
# Testing the central market hypothesis for food markets in the highlands of Central Kenya

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## Abstract

Following extensive market liberalisation efforts in many developing countries, interest in food markets has grown tremendously. With the increase in participation of small traders to replace government controlled parastatals, it is important to assess whether liberalization policies have enhanced the efficiency of food markets. Maize is the main staple food in Kenya while beans are the most important pulse. An error correction model was used to test for bivariate causality between markets and examine the occurrence of central markets. The study used monthly retail prices of maize and beans in nine markets for a period of 15 years. The data was compiled from the sub counties ministry of agriculture annual reports. The results reveal the existence of central markets in the highlands of central Kenya. This shows a tendency of a more organised marketing system which is an indicator of market efficiency. The prices are determined in the low production zones meaning that demand markets are important in price formation. The central markets can be used by the government to effect desired policy changes especially price stabilization.

Keywords: Price stabilization, Food market analysis, Cointegration, Central markets.

## 1. Introduction

In agricultural based economies, which include most of sub-Saharan Africa (SSA), agriculture and its associated industries are essential to growth and to reducing mass poverty and food insecurity. Three of every four poor people in developing countries live in the rural areas and depend on agriculture for their livelihoods (World Bank, 2008). Since independence, Kenya has relied heavily on the agriculture sector as the base for economic growth, employment creation and generation of foreign exchange. The immediate post independence period was characterized by impressive agricultural performance which in turn spilled-over to other sectors of the economy (Wambugu et al, 2011). During this period there was extensive involvement of the Government in production, distribution and marketing. It was thought that the control guaranteed an efficient marketing system, stabilize producer and consumer prices

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and assure food security though strategic reserves by the marketing boards (Nyangito and Ndirangu, 1997).

Many African countries embarked on a series of adjustment policies beginning mid 1980's to restore economic growth after years of economic stagnation that had been brought about by some internal policy distortions (Badiane, 2000). Kenya was among the several other sub Saharan Africa countries that embarked on economic reforms that included the dismantling of price controls, as well as deregulation and privatisation of state controlled sectors (van Wijk and Makokha, 2000). These market liberalisation measures are consistent with economic theory, which postulates that proper functioning of markets and marketing channels is essential for the optimal allocation of resources (Harriss-White, 1995). There was also a marked reduction in the scope of government intervention in the provision of supportive services such as credit, distribution, marketing etc. The basic theory underlying market reforms was that with free market channels and prices, private traders were expected to automatically bid up formerly depressed agricultural prices. However, the results of the reform process varied widely across countries and commodities subsectors: there was progress in some areas and mixed results in others (Kherallah et al., 2000).

Market liberalization encouraged private trade even in cases where parastatals were still active. Small private traders emerged in response to increased market opportunities (Nyoro et al., 1999). However, the expansion of private trade is often constrained by lack of access to credit, uncertainty about the governments' commitment to reforms and high transaction costs (Kherallah et al., 2000). The increase in competition had a large impact on farmers and traders in Kenya. Farmers need to identify buyers for their crops, be sure they are getting a fair price and decide whether it would be best to sell their crops immediately after harvest or to store them in the hope that the prices will rise (Shephered, 2000). In this way, small scale producers and traders can easily be exploited when they do not have adequate information.

An efficient market is one in which price transmission between spatially separated markets reflects product demand. Thus efficient markets enable farmers allocate their resources according to their comparative advantage and intensify their production. In turn an efficient marketing system is an important means for raising the income levels of farmers and for promoting the economic development of a country (Tamimi, 1999). In Kenya, efficient markets are critical in bridging the consumption gap caused by structural deficiency in the production of major cereals and pulses by enabling food distribution from surplus to deficit areas. An efficient market is one in which prices fully reflect the information available such that abnormal profits cannot be earned by exploiting this information set (Ogutate and Folayan, 2006). This implies that for a market to be efficient, information must be transmitted fairly to all players in the market.

Granger causality is a useful approach in determining whether price movements between markets follow well defined paths. The central market hypothesis derives from the concept of causality, which means contributing to predictability (Golleti and Babu, 1994) or simply precedence (Madalla, 2005). Causality testing means that if A and B are observed as

time series, it's possible to establish whether A precedes B, or B precedes A, or they are contemporaneous (Madalla, 2005). Thus if past prices of one market A can be used to forecast the prices in another market B, then market A prices are said to cause market B prices.

Causality could be unidirectional where A causes B (or vice versa) without the reverse being true, it could be bidirectional where A causes B and the reverse is true or there could be independence where no series granger causes the other (Gujarati and Sangeetha, 2007). If market A prices cause prices of several other markets, then market A can be interpreted to be a central market. Ravallion (1987) defines a central market as a central area that dominates price formation. Thus a central market is one whose past prices can be used to forecast prices in other markets. Prices in the dominant market are not exogenous to those in the peripheral market. Thus there is a central market if prices in that market Granger cause prices in other markets in a unidirectional way. The presence of central markets would invariably mean that there is radial transmission of prices and price changes.

In the Kenyan rural food markets, maize and beans are not processed but mainly traded as grain. The traders in these markets take specific set of functions mainly exchange and facilitating functions. The open air markets play a fundamental role in both economic growth and food availability and affordability in the locality. There is however little knowledge about market performance in the central highlands of Kenya. This has been compounded by lack of studies on food markets in the region. Studies on markets in Kenya have largely explored the relationship between rural and urban markets. There is a gap of knowledge on the relationship between rural markets located in different production zones.

This study investigates the long run interdependence between maize and beans prices in the central highlands of Kenya and examines the dynamic relationship between the prices. The objective of the paper is to gain better insight of interacting price behaviour between the markets and to test for the presence of central markets. This study utilizes price theories to generate information that will be useful for policy making, to enhance food security and reduce poverty among the rural poor in Kenya. The study of dynamic interrelationship between maize and beans prices will help producers and traders to plan their business operations and provide the government with information regarding policy formulation. The central markets could be targeted in times of food shortage to transmit price signals to other locations.

## 2. Methodology

### 2.1 Study Area

The central highlands of Kenya which comprises counties in Central and Eastern Regions are very diverse in terms of agro ecological zones, soils, potential for agricultural production and farming systems. This study focused on Tharaka-nithi County, representative of the densely populated high-potential area, and Embu County representative of the low-potential area; similar agro ecological diversity also exists within individual counties. The diversity in climate and soils provides opportunities for agricultural production and trade. Maize and beans are among the main staple food crops grown for subsistence and sale. Muturi et al. (2001)

found that although farmers have multiple outlets for their farm produce, selling at farm gate and selling in local markets predominate in the region. Numerous petty traders operate at local and regional markets. A small group of wholesalers is involved in trading between markets at an interregional level.

### 3.2 Data

Nine markets in Mbeere and Meru South subcounties were selected for data collection namely Kiritiri, Karaba, Makima, Ishiara, Siakago, Chuka, Magutuni, Kaanwa, Kathwana. Secondary data on monthly retail prices of maize and beans was obtained from the Meru South and Mbeere Subcounties Ministry of Agriculture reports and Kenya National Bureau of Statistics for the nine markets.

The time series price data was recorded in Kenya Shillings per kilogram (Kshs/kg). The basic descriptive statistics of for maize and beans prices are presented in table 1. During the 15-year period the average maize prices were higher in Mbeere than Meru south sub counties. The mean maize price was highest in Makima and Karaba markets at Kshs. 19/kg and lowest in Magutuni at Kshs 13/kg.

Markets in Mbeere are located in low production zone of Embu county hence the observed high prices. Kathwana market is located in the drier parts of Tharaka-nithi county and this may explain the high price in relation to the other markets in Meru south sub county. Likewise, beans prices were higher in Mbeere markets. Karaba recorded the highest mean price of Kshs 45/kg and lowest in Magutuni at Kshs 21/kg. With respect to coefficient of variation (CV), Kiritiri ranks highest among the maize markets maize prices. This shows how volatile the maize prices are relative to other markets. Kathwana market ranks highest in volatility while Siakago has the least beans price volatility in terms of CV.

### 3.3 Analytical methods

Several tests have been developed and used to test for causality among economic time series including Granger causality test and Sims' test (Madalla, 2005). The Granger causality test assumes that the past is key to the present. Considering two series, $Y_t$ and $X_t$, the series $X_t$ fails to Granger cause $Y_t$ if a regression of $Y_t$ on lagged X's and lagged Y's, the coefficients of the latter are zero (Madalla, 2005). The Sim's test assumes that the future cannot cause the present, so that regressing Y on lagged, current and lead values of X, if X is to cause Y, then the sum of coefficients of the lead X terms must be statistically equal to zero (Gujarati and Sangeetha, 2007). The Sim's test assumes that $X_t$ fails to cause $Y_t$ in the Granger sense if in a regression of $Y_t$ on lagged, current, and future X's, the latter coefficients are zero (Madalla, 2005).

The error correction representation has been used for testing the direction of causality between cointegrated series (Alexander and Wyeth, 1995). The link between cointegration and error correction is that two cointegrated series can be represented using an error correction mechanism – the short term disequilibrium in one period is corrected in the next period.

Cointegration implies that the system follows an error correction representation and conversely, an error correction system has cointegrated variables (Engle and Granger, 1991). The error correction mechanisms are more stringent as compared to Granger and Sim's test, because they include use of longer lags to capture the dynamics of short-run adjustment towards long-run equilibrium.

The hypothesis of cointegration implies existence of an error correction representation. Such a representation can be used to test for causality. According to Engle and Granger (1991), the following modified Error Correction Model (ECM) can be used to represent two series that are cointegrated.

Where $\Delta$ is the difference operator; $m_i$ and $n_i$ are the number of lags; the $\beta$'s, $\delta$ and $\gamma$ are parameters to be estimated and $\mu_t$ is the error term. The error correction mechanism is provided by the sum of the third and fourth terms with their joint coefficient representing the error correction term (Engle and Granger, 1991). The length of the lags is chosen using Akaike Information Criteris (AIC). Following Goletti and Babu (1994), the null hypothesis of causality from market j to market i can be tested as follows:

The hypothesis is conducted in order to determine whether a cointegrated price variable drives or leads the other prices in the cointegration space.

The Ravallion model assumes that there is one central market that dominates other markets. However, According to Ahmadi-Esfahani (2006), in many developing countries, there are several markets that are interlinked and bypass the central market. Thus the model was applied for each pair of markets, rather than estimate one model for all the markets where only one market is identified as a central market.

Before specification and estimate on of the ECM, it is required to examine the stationarity of the variables. Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests were employed to test the non-stationarity of the price series. Stationarity means that the mean and the variance of a series are constant through time and the autocovarance of the series is not time varying (Enders, 1995). Since wrong transformation of data gives biased results, a stationarity test is important to set up the specification and estimation of the correct model (Engle and Granger, 1987).

## 4. Results and Discussion

The first step in cointegration analysis is to determine whether the price series are stationary, and if not, to investigate their order of integration. The results for ADF and PP tests are reported in Table 2.

The ADF and PP unit root tests for all the maize price levels could not reject the hypothesis of unit roots at 5 percent critical level. When the price series are differenced once, they all become stationary and the null hypothesis of unit roots is rejected. Thus, the maize price series for the markets under consideration are integrated of order one.

The results for testing for unit roots for beans price series are provided in table 3. The tests strongly supported the null hypothesis of non-stationarity at levels and stationary after the first difference. This means that they were all non stationary and integrated of order one. Accordingly, the variables were expressed to be I(1).

Pairwise Granger causality tests were conducted for maize and beans price series, applied to a maximum of two lags. The tables presented show causality results which were significant at 5% level. Table 4 presents results of granger causality tests for pairs of maize markets.

Causality was bi directional for most of the maize markets in the central highlands of Kenya. For instance Magutuni, Chuka and Kaanwa markets caused each other in a bidirectional way. Bidirectional causality are as a result of changes in seasonality and consequently, changing the demand-supply relations of the market pairs. Some markets showed unidirectional causality. Ishiara market showed granger non causality with Siakago, Kiritiri, Kathwana but was caused by them. Unidirectional causality means that maize price changes in Ishiara are initiated by other markets. On the other hand, Chuka and Kaanwa did not cause Kathwana while Kathwana did not cause them. In such markets price changes in any one of the markets cannot be used to predict price changes in the other markets.

Causality test showed that Siakago market unidirectionally caused all the other markets. Thus Siakago is a central market since it granger causes the other markets but not vice versa. This means that maize price changes start at Siakago and then spread to the other markets. Siakago market is located in a low production area and can be classified as consumption zone. The results agree with findings by Goleti and Babu (1994), Mendoza and Rosegrant (1992) and Wambugu (2005) who concluded that central markets are found in consumption zones.

The results for Granger causality in the beans markets are presented in table 5. The results show causality was less between market pairs for beans than maize markets, a tendency towards fewer central markets.

Kaanwa market did not granger cause any market but was caused by all the other markets. This means that observed beans price changes in Kaanwa are as result of changes in prices in the other markets, the other markets did not respond to Kaanwa price changes. Such a market cannot be used to predict prices in the other markets. Ishiara and Siakago markets were the most causing market in that Ishiara granger caused all the other markets while Siakago only failed to cause Ishiara. Thus price movements in such markets can be used to predict prices in the other markets. The main central market for beans in the central highlands of Kenya was Ishiara which unidirectionally caused all the markets but caused by none of them.

The results from pairwise Granger causality test show that, just like in the case of maize, the central markets for beans were found in a consumption zone. Since causality for these markets goes in one direction, this can be interpreted as price leadership for the price that does not adjust. The distinct central market of Ishiara is not located in a high production zone meaning that demand markets are important in beans price formation.

Arbitrage which is a driving factor behind market integration works between markets when they are integrated. If prices are determined in a central market and transmitted to dependent markets then price determination for a region can be determined from investigating the price determination process in the central market (Asche et al. 2012). Central markets are important for policy targeting during times of famine to send price signals to other markets. Food assistance will have more impact if provided to a central market. The traders and farmers can also use the observed price movements in central markets to predict what is likely to happen to prices in the other markets.

**Conclusion and Policy Implications**

This article analyses the possible relationships among maize and beans prices in the highlands of central Kenya. The main objective was to test for the occurrence of central markets. Causality analyses showed evidence of central markets in the central highlands of Kenya. Central markets are common in situations where market networks are organized around regional centres partly due to infrastructural reasons which impede trade flows among markets, which is the case for the markets studied. This study found that demand markets are important in driving maize and beans retail prices. The implication of the finding that there are central markets suggests that the private sector is responding to price signals appropriately.

Central markets are important for policy targeting during times of famine to send price signals to other markets. Siakago and Ishiara markets which were central markets for maize and beans respectively are the markets for surveillance and intervention to stabilize prices. This therefore means that the County and Central governments may use the markets to effect a desired policy change especially price stabilization. In times of food shortages the government should target the low production areas to stabilize food prices. The traders and farmers can also use the observed price movements in central markets to predict what is likely to happen to prices in the other markets in the region.

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**Table 1 Descriptive statistics for maize and beans prices**

| | | Maize | | Beans | |
|---|---|---|---|---|---|
| Market | N | Mean | CV | Mean | CV |
| Siakago | 192 | 18.13 | 2.13 | 36.69 | 2.34 |
| Karaba | 192 | 19.13 | 2.82 | 45.16 | 3.10 |
| Makima | 192 | 19.18 | 2.80 | 44.39 | 3.28 |
| Ishiara | 192 | 17.55 | 2.77 | 38.15 | 3.04 |
| Kiritiri | 192 | 18.47 | 4.16 | 42.11 | 3.02 |
| Kathwana | 192 | 17.37 | 3.16 | 37.32 | 3.71 |
| Magutuni | 192 | 13.39 | 3.01 | 20.73 | 3.09 |
| Chuka | 192 | 17.93 | 3.24 | 42.01 | 3.26 |
| Kaanwa | 192 | 15.94 | 2.63 | 38.03 | 3.62 |

**Table 2 Stationarity test for maize price series**

| | Augmented Dickey-Fuller | | | Phillips-Perron test | | |
|---|---|---|---|---|---|---|
| Series | Levels series | First Differences | Lags | Levels series | First Differences | I (d) |
| Siakago | -2.122 | -10.667 | 1 | -2.422 | -15.782 | I(1) |
| Karaba | 2.274 | -11.156 | 1 | 2.4500 | -15.529 | I(1) |
| Makima | -2.344 | -11.521 | 2 | -2.340 | -14.565 | I(1) |
| Ishiara | -2.294 | -10.490 | 1 | -2.963 | -14.615 | I(1) |
| Kiritiri | -2.464 | -6.396 | 4 | -2.367 | -14.894 | I(1) |
| Kathwana | -2.576 | -4.691 | 12 | -2.382 | -14.676 | I(1) |
| Magutuni | -0.208 | -6.888 | 12 | -2.298 | -15.586 | I(1) |
| Chuka | -2.259 | -3.898 | 11 | -2.189 | -12.998 | I(1) |
| Kaanwa | -2.596 | -11.678 | 12 | -2.030 | -11.678 | I(1) |

5 percent Critical Values=-3.5 (MacKinnon, 1991)

**Table 3 Stationarity test for beans price series**

| | Augmented Dickey-Fuller | | | Phillips-Perron test | | |
|---|---|---|---|---|---|---|
| Series | Levels series | First Differences | Lags | Levels series | First Differences | I (d) |
| Siakago | -3.454 | -18.273 | 0 | -2.784 | -17.37 | I(1) |
| Karaba | -3.344 | -10.214 | 3 | -3.471 | -16.375 | I(1) |
| Makima | -3.336 | -8.315 | 4 | -3.356 | -15.919 | I(1) |
| Ishiara | -3.341 | -8.029 | 4 | -3.426 | -18.383 | I(1) |
| Kiritiri | -3.485 | -14.727 | 0 | -3.306 | -16.229 | I(1) |
| Kathwana | -3.436 | -4.278 | 11 | -3.442 | -15.501 | I(1) |
| Magutuni | -0.619 | -4.926 | 11 | -1.852 | -17.459 | I(1) |
| Chuka | -3.091 | -10.964 | 0 | -3.263 | -10.691 | I(1) |
| Kaanwa | -3.338 | -13.333 | 0 | -3.409 | -14.796 | I(1) |

5 percent Critical Values=-3.5 (MacKinnon, 1991)

**Table 4 Pair wise Granger Causality Test for Maize**

| | Siakago | Karaba | Makima | Ishiara | Kiritiri | Kathwana | Magutuni | Chuka | Kaanwa |
|---|---|---|---|---|---|---|---|---|---|
| Siakago | | → | → | → | → | → | → | → | → |
| Karaba | - | | → | → | - | - | → | → | - |
| Makima | - | → | | → | → | - | - | - | - |
| Ishiara | - | → | → | | - | - | → | - | - |
| Kiritiri | - | - | - | → | | - | - | - | - |
| Kathwana | - | → | - | → | - | | - | → | - |
| Magutuni | → | → | → | → | - | - | | → | → |
| Chuka | - | - | - | - | - | - | → | | → |
| Kaanwa | - | - | - | - | - | - | → | → | |

**Table 5 Pairwise Granger Causality Test for Beans**

| | Siakago | Karaba | Makima | Ishiara | Kiritiri | Kathwana | Magutuni | Chuka | Kanwa |
|---|---|---|---|---|---|---|---|---|---|
| Siakago | | → | → | - | → | → | → | → | → |
| Karaba | - | | - | - | → | - | - | - | → |
| Makima | - | - | | - | → | - | - | - | → |
| Ishiara | → | → | → | | → | → | → | → | → |
| Kiritiri | - | - | → | - | | - | - | → | → |
| Kathwana | - | - | - | - | - | | - | → | → |
| Magutuni | - | - | - | - | - | - | | → | → |
| Chuka | - | → | → | - | - | - | - | | - |
| Kaanwa | → | - | - | - | - | - | - | - | |