesale real price (-1)	-0.1707	0.2191	-0.7792	0.4371
1st diff Sunyani wholesale real price	0.3802	2.9429	0.1292	0.0031
1st diff Sunyani wholesale real price (-1)	-0.2564	0.1356	-1.9050	0.1005
1st diff Koforidua wholesale real price	0.2094	0.1183	1.7704	0.0809
1st diff Koforidua wholesale real price (-1)	-0.2749	0.1327	-2.0720	0.0502
1st Diff Goaso wholesale real price	0.1400	0.1642	0.8525	0.4004
1st diff Goaso wholesale real price (-1)	0.4051	0.3700	2.6323	0.0052
1st diff Begoro wholesale real price	0.2708	0.1120	2.4174	0.0209
1st diff Begoro wholesale real price (-1)	-0.2781	0.1202	-2.3129	0.0194
1st diff Obogu wholesale real price	-0.0621	0.3698	-0.1679	0.8731
1st diff Obogu wholesale real price (-1)	-0.4019	0.3785	-1.0617	0.1535
Dummy (2007)	-0.0101	0.0592	-0.1706	0.8652
X (Residual term)	-0.2773	0.1391	-1.9930	0.0473
Constant	0.0140	0.0329	0.4244	0.3913
R-squared	0.6882	F-statistic		21.7277
Adjusted R-squared	0.6403	Prob(F-statistic)		0.0001

X (residual term) denotes the error correcting term. Dependent variable: First differenced Accra wholesale real price. Included observations: 70 after adjustments.

differenced of the wholesale real price in Accra market has a positive and significant effect on price stability, suggesting that any previous disequilibrium in the long-run wholesale real price in Accra market would be corrected in the short-run. The short-run effects of both the current and lagged first differenced of the wholesale real prices in Kumasi and Obogu markets are again insignificant. Also, the short-run effect of the current first differenced of the wholesale real price in Goaso market is also insignificant. However, the current first differenced of the wholesale real prices in Sunyani, Koforidua, and Begoro markets have positive and significant effects on stabilizing the wholesale real price in Accra, while the lagged of the first differenced of their wholesale real prices have negative and significant effects. Also, the lagged of the first differenced of the wholesale real price in Goaso has positive and significant effect on stabilizing the wholesale real price in Accra. These significant adjustment coefficients suggest that any distortion in the long-run wholesale real price in Accra would be corrected in the short-run, by the required either upward or downward movement towards the long-run equilibrium level. The dummy variable for price shock in the plantain marketing system in year 2007 also has the expected negative sign but an insignificant effect on the stability of the wholesale real price in Accra.

The coefficient of the error correction term, *X*, which signifies the speed at which plantain wholesale real price in Accra adjusts to their long run equilibrium level, is negative and statistically significant at the 5% level. The significant coefficient of the error correction term confirms the existence of a long-run equilibrium relationship of wholesale real price for plantain in Accra with the wholesale real prices in the other markets included in the analysis. The coefficient of the error correction term of 0.2773% implies that, the feedback into the short-run dynamic process from the previous period is 27.73% and the negative sign suggests that the adjustment is from a higher price shock (price rise) to the long-run price level. This means that the adjustment from the short-run to long-run equilibrium is about 27.73% which is relatively weak compared to perfect adjustment of 100% threshold. It suggests that the wholesale real price in Accra adjust partially to its long-run level after a price rise (shock). Nkendah and Nzouessin (2006) found a 21 to 27% speeds of adjustment of prices in pairs of plantain

Table 6. Wald test results for market integration.

Null hypothesis	Wald test statistics F-statistics	P value
Long-run market integration		
$\sum_{i=1}^{k} A_i = 1$	0.00	0.9614
Short-run market integration		
$A_{i0} = 1$	0.11	0.7426

markets in Cameroon and concluded that a weak integration exist in the markets and hence urban consumer price increase because there is bad information circulation between the various markets.

Wald test for market integration

In order to find the nature of long-run and short-run market integration, the Wald test restriction of the F-statistic was applied to determine market integration in the plantain markets. Table 6 presents the results of the Wald test. The F statistical values of 0.00 and 0.11 with probability values of 0.9614 and 0.7426, respectively, show that they are not significant even at 10%. The long-run and short-run null hypotheses that plantain market real prices are integrated and a price change in a market is immediately transmitted to other markets, respectively, therefore cannot be rejected. The results mean that there exist both long-run and short run market integrations between Accra and the other selected markets (both producing and assembling markets). Thus, changes in plantain real price in any producing or assembling market would cause plantain real price in Accra to adjust immediately and the estimated speed of adjustment is about 27.73% (Table 5).

Conclusions

This study explored market integration for plantain monthly prices in Ghana, for the time period 2004 to 2009, using the Johansen multivariate co-integration approach and the error correction model. The results of the market integration analysis obtained by the Johansen multivariate co-integration approach indicate at least one co-integrating equation. While the wholesale real prices for markets in the Eastern region (Koforidua and Begoro markets) and Brong-Ahafo region (Sunyani and Goaso markets) are spatially integrated with the wholesale real price in Accra (the central consumption market), the wholesale real prices for markets in the Ashanti region (Kumasi and Obogu markets) are not. But the directional effects (signs of the coefficients) of the integration between Accra market and the markets in the Eastern region are different from (opposite to) the directional effects of the integration between Accra market and the markets in the Brong-Ahafo region. The differences in these effects could be due to differences in trade volumes/levels and information flow among the different regions.

Again the results of the market integration analysis obtained by employing the error correction model (ECM) show that price signal is transmitted in the short-run between the current wholesale real price in Accra market and the other markets. The Wald test results for market integration suggest that the long-run and short-run null hypotheses that plantain market real prices are integrated and a price change in a market is immediately transmitted to other markets, respectively, cannot be rejected. The estimated coefficient for the error correction term suggests that plantain real price signals are transmitted between Accra market (the consumption market) and other selected markets in the short-run with a negative speed of adjustment of 27.73%. These results show that there is relatively weak integration/adjustment of the plantain production and assembly markets to the consumption market compared to perfect adjustment of 100% threshold. It suggests that the wholesale real price in Accra adjust partially to its long-run level after a (higher) price shock. This would mean urban consumer real price for plantain increases and returns only partially to its expected long-run real price level.

The speed with which price signals are transmitted in the short-run shows that there is the need for further market integration between the plantain markets especially in the short-run. Thus, high development of market information delivery will further help to enhance market integration. Expansion of market information systems especially into producing areas can be considered. More information on availability and prices of plantain may partially be useful in monitoring the status of food security situations in the country. If market participants have accurate and timely information on plantain conditions, plantain markets may be able to respond more quickly to market shocks, and market channel members can efficiently and effectively distribute plantain from surplus to deficit markets.

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