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Deepening Market Integration In Kenya through Increased maize production

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ABSTRACT

Market integration promotes effective market reform in developing countries. Where there is a of market integration, markets are competitive and there is no justification for costly government interventions designed to improve market competitiveness. . The supply of maize in Kenya is dependent on prevailing market price; hence maize price integration is critical to the maize industry. To test this, a market integration survey was carried out in five major maize markets in Kenya (Nairobi, Mombasa, Eldoret, Busia and Kisumu). Secondary data was used from the existing data banks to evaluate the transmission of price signals across the country. The study used results from Johansen cointegration and VECM to assess the speed of price adjustment between the markets. Price analysis results showed that despite supply shocks, there exists a long run relationship between the markets in the study area. Increased local production through irrigation increases the number of cointegrated markets through improved long run relationships and market efficiency. However, short run price adjustments in Kenya were slow for all the markets, ranging between 3 and 4 months.. Glut would generally benefit consumers with the lower market price and enhanced food security mission. The study concluded that although the current markets are integrated though with low efficiency. Increased sustainable of maize production from irrigation inn the ASAL areas promotes availability of cheap maize and can increase the number of rural poor.

Key words. ***Market integration, VECM, Johansen multiple cointegration, Irrigated Maize***

1.0 INTRODUCTION
1.1 BACKGROUND TO TH EPROBLEM

Achieving national food security is one of the objectives of the agricultural sector in Kenya. The sector is the main driver of economic growth and the main source of livelihoods to about 80% of Kenyans. An increasing number of households in Kenya are food insecure. Food security in this case is defined as " a situation in which all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food which meets their dietary needs and food preferences for an active and healthy life" (Kenya Food Security Steering Group, 2008). These households also incur higher food bills due to the high food prices. Maize is the main staple food and its supply does not meet local demand given that most households have limited choices of other food stuffs.

Kenya is mainly and arid and semiarid country with only 17% of her 584,646 km^2 and of this only 17% is of being medium to high potential areas and suitable for agriculture. The arid and semi-arid lands can be used for crop production by applying irrigation and water harvesting technologies are used. This is what informed investment in the unsuccessful Galana-Kulalu food security project. The adoption of irrigation farming is provides a solution to the problem of overreliance on rainfed food production system in the country.

The effects of climate change and variability, and, unreliable rainfall patterns affected agriculture negatively leading to frequent crop failure, reduced harvest, and scarcity of food and high food prices. Therefore, to support the ever increasing population and for continued economic growth where land holdings of high to medium potential are dwindling, adoption of new technologies was critical. . The government therefore invested in irrigated maize production at Galana Kulalu food security project in Tana and Kilifi Counties. The project was established on a ranch measuring approximately 1.2 million acres and was expected to produce 40 million bags of maize annually from 500,000 acres of land. While the project was not successful, ideas from its potential success are used in this study.

Food markets in Kenya, like in other developing economies, are suspected to be segmented due to inadequate infrastructure. Two trading markets are assumed to be integrated if price change in one leads to an identical price response in the other. There are three types of market integration. Intertemporal market integration relates to the arbitrage process across periods. Vertical market integration is concerned with stages in marketing and processing channels. Spatial integration is concerned with the integration of spatially distinct markets i.e. if price changes in one market are fully reflected in alternative market then these markets are said to be spatially integrated.

1.2 SPATIAL INTEGRATION TRANSPORT COSTS AND THE LAW OF ONE PRICE

Spatial market integration refers to co-movement or the long-run relationship among market prices and the smooth transmission of price signals and information across spatially separated markets (Ghafoor, Mustafa, Mushtaq and Abedulla, 2009). In these markets, prices are determined simultaneously in various locations, and information of any change in price in one market is transmitted to the other markets (Gonzalez-River & Helfand, 2001). The markets are very similar toin all aspects and one market can be representative for the group of markets gathered around a common trend. In cointegrated markets, price signals move together over time. Investors would therefore not maximize gains of diversification or hedging. (Kasa, 1992).

Faminow and Beson 1990) stated that spatial market integration of agricultural markets has been used as an indirect measure of market efficiency. (. In efficient markets, there is free flow of information for all rational investor therefore no one trader can outperform the markets and earn extra profits (Shleifer, 2000;Fama ,1991; Gilson and Kraakman.1984). Therefore, it is difficult for a trader to source goods from one market and sell them in another to earn excess profit (Shleifer and Vishny, 1997).

Price change in one market relative to another can be due to shifts in demand or supply, changes in the pattern of trade costs and transfer cost under competitive market structures (Dessalegn et al, 1998 Takayama, and Judge, 1971, Ardeni, 1989). This could be due to Transfre costs y consist of transportation, handling, fixed costs, and unmeasured transaction costs (Goodwin, and Schroeder, 1991). This defines the law of market areas which states that where under competitive market conditions and in the absence of trade barriers, the price differential prevailing between trading areas is less than or equal to transfer costs (Tostao,and Brorsen, 2005, Tomek & Robinson, 1981 Shrestha et al 2014, Saran and Gangwar, 2008, Edinc and Milla, 2008).

In agriculture, the point of production tends to be different from the point of consumption. Since agricultural products are bulky and/ or perishable, there movement incurs expensive transport costs (Sexton, Cling & Carmon, 1991). Market integration is therefore important as it plays a role in the optimization of resource use, output management, increase in farm incomes, widening of markets, growth of agro-based industries, addition to national income through value addition, and employment creation, ensures product competitiveness by communicating accurate price signals to both consumers and producers thus ensuring effective arbitrage and the efficiency of pricing (Lohano, Mari and Memon: 2005)

Price movements do not follow any trend or pattern and this unpredictable pattern of the price movement can be called a 'random walk'. However, cointegration implies that market indices follow the same common pattern in the long run (Richards, 1995). Therefore, cointegration tests are usually done to determine if efficient market hypothesis hold. The test helps to predict the behavior of the maize prices in other markets (Hakkio and Rush, 1989). Thus any known fact about one market price index should provide valuable information about the common trend between them. This will make it possible to predict (Hakkio and Rush, 1989).

Price difference in different markets offer arbitrage arbitrated opportunity for traders in closely integrated markets. The prices are also mean-reverting in the long-run manner, the spread always returns back to its mean value (Tomek & Robinson, 1981). However, this is not the case when irrational investors (noise traders) are present in the market. Traders and investors can therefore be able to predict how the spread will behave in the long-run (Shleifer and Vishny, 1997;, Alexander, 2001). Economists believe in the law of one price for similar commodities and that arbitrage usually push prices back to equilibrium.

Where there are irrational traders, the difference between market prices may become significant. In such scenarios, the spread between the prices will not return to equilibrium and rational investors will loose on their investment (De Long *et al.* 1990). The basis for this assumption is that, if regional price differences exceed transfer costs, buyers would be motivated to buy and transport grain from low price areas to those with high price. This will eventually cause prices in the supplying areas to increase and those in the importing areas to decrease to a level at which price differences no longer exceed transfer costs (Tomek & Robinson, 1981). However, the comparison of costs and actual margins is difficult because of the unmeasured and perhaps immeasurable "transaction cost" portion of marketing costs, that is, the transaction and risk costs mentioned above. Nevertheless, some insights are possible simply by comparing observed price spreads with the measurable component of spatial transfer costs (Dessalegn *et al*, 1998). In addition, due to the seasonality of maize production, prices are normally expected to be low during the harvest season and to rise afterwards up to the next harvest as a function of costs of storage. Under competitive situations, the seasonal price differences should be equal to the storage costs incurred between the time of harvest and the subsequent points in the year. Thus, it is assumed that maize is allocated throughout the year by the relationship of current and expected prices to storage costs including direct costs of warehouse rent, labor, and interest on capital invested in inventories, risk and normal profit. If seasonal price differences are over and above storage costs and normal profit, this may also indicate the existence of some degree of inefficiency in storage (Tomek & Robinson, 1981).

1.2.1 PRODUCTION AND CONSUMPTION

We study spatial market integration in the context of Kenyas maize market. Maize is the principal marketed crop in the country whose production is based upon rain-fed production systems. Total maize production in any given year depends upon the timing and quantity of rains.

Urban based households spend about 30 percent of average monthly total household expenditure on bread and cereals, half of which is used to purchase maize and maize products. Nairobi with a population of about 4,000,000 is by far, the major consumption area, with a strong demand-pull for maize. The maize market in Kenya was liberalized in the late 1980s. The aim was to allow the invisible hand to guides efficient exchange and guarantees an efficient production, which is the main source of welfare gains. Kenya maize market is inefficient due to high cost of production and government involvement through subsidies. This has led to loss of welfare gains. The net effect is poor price signal transmission from deficit to surplus areas, increased price volatility, lack of specialization in production based to long-term comparative advantage, and the gains from trade will not be realized (Baulch, 1997). Does Kenya experience the same effects and what are the policy implications?

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1.2.1 Objectives

The main objective of this study was to assess the effects of spatial maize market integration in the context of food security in selected maize markets.

The specific objectives are

1. To investigate the pattern of maize price variation in maize markets in Kenya
2. To establish the existing price relationship between the source and consumption markets of maize in Kenya,
3. Determine the speed of speed of price adjustment in maize markets in Kenya

The study hypothesized that maize markets 'the wholesale prices of maize in different markets across the country are not cointegrated and that there is no lead market.

1.3 DATA AND METHODOLOGY

The study used secondary monthly price data to evaluate the transmission of price signals across the country. The data covering a 10 year time series data was for five major maize markets in Kenya (Nairobi, Mombasa, Eldoret, Busia and Kisumu) for the period 2004 to 2014. Additional data was sourced from simulated increased local production under irrigation at Galana Kulalu food security project.

1.3.1 Justification for the study

The study is motivated by the existence of unit root and an analysis of amongst detrended price series to estimate market integration. Studies define cointegration as a linear combination of two or more non-stationary series that is stationary (Gopal *et al*., 2009: Engle and Granger, 1987). The stationary linear combination is the set of cointegrating equations and may be interpreted as a long–term equilibrium relationship among the variables.

The degree of market interconnectedness can be derived from the behavior of prices of a homogeneous good in different markets. Hence, the first studies on market integration looked at simple correlations between prices of a homogeneous good in different markets. Realizing that most price series are non-stationary, market integration became synonymous to co-integration of price series. However, the nonlinear adjustment process of prices, with adjustment of price differences depending on the price margin being larger or smaller than the transaction cost, resulted in lower power of cointegration tests (Penzhorn and Arndt, 2002: Traub, et al, 2010 and Van Campenhout, 2007).

1.3.2 ANALYTICAL APPROACH

The study used the unit root test determine the stationarity characteristics of the data. The ADF test of unit root was conducted within the context of three distinct models of generating processes of a series y as follows:

$$\Delta y_t = \rho y_{t-1} + \sum_{i-1}^{P} \partial_i \Delta y_{t-i} + u$$ ……………………model 1 without constant and trend. ……………1

$$\Delta y_t = \alpha + \rho y_{t-1} + \sum_{i-1}^{P} \partial_i \Delta y_{t-i} + u$$ ……………………… Model 2 with constant no trend ………….2

$$\Delta y_t = \alpha + \beta t + \rho y_{t-1} + \sum_{i-1}^{P} \partial_i \Delta y_{t-i} + u$$ …………………..model three with constant and trend…..3

The null hypothesis is H_0:ρ=0 , meaning that a unit root exits in y, that is, y is non-stationary. If a variable is stationary, that is, it does not have unit roots, it is said to be integrated of order zero or I (0). When the non-stationarity problem is present in series data, the original data is differenced and retested. (Dickey and Fuller, 1981). Through this process, the order of the integrated process for each data series is established. Only when the unit root tests indicate that all variables are integrated of the same order should the market be examined for cointegrated.

The ADF test which is a test for stationarity is supplemented by Johansen-Julius Maximum likelihood method. This method is preferred to the others because it addresses endogeneity and simultaneity problems associated with other bivariate models as well as its ability to test more than two variables at a time.

In the analysis. A stationary series (Y_t) is modeled as a linear combination of the non-stationery series (X_{1t}, X_{2t},……., X_{kt})

$$Y_t = \beta_0 + \beta_1 X_{1,\ t} + \beta_2 X_{2,t} + ... + \beta_k Xk,_{k,t}$$ ……………………………………………..…….4

6

A general regression model for non-stationary time series variables gives spurious (nonsense) results. The only exception is if the linear combination of the (dependent and explanatory) variables eliminates the stochastic trend and produces stationary residuals.

$$Y_t + \gamma_1 X_{1,t} + \gamma_2 X_{2,t} + \cdots + \gamma_k X_{k,t} \sim I(0) \quad \text{……………………………………}5$$

Such a combination is said to have cointegrated variables and its regression can give a good model. Cointegration assumes there is a common stochastic non-stationary I(1) process underlying two (or more) processes X and Y.

$$X_t = \gamma_o + \gamma_1 Z_t + \epsilon_t \sim I(1) \text{………………………………………………………..…..……}6$$

$$Y_t = \delta_o + \delta_1 Z_t + \eta_t \sim I(1) \text{……………………………………………………………………}7$$

$$Z_t \sim I(1) \text{……………………………………………………………………………………..}8$$

$$\epsilon_t, \eta_t \sim I(0) \text{………………………………………………………………………………}9$$

ϵ, η are stationary process I(0) with zero mean, but they can be serially correlated.

Although,X_t and Y_t are both non-stationary I(0), there exists a linear combination of them, which is stationary:

$$\delta_1 X_t - \gamma_1 Y_t(0)$$

In other words, the regression of Y and X yields stationary residuals {ε}.

In general, given a set of non-stationary (of type I (0) time series variables {X_{1t}, X_{2t}, ……., X_{kt} }, there exists a linear combination consisting of all variables with a vector ß, such that:

$$\beta_1 X_{1,t} + \beta_2 X_{2,k} + \cdots + \beta_k X_{k,t} \sim I(0) \text{………………………………………………………}10$$

Where $ß_j \neq 0$, j= 1,2,………,k. If this is the case, then the X's are cointegrated to the order of CI(1,1)

In principle, testing for Cointegration is similar to testing the linear regression residuals $\{\varepsilon_t\}$ for stationarity.

$$X_{1,t} = \alpha + \beta_2 X_{2,k} + \beta_3 X_{3,k} + \cdots + \beta_k X_{k,t} + \epsilon_t \quad \text{.......................} 11$$

To establish a cointegration relationship, an OLS regression model was run for the variables and the residuals tested for stationarity. The selection of the dependent variable is important since the residuals vary based on which time series is designated as the dependent variable, and the tests may give different results.One important test for cointegration that is invariant to the ordering of variables is the full-information maximum likelihood test of Johansen.The Johansen test approaches the testing for cointegration by examining the number of independent linear combinations (k) for an m time series variables set that yields a stationary process.

The study also used the Johansen and Juselius (JJ) (1990) hypothesis testing approach to determine, the number of cointegrating vectors. These are:

1. Trace test: This helps to determine the number of cointegration vectors.To determine the number of cointegrating vectors, r, we test the sequence of null hypothesis r=0, r≤1, r≤2, r≤(q-1). If r≤q is the first null accepted then we conclude that there are r=q cointegrating vectors.
2. Maximal eigenvalue test: The null hypothesis of the test is that the number of cointegrating vectors is r versus the alternative hypothesis that the number is r+1. The test statistic is.

To determine the number of cointegrating vectors, r, we test the sequence of null hypothesis r=0, r=1, r=p-1. If r=q is the first null accepted, then we conclude that there are r=q cointegrating vectors.

Take this to the analysis

The speed at which dependent variable returns to equilibrium after a change in an independent variable o was estimated using an error correction model. Theoretically, ECMs estimates both short-term and long-term effects of one time series on another. The ECM model combines the long run cointegrating relationship between the levels variables and the short run relationship between the first differences of the variables. All the variables used in the estimated equation are stationary. Since differencing leads to loss of information in the data, an error correction term is usually introduced in the theory of co integration to integrate the short run dynamics of the series with its long run value. The residuals obtained from the equation are introduced as explanatory variables into the system of variables in levels. The error correction term thus captures the adjustment towards long –run equilibrium.

Borrowing from Asari et al 2011, a Vector Error Correction Model (VECM) is specified.

$$\Delta Y_t = \alpha_1 + p_1 e_1 + \sum_{i=1}^{n} \beta_i \Delta Y_{t-i} + \sum_{i=1}^{n} \delta_i \Delta X_{t-i} + \sum_{i=1}^{n} \gamma_i Z_{t-i}$$

$$\Delta X_t = \alpha_2 + p_2 ei - 1 + \sum_{i=1}^{n} \beta_i \Delta Y_{t-i} + \sum_{i=1}^{n} \delta_i \Delta X_{t-i} + \sum_{i=1}^{n} \gamma_i Z_{t-i}$$

A negative and significant coefficient of the ECM (i.e. e_{t-1}in the above equations) indicates that any short-term fluctuations between the independent variables and the dependent variable will give rise to a stable relationship between the variables (Asari et al 2011).

A general specification of the Granger causality test in a bivariate (X, Y) context can be expressed as:

$Y_t = \alpha_0 + \alpha_1 Y_{t-1} + \ldots\ldots + \alpha_0 Y_{t-i} + ß_1 X_{t-1} + \ldots\ldots\ldots ß_i X_{t-i} + \mu$. ……………………………(7)

$X_t = \alpha_0 + \alpha 0 X_{t-1} + \ldots\ldots + \alpha_i X_{t-i} + ß_1 Y_{t-1} + \ldots\ldots\ldots ß_i Y_{t-i} + \mu$ ……………………………(8)

In the model, the subscripts denote time periods and μ is a white noise error. The constant parameter "0 represents the constant growth rate of Y in the equation 7 and X in the equation 8 and thus the trend in these variables can be interpreted as general movements of cointegration between X and Y that follows the unit root process. We can obtain two tests from this analysis: the first examines the null hypothesis that the X does not Granger-cause Y and the second test examines the null hypothesis that the Y does not Granger-cause X. If we fail to reject the former null hypothesis and reject the latter, then we conclude that X changes are Granger-caused by a change in Y. Unidirectional causality will occur between two variables if either null hypothesis of equation (7) or (8) is rejected. Bidirectional causality exists if both null hypotheses are rejected and no causality exists if neither null hypothesis of equation (7) nor (8) is rejected.

1.4 RESULTS AND DISCUSSION

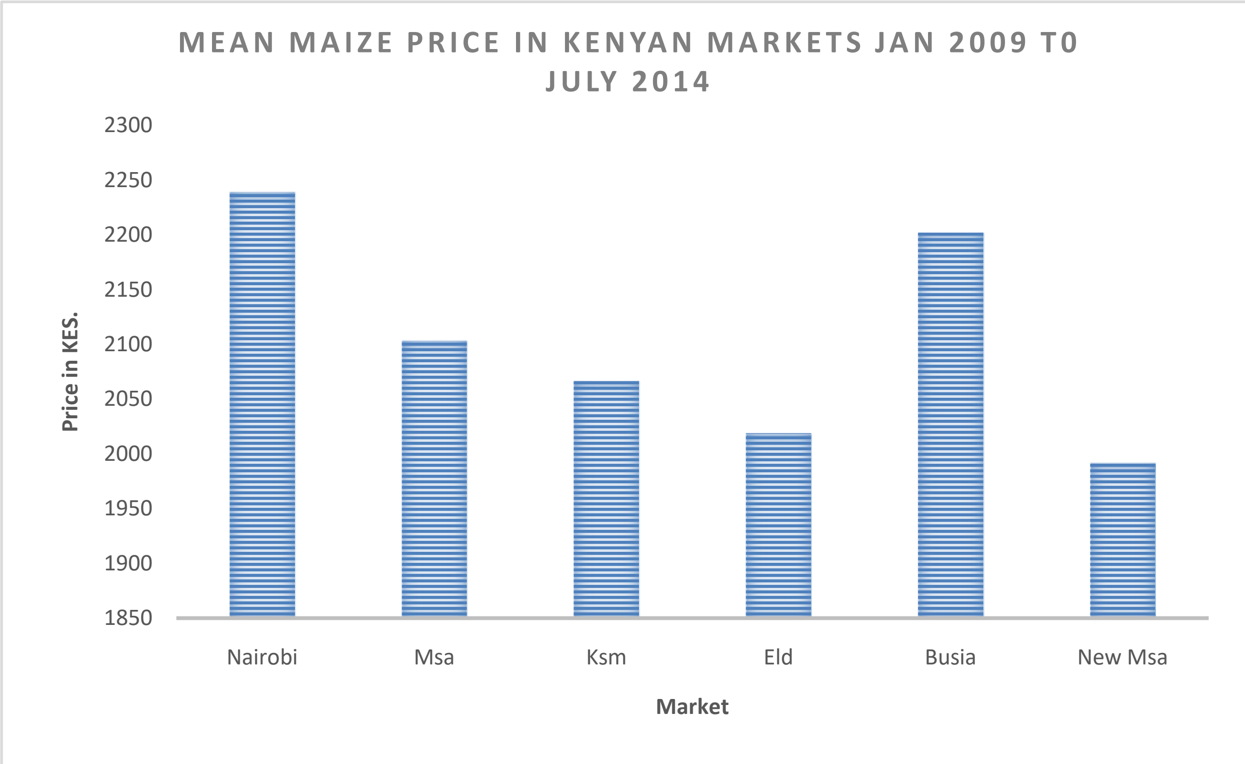

Figure 1 Mean maize market price between 2009-2014

Figure 1 above shows the mean deflated prices maize price variation in the selected markets base year was 2010. The simulated price from irrigation assuming increased production from Galana Kulalu is represemted by New Msa turned out to be lowest. This reflects the potential effects of increased production from Galana Kulalu food security project. The low price would mark Mombasa to be the main source market though with the failure of GKFSP, Eldoret remains the major source market. Nairobi maize market was the most attractive followed by Busia market. A market with a higher price makes the low priced markets to be their maize supply areas. These markets have to attract maize from the surrounding regions. Busia market attracts maize from Uganda which is the main source of maize in the months of September.

Mombasa, Eldoret and Busia are maize market areas for Nairobi which has a high market price. With no production from GKFSP, the Eldoret maize market supply maize to Nairobi Kisumu, Busia and Mombasa. Busia market has a high maize price hence it cis a market area for maize from Mombasa, and Eldoret markets and at the same time supply maize to Nairobi. .

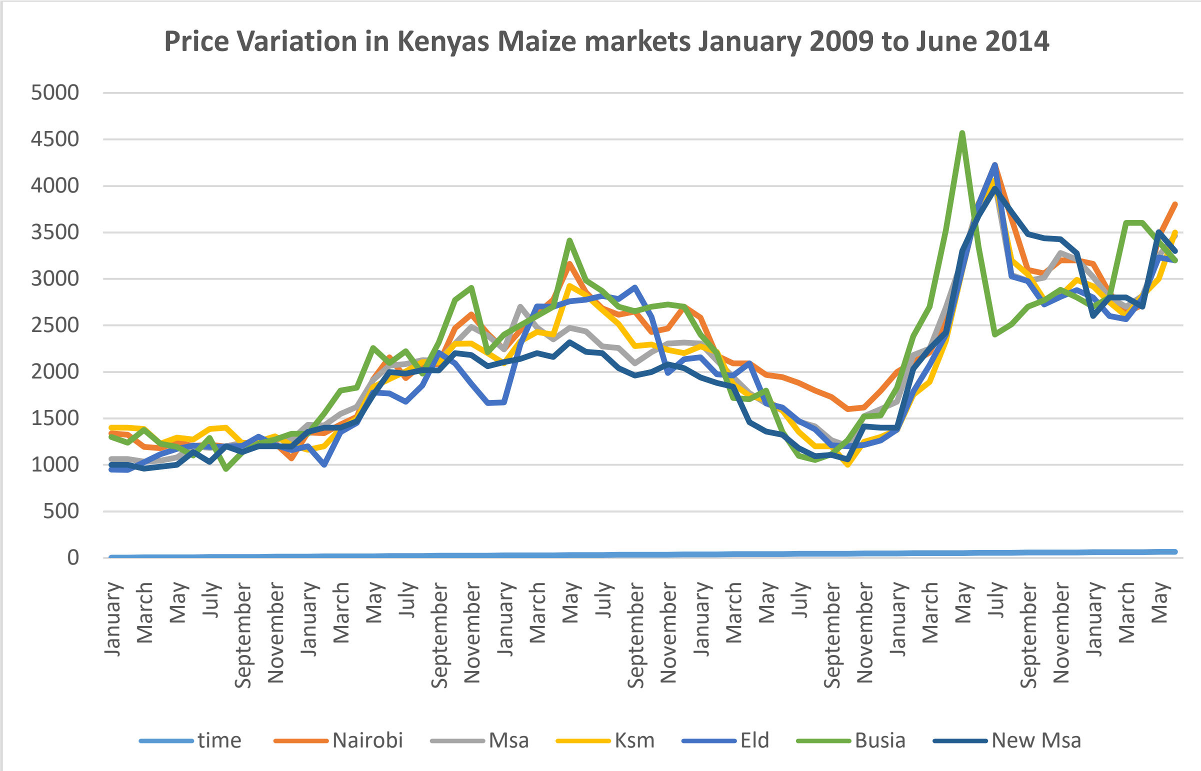

Figure 2 Annual price variation in selected maize markets in Kenya 2009-2014
Source: Author 2020

Annual price variation for maize price showed that high prices are reported in May and September for Busia and Eldoret maize markets respectively. These are source markets of maize and would dictate the price changes in markets with higher prices. The inclusion of Galana Kulalu maize would dampen the prices during periods of poor output. In the figure 2 above, the New Mombasa maize price is kept low throughout the year.

In terms of price variability, the highest variation was reported for the simulated maize prices followed by Busia and Kisumu had the least price variation (Table 1). The explanation for this is that Kisumu market depends on different markets as their source for maize hence its purchases is from the cheapest markets at all times. This is the lowest possible price the consumers would get. Imported maize has a low price and ensures low price variation in in Mombasa. However, combining imported maize and locally produced maize increases price variation as can be seen for the case of New Msa and the Busia prices. This is because the locally produced maize would sell at lower price compared with imported maize. Busia relies on both local and imported maize hance the high price variation. Otherwise looking at the mean price levels, ANOVA results suggested that the means of the market prices of maize are not significantly different over time.Table 1 Descriptive statistics of maize price in the study markets

	Nairobi	***Msa***	***Ksm***	***Eld***	***Busia***	***New Msa***
Mean	2239	2103.50	2066.80	2019.00	2202.00	1992.20
Standard Error	94	91.68	89.87	95.16	99.89	100.04
Median	2165	2124	2095	1914.731	2285	2000
Standard Deviation	767.9999	744.7778	730.1209	773.1118	811.4983	812.7673
Minimum	1069	1035	1000	944	955	960
Maximum	4225	4030	4060	4225	4568.25	3969
Count	66	66	66	66	66	66
CVV	0.34301023	0.35407	0.35326	0.38292	0.36853	0.40797

Source Author 2020

For the sampled period, Nairobi had the highest men price of KES 2,239 followed by Busia at KES 2,202 The least price was reported in Eldoret KES 2,019 Eldoret had a low price since it is the major grain producing area. For Busia, the high price which implied that is a major consumption or destination market especially of maize from Uganda. Kisumu a major maize deficit area had a price slightly higher than Eldoret of KES 2,066. It is also worth noting that prices in Busia can go to very low levels KES 955, the second lowest recorded price. This arises when there is bumper harvest both in Kenya and Uganda. With local production from Galana Kulalau food security project, maize prices in Mombasa New (Msa) would become the lowest at KES 1,991.197. making it a new source market. An ANOVA results however shows that the mean market prices in Kenya are not significantly different.

Table 2 ANOVA for maize prices in the study markets

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	3232199	5	646439.7	1.079073	0.371403	2.23713
Within Groups	2.34E+08	390	599069.4			
Total	2.37E+08	395				

Source Author 2020

A highly significant correlation was observed between the maize prices in the markets under study. This is a sign of market integration implying the markets are competitive and could be obeying the law of one price Table 1. . Most of the correlation coefficients are greater than 0.8 and are all positive. The correlation coefficient between Mombasa and Nairobi maize markets was 0.96, Eldoret and Nairobi is 0.953 and between Kisumu and Nairobi is 0.961. Increasing maize production at Galana Kulalu irrigation scheme is likely to make maize prices fall hence increased demand. . Overall, the results from the correlation coefficients suggest some insight on the short-term relations between Maize markets in Kenya.

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1.4.2 Test for stationarity

Levin-lin Chu test, rejects the null hypothesis of no unit roots for all the time series but not at first difference ADF test, (Table 3). Thus, the variables are stationary and integrated of same order, i.e., I (1)

Table 3. ADF test for the panel data

Status and lags	At level with 1 lag		First difference with 1 lag	
	Statistic	P-Value	Statistic	P-Value
Unadjusted	-3.9800		-12.7234	
Adjusted	-0.6048	0.2726	-0.90540	0.000

Authors data 2020

The traditional approach of testing market integration by referring to correlation coefficients cannot provide complete and enough information in this regard. The CI rank (R) was tested with the trace and the maximum Eigen value statistics (Table 3). In this test, H_0: r = 2 is not rejected at the 5% level (24.6437 <29.68). The final number of cointegrated vectors with two lags is equal to one, i.e. rank ( ) =2. Since, the rank is equal to 2 which is more than zero and less than the number of variables; the series are cointegrating among the variables. The results are presented in Table 4 below. The lag order was found to be 2

Table 4 Cointegration test

5% maximum	trace	critical			
Rank	parms	LL	eigenvalue	statistic	value

0	30	-2107.27	.	94.6219	68.52
1	39	-2088.44	0.44482	56.9601	47.21
2	46	-2072.28	0.39646	24.6437*	29.68
3	51	-2066.1	0.17559	12.286	15.41
4	54	-2061.75	0.12722	3.5774	3.76
5	55	-2059.96	0.05436		

Authors data 2020

Co-integration analysis was conducted at both bivariate and multivariate levels in order to obtain more insight into the interrelationships among our markets of concern. The VECM was then run to establish the long run and short run co-integration coefficients. The results are presented in Table 5. Thus, co-integration is present where there is a combination of non-stationary variables that is stationary, just like in our case. The test shows that there is co-integration in at least two markets based in the trace statistics. The results of the found in Table-5 below gives the speed of price adjustment and the coefficients of co-integrating relationships tested at 10%. Generally, their signs came out to be in accordance with the correlation coefficients.

The short run relations show that

ΔNrb = -0,3066***+ 0.03598lg Nrb -0.1404lgMsa + 0.3003 Ksm *** + 0.0584Eld + 0.2387 Bsa ***

Table 5 Johansen Multivariate test

	_Cel 1 L1	Lg Nai	Lg Msa	Lg Ksm	Lg Eld	Lg Bsa	Const	R-sq
Nai	-.3066***	0.03598	-0.1404	0.3003***	0.0584	0.2387***	-3.698	0.644
Msa	-0.1575***	-0.007	-0.3440**	0.4488**	0.0321	-0.0294	15.61	0.356
Ksm	-0.2727***	0.325***	-0.114	-0,2153	0.0115	-0.0482	-11.73	0.692
Eld	-0.2622***	-0.1825	-0.1117	0.3757	-.0013	-0.1074	1.802	0.389
Bsa	-0.05	0.034	-0.081	-0.748**	0.29	0.1732	28.03	0.15

The short term responses to the price of the dependent variable *** Significant at 1%, **at 5%

Author data 2020

The presence of cointegration suggests the presence of long run relationship among the price series. In all the cases, the goodness of fit is well explained except for Busia maize market price which that is distorted by seepage of maize into the country from Uganda. All the markets have significant long run equilibrium except the Busia market. In terms of speed of price adjustment, 31% of the previous maize price in Nairobi markets is adjusted in the subsequent month. This implies that it would take slightly more than 3 months for convergence to be attained within the maize markets in Nairobi and four months for Kisumu and Eldoret. It takes one month for the equilibrium to converge between Nairobi and Kisumu maize prices.

The VECM model was applied to assess the effects of increased local production. It reveals how the target market responds t a 1% increase in adjacent specific market. The relationship gives the long run relationship between the two markets.

Table 6 VECM for prices without output from Galana Kulalu irrigation project

Equation	Parms	chi2	P>chi2
_ce1	4	252.2361	0.0000

Identification: beta is exactly identified

Johansen normalization restriction imposed

beta	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
_ce1						
nairobi	1	.	.	.	.	.
ksm	1.417343	.4051463	3.50	0.000	.623271	2.211415
eld	-.3322738	.2658251	-1.25	0.211	-.8532815	.1887339
busia	-.9579482	.1653752	-5.79	0.000	-1.282078	-.6338187
msa	-1.082675	.2631245	-4.11	0.000	-1.598389	-.56696
_cons	-196.331	.	.	.	.	.

Author data 2020

The long run equilibrium equation becomes

Nairobi Price =1.417Ksm***-0.332Eldoret -0.958Busia***- 1.083 Msa*** -196.331 +0,3067ECT$_{T-1}$.

The error term gives the speed of adjustment where a 1% shock price increase of maize price in Kisumu leads to a 1.417% increase in maize market price for equilibrium to be attained. The increase is significant and takes place with 31% of the adjustment taking place in the subsequent month. Full adjustment is thus expected to take place in slightly over three week. Similar increases in the prices in Eldoret and Busia leads to a 0.332% and 0.958% fall in price in Nairobi.

Maize price in Eldoret market had no significant effect on maize market price adjustment in Nairobi. However, the maize price in Mombasa, Busia and Kisumu markets had a significant influence the market price of maize in Nairobi. The VECM showed that there is just one co-integrating equation upon simulating the Mombasa maize market price. With the exception of Busia maize market prices, all long run causalities are significant.

Analysis with simulated maize prices from irrigated production reveals that increased local production makes more markets to attain long run equilibrium. The results revealed that with increased output from local production makes price signals from all markets had significant impact on Nairobi price. Further, the Mombasa maize markets prices are influenced by lagged Mombasa and Kisumu price signals in the short run. In the new change with high production, maize market price equilibrium Kisumu price was influenced by Nairobi price and Busia price received price signals from Kisumu. Maize price changes in Busia and Kisumu markets have a significant impact on market prices in Nairobi markets. Increased maize production, makes the price signals from Mombasa dampen the equilibrium levels Nairobi maize markets.

Kisumu market is a maize deficit area and thus competes with maiirobui for maize in yeh country. Increased local production from irrigation and local production in Eldoret significantly lowers the lowers the equilibrium price for maize in Nairobi maize market.

Eldoret thus become a significant influencer of prices in all markets since it becomes an alternative source market. There and thus an alternative competing market is created in Kisumu which draws maize from Nairobi. Upon analyzing all the relationships, we find interesting Granger causality relationships. The price signals move from Kisumu, to Busia, Nairobi and Mombasa. Kisumu is a major maize deficit area and thus it granger causes market price changes in other markets. Mombasa being a source market has its prices influenced by the Kisumu maize market price. It is also sensitive to its previous maize price levels.

Table 7 Cointegration equation with increased irrigated maize production

Cointegrating equations

Equation	Parms	chi2	P>chi2
_ce1	4	217.6103	0.0000

Identification: beta is exactly identified

Johansen normalization restriction imposed

beta	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
_ce1						
nairobi	1	.	.	.	.	.
ksm	2.497304	.4812706	5.19	0.000	1.554031	3.440577
eld	-.7364076	.3085398	-2.39	0.017	-1.341135	-.1316807
busia	-1.38135	.1884926	-7.33	0.000	-1.750789	-1.011912
newmsa	-1.204242	.2353382	-5.12	0.000	-1.665496	-.7429876
_cons	-588.3688	.	.	.	.	.

Author data 2020

There is a significant decline in the average maize price with increased local production. The other impact is that Eldoret maize price has a significant long run effect on maize price in Nairobi market. With the new output, a 1% price shock from Kisumu will push the equilibrium price in Nairobi market by 2.5%. A 1% price increase in Eldoret, Busia and New Msa maize prices markets will pull the maize market equilibrium price in Nairobi by down by 0.73%, 1.381% and 1.204% respectively. The equilibrium price of of maize is significantly unlike previously when the fall was not significant. relative to Nairobi price if equilibrium is in this market. The source markets makes the Nairobi market price to fall while competing market like Kisumu will have a likelihood of making maize prices in Nairobi markets to increase. Kisumu competes with Nairobi for the available maize in the market.

Using the VECM, the long run maize market equilibrium model becomes. Equation 1 is the long run adjustment with simulated price and equation 2 is without production from Galana Kulalu irrigation project.

Nairobi-1.20Msa+2.5Ksm -0.736Eld -1.38Bsa -588.7= Error ………………………………..1

Nairobi -1.08 Msa +1.41 Ksm -0.332 Eld -0.958Bsa -196.3 = Error …………………………2

There is greater adjustment to attain stability with simulated prices. This is what will reduce price instability. With the signs retained in the long run equation, there is no significant change in decision criteria. Low price with and increased speed of adjustment given the maize output from irrigated maize production, increases increased stability in the maize market price. This shows that production of maize under irrigation has a significant impact on the market prices of maize the maize in Kenya. Cheap maize production on the whole, maize has become cheap in Kenya.

1.5 CONCLUSION AND POLICY IMPLICATIONS

This study investigated the existence of long run equilibrium between the maize markets in Kenya. A multivariate co integration technique was used to establish the short run influence and the establishment of how long it takes for one factor to influence the other one was found to range between 3 to 4 months using the Nairobi model. Nairobi was identified as the central market upon analysis. The data used was at level. Johansen test showed cointegration using the trace and eigen value test with at least two cointegration equations. Price adjustment was found to be slow and there is need for intervention to ensure that there is movement of food from the surplus to the deficit areas in Kenya.

The study reveals the following policy implications. Integrated markets are efficient and thus increased production in Kenya will enhance efficiency and market integration in maize markets in Kenya. The potential fall in market price associated with increased maize output will ensure low food prices hence consumer will be the winners.

Increased output from irrigated maize production guarantees maize consumer cheap food. Producers of maize substitutes will have to prepare for stiff competition through low prices and low profits since the market forces will settle the equilibrium at a lower price.

Unstable falling price of maize increases the number of people living below the poverty line. This has a rather different policy implication since it will make the rural poor even poorer since majority of the rural population relies on agriculture and maize production is a key element. A wau forward is for the government to let the market forces operate while controlling imports to protect and enhance producer’s returns.

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