ANALYSIS OF PRICE TRANSMISSION AND MARKET INTEGRATION OF SUGAR: A CASE OF SELECTED MARKETS IN KENYA

TIMOTHY OUMA ODIPO

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DECLARATION AND APPROVAL

DECLARATION

I declare that this thesis is my very original work and has not been presented in this or any institution of learning whatsoever for any award.

Timothy Ouma Odipo

Signature: ----------

Date: ----------

APPROVAL

I declare that this work has been submitted to graduate school for examination under our approval as university supervisors.

Dr. Hillary Bett, (PhD)

Department of Agricultural Economics and Agribusiness Management,

Egerton University, Njoro

Signature: ----------

Date: ----------

Prof. J.K Lagat (PhD)

Associate Professor, Department of Agricultural Economics and Agribusiness,

Egerton University, Njoro

Signature: ----------

Date: ----------

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DEDICATION

I dedicate this work to my beloved guardians Richard and Maurice, my friends Silvanus and Kennedy and my late parents Saline and Bruno. “For you gave it all so that I could get it all”.

God bless you.

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This thesis is part of the results of my two years' work as a Collaborative Masters in Agricultural and Applied Economics (CMAAE) student at the department of Agricultural Economics and Business Management of Egerton University (Kenya) in collaboration with the department of Natural Resources and Agricultural Extension of University of Pretoria (South Africa). This work would not have been completed without valuable input rendered by many institutions and individuals.

First, I wish to thank my supervisors, Dr. Hillary Bett, (PhD) and Prof. J.K Lagat, (PhD) for their tireless efforts and for dedicating their time and guiding me through each and every step of this work. Secondly, I wish to acknowledge the CMAAE Program and AERC which sponsored a large part of my studies and the research work. Thirdly, my gratitude goes to the Kenya Sugar Board (KSB), for providing valuable secondary data which was used in the analysis. The contribution by many other individuals and the positive criticisms from my colleagues and friends during the period of my studies will not go unmentioned. Above all I say thank you to the almighty God for giving me the energy and good health during the entire period. All glory and honour are unto His holy name.

ABSTRACT

Measuring market integration is one of the most important aspects that can be used to assess the impacts of market development and liberalization policies. The study used cointegration approach to evaluate market integration in the sugar industry in Kenya. The approach used appreciates the existence of transaction cost and other determinants of market integration including effective communication as well as good transport network. The nature of movement of sugar prices in different markets in Kenya was established. The objectives of the study were: to determine the existence of integration between the sugar markets selected; to establish the existence of causality between the sugar markets identified; and to establish the determinants of price differences and spatial integration between the sugar markets. Data was obtained for average monthly prices of sugar from January 2008 to December 2012. The analysis of the objectives was done using Cointegration model, Granger Causality model and descriptive statistics. Statistical Package for Social Sciences, Microsoft Excel and STATA computer programs were used to process the data. The result obtained from the study revealed that market integration is greatly affected by road networks, communication networks, consumers' purchasing power and the distance between the markets. The study observed that only markets that were connected with good road networks experienced arbitrage. The information generated by this study is important in guiding policy makers to identify points of interventions as well as in designing effective and efficient sugar marketing channels. The study observed that there is need to effectively design communication network systems in order to disseminate necessary information to sugar traders.

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LIST OF ACRONYMS AND ABBREVIATIONS

ADF	Augmented Dickey-Fuller
AERC	African Economic Research Consortium
CMAAE	Collaborative Masters in Agricultural and Applied Economics
ECM	Error Correction Model
FAO	Food and Agriculture Organization
GDP	Gross Domestic Product
KSB	Kenya Sugar Board
MSC	Masters of Science
R&D	Research and Development
SONY	South Nyanza
SPSS	Statistical Package for Social Science
SSA	Sub-Saharan Africa
SSATP	Sub Saharan Africa Transport Programme

CHAPTER ONE
INTRODUCTION

1.1 Background of the study

Market integration can be defined as the markets that are connected through a process of arbitrage. There is undisputable importance of well integrated markets to a country. Linkages to marketing centres have been found to contribute significantly to rural households' escape out of poverty (Krishna, 2004; Krishna *et al*., 2004).

Sugar is a vital product that nearly all households in Kenya hardly miss among their daily meals. Kenya's sugar consumption continues to grow and outpace production in line with the increasing population. Domestic production supplies about 70 percent of total consumption and the shortfall must be met through imports. Kenya Sugar Board forecasts consumption to grow at an annual rate of 4 percent (KSB, 2011), and this is nearly the same rate of growth in population. The other factor driving consumption increase is the expansion in industrial use. The use of sugar in industrial activities such as manufacturing soft drinks, biscuits, other beverages and confectionary products is rising steadily (KSB, 2011). It is this fact that necessitates a well-informed study to heighten development of sugar marketing in Kenya.

Past literature shows that very few studies have been done concerning market integration in Africa. Indeed, the most innovative studies on market integration are on markets in developed economies (Spiller and Huang, 1986; Ardeni, 1989; Sexton *et al*., 1991; Goodwin and Schroeder, 1991; Goodwin and Piggott, 2001). Since it is through marketing that the surplus commodities in a production region can be adequately distributed to areas of scarcity, studies that focus on market integration are thus important.

Distribution of the processed sugar in Kenya is done by company agents or wholesalers. These distributers use their own transportation vessels save some retailers. The country does not have any competitive advantage in the world and regional market. However, according to Mumias Sugar bulletin (2011), regional cross border trade remains a common occurrence with Mumias Sugar Company exporting ten percent of its produce to the neighbouring Uganda, Sudan, Rwanda and Ethiopia.

To increase sales and product identification, local sugar mills have not only segmented the consumer market but also branded their products. They have packaged both white and brown

sugar in different sizes (2kg, 1kg, 1/2kg, 1/4kg, 100g and 5g) to cater for different markets and different pockets (KSB, 2011). Producer companies have adopted different strategies to market their sugar.

According to Kenya Sugar Board Report (2011), Kenyan millers sourced 80 percent of their brown sugar from Egypt in marketing year 2010, while South Africa and Saudi Arabia supplied 47 and 42 percent of refined sugar, respectively. However, the occasional sugar shortage in the country sometimes lead to sugar rationing where an individual is not allowed to purchase more than 2 kilograms of sugar in leading supermarkets. Such shortage often aggravates the increase in sugar prices which the traders pass to consumers.

Market integration can be vertical, spatial or inter-temporal. Spatial market integration refers to a situation in which prices of a commodity in spatially separated markets move together and price signals and information are transmitted smoothly across the markets (Ghosh, 2000). An integrated market is synonymous with pricing efficiency, that is, prices as defined by Fama and Eugene (1970), should always reflect all information. For instance, prices move from time to time and their margins are subject to various shocks that may drive them apart or not. If in the long run the prices exhibit a linear constant relation then it is said that they are cointegrated.

The study focuses on investigating the price co integration among Kenya's major sugar markets. These involve several issues, namely, whether causality exist within pair-wise markets. It also involves the mechanisms to achieve the causality, for example to establish which market is the first-mover within a particular model. The issues involved relate to whether pair time-series variables are co integrated. If co integrations exist between paired markets then the information about their causality is also investigated. Potential long run co integration relation between different markets is a good indicator of price efficiency. Price efficiency in an economy acts as a major motivation to development. It also eliminates unwarranted government control and other factors that might accentuate market distortion. This research was therefore focused to investigate whether regular price fluctuation in Kenya is as a result of poorly integrated sugar markets in Kenya or other factors that are beyond the scope of this study.

1.2 Statement of the problem

Sugar is a major commodity that is consumed almost on daily basis by many households in Kenya. In addition, other consumers include learning institutions, hotels and restaurants as well as industrial users. These consumers obtain the commodity from outlets within their vicinity. Given this extensive market, the relationship between different markets has not been established though the information is latent in prices charged in different outlets. Despite an apparent irregular pattern exhibited in different markets, there is thin knowledge concerning whether the sugar market in the country is integrated or segmented. Many research studies that have been conducted in Kenya on sugar relate to productivity but little has been done on market integration. The information from this study would expose sugar market inefficiency/efficiency.

1.3 General objective

The broad objective of the study was to contribute to knowledge on market integration of sugar in Kenya so as to establish the basis of policy design within sugar market.

1.3.1 Specific objectives

i. To establish the determinants of price differences and spatial integration.
ii. To analyse price differentials of the identified sugar markets.
iii. To determine the existence or non-existence of integration between the selected sugar markets.
iv. To establish the existence or non-existence of causality between the selected sugar markets.

1.4 Hypotheses

i. Road networks and transaction cost are not the only factors influencing price differences and spatial integration.
ii. There are no price differentials in the selected sugar markets.
iii. There is no integration between the selected sugar markets.
iv. There is no causality between the identified markets.

1.5 Justification of the study

Market efficiency is the goal of each economy and efficient product movements can be designed through knowledge of market integration. The extent of market integration also has consequences for designing successful agricultural price stabilization policies (Fackler and Goodwin, 2001). A well improved marketing sector in terms of product movement and information availability especially when all determinants of price transmission and spatial integration are carefully looked into will boost not only the marketing of the sugar industry in Kenya but also the development of the country as a whole. Causality results generated from this study will inform predictability of price formation which will infiltrate to consumers through rational decision making.

When market integration is well understood in the sugar sector, even other markets will enjoy the positive externalities such as improved road network as well as informed policies that will be made by the government thereafter. On the other hand, a well networked economy in terms of transport system smoothen the arbitrage of goods between markets in that economy. Well informed government policies eliminate duplication of resources in ventures which can be sorted out by efficient market integration in the economy.

1.6 Scope and limitations

The study was conducted in four markets in Kenya namely Kisumu, Garissa, Machakos and Nairobi. Commodity prices were used in this study since it is easier to acquire time series data on prices of sugar than any other data. Average sugar prices from 2008 to 2012 per kilograms were used.

The study was limited to sugar which is one of the many products of sugarcane. Other sugarcane products that were left out of the study include molasses, bagasse and press mud. These by-products are used either in making fertilizer, animal feed or food processing.

1.7 Definition of terms

Market integration: Market integration concerns the free flow of goods and information, (and thus prices) over form, space, and time through the process of arbitrage. Market integration therefore is concerned about linkages among markets.

Cointegration of markets: An alternative procedure for evaluating spatial market linkage in the presence of stochastic trends in price series. It requires that deviations from equilibrium conditions between two economic variables, (which are individually non-stationary in the short-run) be stationary in the long-run.

Causality: An elusive concept that shows the relationship between two or more variables as well as the direction of relationship that exists between those variables.

Segmentation of markets: Occurs if the price movement in one market is completely irrelevant to forecast price movement in another market.

CHAPTER TWO
LITERATURE REVIEW

2.1 Over view of market integration

According to Goodwin and Schroeder (1991), 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. The existence, extent and persistence of famines in market economies are also closely linked to market integration (Campenhout, 2007). Like other developing countries in Africa, Kenya is majorly characterized by agricultural production and thus well-integrated agricultural markets can be of positive significance towards increasing her development.

Studies show that despite depending on agriculture for food security, majority of agricultural markets in African countries are inefficient and poorly integrated (Onyuma *et al*., 2006). Christensen and Erickson (1989); maintains that the vagaries of weather, poor infrastructure and information asymmetry cause existing agricultural markets in Africa to be less competitive. However, it is a fact that where there is less competition even efficiency and effectiveness may lag behind.

Many scientific studies (Kibiego *et al*., 2003; Mauyo *et al*., 2007; Gichangi *et al*., 2010) have been conducted analyzing bean market integration at various market levels. However, little attention has been given to the study of sugar market integration whereas most studies that have been done in the sugar sector in Kenya majorly focus on Sugar productivity.

2.2 Transport services and market integration

Chambers (1983) lists isolation as one of the five factors (isolation, powerlessness, vulnerability, poverty and physical weakness) which contribute to the deprivation trap or perceptual isolation. Isolation will increase marketing and production costs, slow down the diffusion of new technologies and techniques, and limit access to education and health facilities. Improved transport, however, as part of a multidisciplinary approach to poverty reduction, plays an important role in improving access to vital social and economic facilities through more reliable and lower cost access. However, the research from SSA points to high transport costs,

unreliable and infrequent vehicle services with the inevitable implications that this has on rural development and poverty eradication (Kibiego *et al*., 2003 and Gichangi *et al*., 2010). It is asserted that this is in part due to an over emphasis on physical infrastructure and under emphasis on the vehicle services themselves. The problem of inadequate transport facilities has also been highlighted in the past by such authors as Dawson and Barwell (1993) and Carapetis *et al.* (1984).

The role of transport is very crucial. It is a phase in production process which is not complete until the commodity is in the hands of the final consumers (Adefolalu, 1977). Availability of a transport facility is a critical investment factor that stimulates economic growth through increased accessibility, its efficiency and effectiveness (Ajiboye, 1994). It affects the basic function of production, distribution, marketing and consumption in many ways. Transportation also influences the cost of commodity consumed and the purchasing power of the consumers. Good transport thus leads to market integration especially markets which are spatially separated. Transport system therefore has positive relationship with market integration.

2.3 Overview of sugar marketing in Kenya

This study employed commodity approach in reviewing sugar marketing in Kenya. The term 'commodity' is commonly used in reference to basic agricultural products that are either in their original form or have undergone only primary processing (FAO, 2006). Commodity approach analyses the product from the time it leaves the firm to the time it arrives to the hands of the final consumer. The sugar sub-sector in Kenya is the third most important agricultural contributor to the GDP after tea and coffee. It supports directly or indirectly 6 million Kenyans. It is a source of livelihood for about 170,000 farmers in western Kenya (Wawire *et al*., 2006; Odenya *et al*., 2007).

The major stakeholders involved in sugar marketing include wholesalers, company agents and retailers among other small scale traders. The company engages these middlemen through either the contracting method or through the agent. From the producing companies the product is distributed by the middlemen to the consumers. Other cases involve direct sales by the company to the clients. In-depth understanding of the commodity approach in marketing helps the firms to adjust their objectives to meet consumers' tastes and preferences. It also enables the firms to allocate resources effectively and efficiently in carrying out the marketing activities. A

firm that embraces this approach will compete therefore effectively in the market and may end up gaining larger market share.

2.4 Determinants of market integration in Africa

Factors constraining the existence of efficient agricultural markets in Africa include price fluctuations that are not consistent with demand and supply conditions causing price risks in residual market (Hull, Tomek, Ruther and Kyerene, 1981), poor market conditions (Djisktra and Magori, 1995), inadequate transportation infrastructure and poorly developed market information system (Eicher and Baker, 1982; Wanmali and Idachaba, 1987; Ayieko, 1995) and low consumer purchasing power. For instance, a primary factor affecting market integration is an agent's cost and risk associated with trade between markets (Buccola, 1983). This would indeed alter the transaction costs between markets, but this does not automatically mean that the adjustment speed changes. The agent's access to market information, on the other hand, is more likely to influence the speed of adjustment than the transaction cost. For example, in the context of rural food markets, the existence of a telephone line between two markets might dramatically increase the speed of adjustment, without significantly affecting the transaction cost.

Other factors include inappropriate government policies meant to achieve socio-political objectives that do not acknowledge the economic role of competitive markets in allocation of resources and costs among producers, consumers and middlemen by giving erroneous information about market and market actors (Christensen and Erickson, 1989). In addition, resource limitation and weather that influence what is to be produced and sold in markets and lack of viable and cheap post-harvest technologies to boost marketing are also constraining variables (Maritim, 1995).

These are only some of the vital factors in determining not only the effectiveness of market integration in the country but also the market efficiency. Absence of market information can drive some consumers to make uninformed marketing decisions. Such decisions may result to decrease in consumer welfare.

2.5 Price fluctuations and market integration

Market integration and price of agricultural commodities are closely related. Although market integration involves the arbitrage between two markets, price information play important

role in studying market integration. The extent of price transmission from world to domestic prices is a critical parameter in empirical trade models which attempt to assess the impact on prices. Studies show that price movement in Sub Saharan African market is higher in cereals than other agricultural products (Greb *et al*., 2012). African rice markets show the highest share of cointegrated price pairs (Greb *et al*., 2012). Factors constraining the existence of efficient agricultural markets in Africa include price fluctuations that are not consistent with demand and supply conditions causing price risks in residual market (Hull, Tomek, Ruther and Kyerene, 1981). Efficient price movement within and across market is therefore necessary for the existence of market integration. Seasonality and irregularities in commodity prices greatly influence the direction of integration and causality in different markets. Consumers of different products use price as a measure of quality thereby influencing the arbitrage within the markets.

Kibiego *et al*. (2003) used prices to evaluate market performance by considering marketing margins and the extent of market integration. Barrett and Li (2002) suggest that market integration might be most usefully defined as tradability or contestability between markets. This implies the transfer of excess demand from one market to another, manifest in the physical flow of the commodity, the transmission of price shocks from one market to another, or both. The physical flow of goods between two markets is, thus, sufficient but not necessary to demonstrate tradability.

According to Fackler and Goodwin (2001), the actions of spatial arbitrageurs will ensure that the prices of a homogeneous good at any two locations will differ by, at most, the cost of transferring the good from the region with the lower price to the region with the higher price. In summary, measuring the degree of price transmission lacks a single explicit empirical test because of market dynamic relationships that arise due to inertia or discontinuity in trade as well as non linearities that arise due to distortions in arbitrage. In this study, cointegration and causality techniques have been used to test for price transmission.

2.6 Theoretical framework

To analyse market integration of sugar in selected markets, this study focused on the aspect of market integration. The separation of different markets by space was crucial in this study. The first attempts to measure the extent of market integration did not consider the existence of transaction costs and took price co-movement as evidence for market integration.

The first models used simple bivariate correlation coefficients (Blyn, 1973). Ravallion (1986) formulated a dynamic model of spatial price differentials, allowing differentiation between short-run market integration, long-run market integration and market segmentation.

However, in the measurement of market integration by use of correlation studies, many factors are not accounted for. These may include transaction cost, which is influenced by factors including improvements to the transportation infrastructure, gradual improvements in information dissemination (telecommunications, newspaper availability) among others. Barrett (1996); Maina (2011) argued that simple bivariate correlation coefficients require filtering to eliminate bias toward spurious integration due to common exogenous trends (For instance, general inflation), common periodicity (For example, agricultural seasonality), or autocorrelation. This makes price spread observations unreliable indicators of market integration or competition, since those spreads vary seasonally. In addition, these simple statistics fail to recognize the heteroskedasticity common in price data of reasonably high frequency (Barret, 1996). Other methods include Variance Decomposition Approach (Delgado, 1986) and Radial Market Integration Approach (Ravallion, 1986). However, these methods have their own limitations and have been criticized by most researchers.

Co-integration procedure therefore stands to be the most viable technique for measuring the degree of market integration. It takes into account the critique that is bestowed to other econometric procedures used to estimate market integration at the moment. It also estimates both the degree and the direction of the integration in the market. The concept of co-integration was developed and applied by Engle and Granger (1987), and further extended by Engle and Yoo (1987). It is an alternative procedure for evaluating spatial market linkage in the presence of stochastic trends in the price series. Its underlying importance is that it ensures deviations from equilibrium conditions between two economic variables, (which are individually non-stationary in the short-run) and are stationary in the long-run.

2.5.1 Conceptual framework

Variables which influence market integration of sugar among these four markets: Kisumu, Machakos, Garissa and Nairobi were captured in this conceptual framework. The variables included road infrastructure, communication networks, availability of vehicles (Trucks) and efficiency of the marketing channels all of which affects the transaction cost (Figure 1).

Producers, wholesalers and retailers are related as they are part of the supply chain in sugar market. Wholesalers charge relatively low prices for sugar as opposed to prices charged by retailers. Price variation between wholesalers and retailers depend on road networks, availability of transport vehicles and the transaction costs. Consumer price determines whether there exists a relationship among the markets under the study. Segmentation and integration of various sugar markets is thus a function of consumer price.

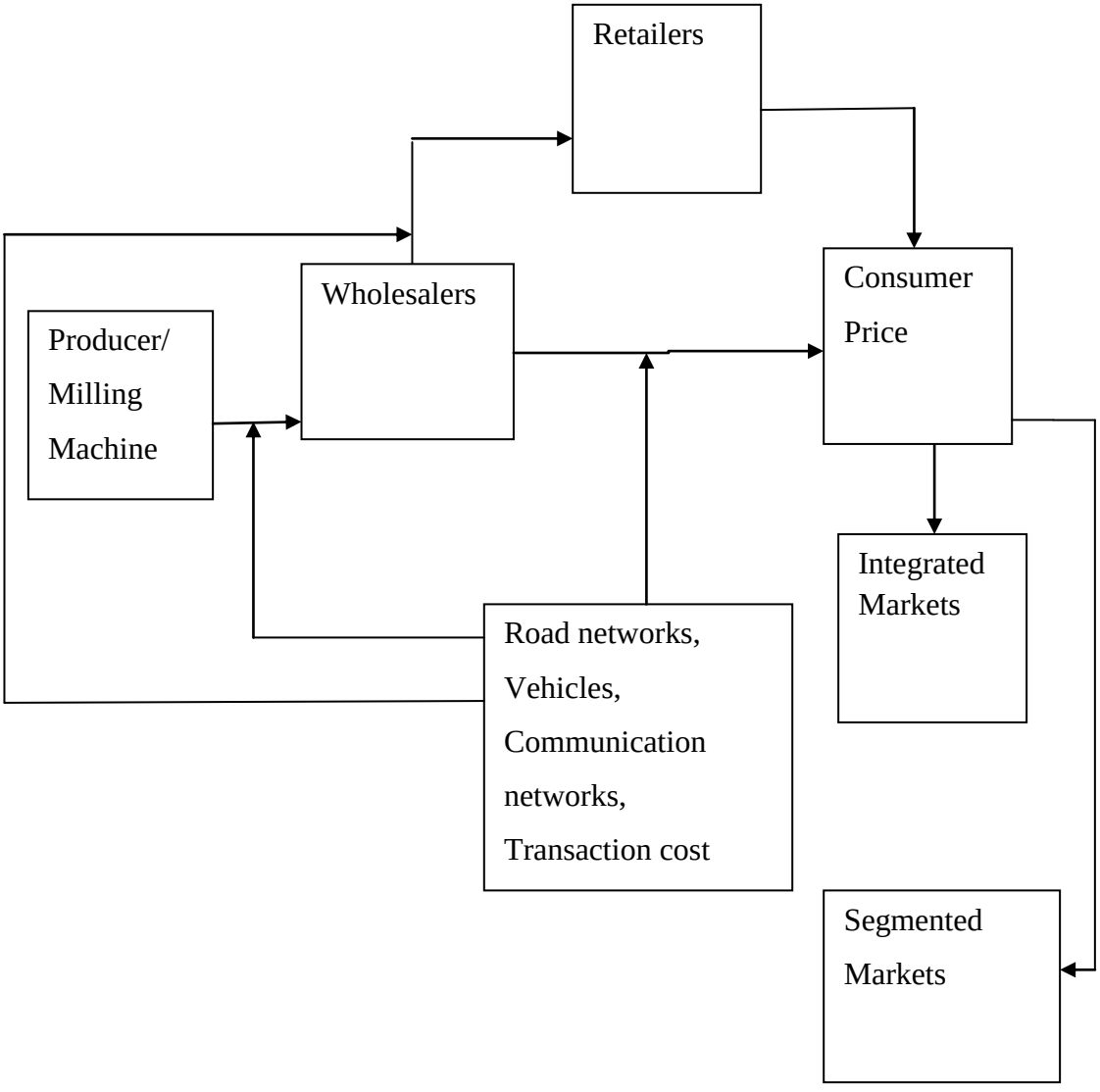

Figure 1: Conceptual framework

Source: Own conceptualization, (2013).

CHAPTER THREE
METHODOLOGY

3.1 Study areas

The study was conducted in four different selected markets in Kenya. These were Kisumu which is served mostly by the South Nyanza Sugar Company Limited, Garissa, Nairobi and Machakos market (Figure 2). These four markets were selected because of the following reasons: Kisumu is the major market located in close proximity to main sugar producing areas such as Awendo and Mumias. It acts as a surplus region for the sugar industry. Kisumu is a port city at the shore of Lake Victoria in western Kenya at 1,131 metres located at the coordinates 0°6′0″S and 34°45′0″E. It has a population of 394,684 (2009 census).

Nairobi market was selected in this study because of its spatial separation from the production area and the vast population of the consumers of sugar. It is also deficit region and the major consumption point of sugar produced in Kenya. Nairobi is the capital city of Kenya. Nairobi city is located at the coordinate's 1°16′59.88″S and 36°49′ 0.12″E. Garissa is located at the coordinates 0°27′ 25″S 39°39′30″E. It is the capital of Garissa County. It was chosen in this study because of the poor road networks and poor communication networks that it has in the country.

Machakos is a town in Kenya, 64 kilometres southeast of Nairobi. It is the capital of the Machakos County in Eastern Province of Kenya. Machakos Town is a major rural centre, and also a satellite town due to its proximity to Nairobi. Machakos is located at 1°31′S 37°16′E and 1.517°S 37.267°E.

Garissa, Machakos, Nairobi and Kisumu therefore served as the four major markets where the monthly average prices of sugar was obtained for the period of five years beginning January 2008 to December 2012. Kisumu acted as the source market for sugar whereas Garissa, Machakos and Nairobi acted as deficit regions which depended on the integration with Kisumu.

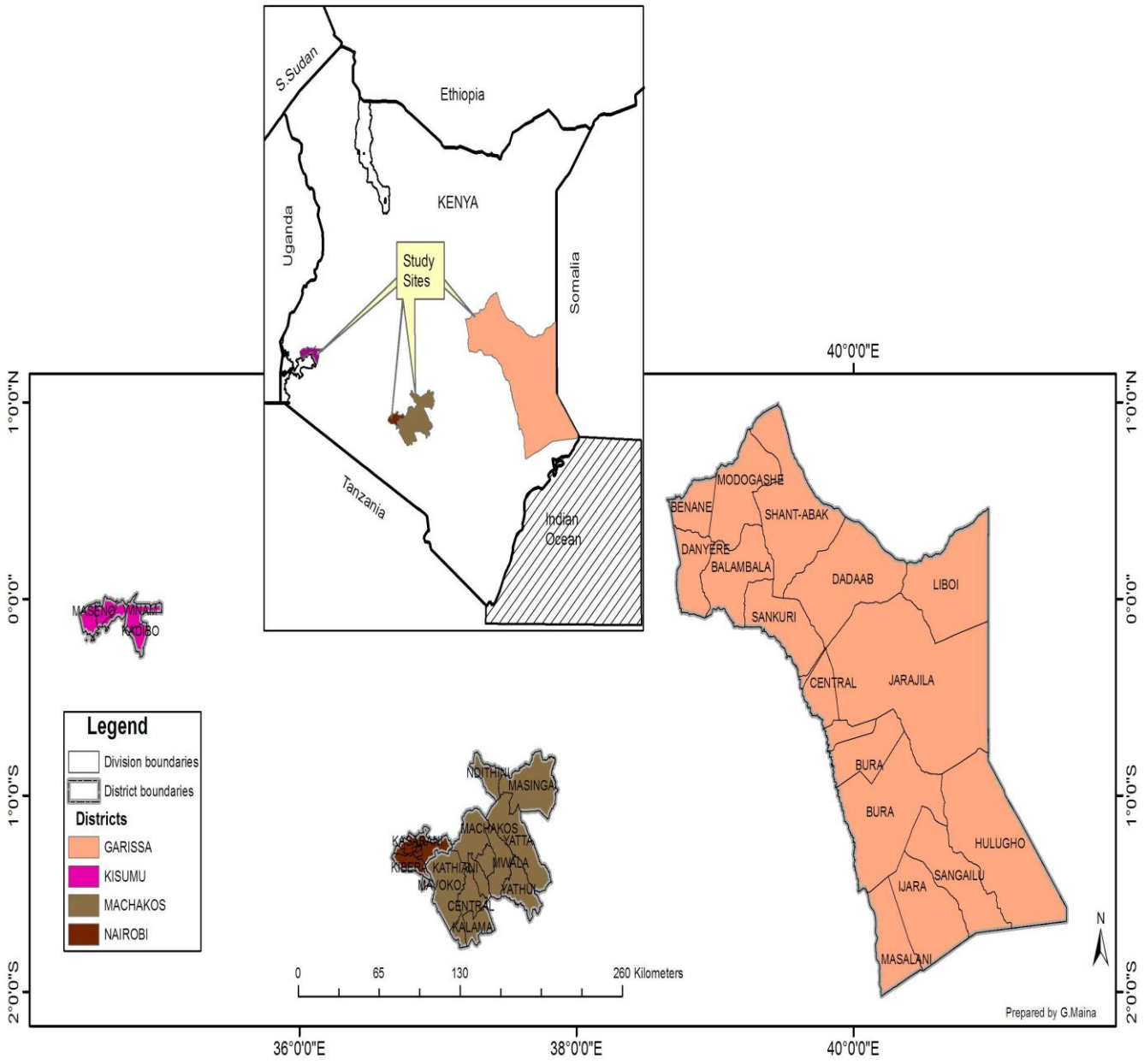

Figure 2: Map of the study sites

Source: www.wri.org

3.2 Sampling procedure

The study adopted purposive sampling where four cities were selected: Kisumu Nairobi, Garissa and Machakos. Time series data of average monthly prices of sugar was used.

3.3 Type of data

Secondary data was used in this study. The data was obtained from the Kenya Sugar Board (KSB). Retail price data were obtained from the Kenya Sugar Board (KSB) for the four cities. Sugar prices were obtained for every month for five years since January 2008 to December 2012. This showed the trend for 60 months for each market.

3.4 Data analysis

Objective one and two

Descriptive statistics was used to analyse the determinants of price differences and spatial integration. During the analysis SPSS package was used to generate mean values of the independent variables. Econometric moment, mean, were therefore used. Graphs and percentages were also used to present various results in the study. Price differentials and seasonal index was established and presented in the analysis.

Objective three

To analyse the direction of market integration in the three different markets in Kenya, Co-integration analysis was used. However, the method of estimation depended on the stationarity properties of the independent time series. Augmented Dickey-Fuller (ADF) test was applied to establish for the stationarity in price series. Co-integration analysis was then used to test for price connection among the regional markets; based on the model as developed by Engle and Granger (1987) and as used by Goodwin and Schroeder (1991).

Cointegration approach to market integration

Co-integration analysis was used to determine the relationship between prices in different locations. When a long-run linear relation exists among different price series, these series are said to be co-integrated. If geographically separated markets are integrated, then there exists an equilibrium relationship amongst them Goodwin and Schroeder (1991) and Sexton *et al*., (1991). The long run equilibrium relationship for analyzing market integration as used in Goodwin and Schroeder (1991) was specified as:

$Y_t = \alpha + \beta X_t + U_t$…….…….. …….. (1).

Where; $Y_t$and X_t is commodity prices of a homogenous good (sugar), in two different markets at time t, and α and β are parameters to be estimated.

If two markets are perfectly spatially integrated, then β =1. If this holds, then price changes in one market are fully reflected in alternative market. When β ≠ 1 (i.e. β< 1 or β> 1), then the degree of integration may be evaluated by investigating how far the deviation of $\alpha_1$is from unity.

Since price time series are usually non-stationary whereas standard statistical models do not allow explicit determination of α and β, a 2- step model by Engle and Granger (1987) was used. The first step was to determine the "order of integration" of each price series by checking for stationarity. A time series (say Y_t) is stationary if the joint distribution of $Y_t$and Y_t+ t is independent of time (t). This was guaranteed by ensuring that the time series is integrated of order zero [I (0)]. Since most price series have trends in them if only because of inflation, they are I (1) and thus they need differencing once to obtain I (0) process.

Augmented Dickey-Fuller test was used to determine the order of integration. This was achieved by regressing ΔY_ton Y_t-1 and several lags of ΔY_t(enough to eliminate autocorrelated disturbances).

The model is specified as:

$\Delta Y_t = \alpha_0 + \alpha_1 Y_t$ -1+ ε t…….…. (2).

Where: $\Delta Y_t$is the first difference of prices in market Y, Y_t-1 is the lagged price of sugar in market Y, α_0 and $\alpha_1$are parameters to be estimated, ε t is the error term.

The t-statistic on the estimated coefficient of $Y_t - 1$ will then be used to test the hypothesis that:

Ho: Y_t ~ I(1) Vs H1: Y_t ~ I(0)

If we fail to reject the null (Ho) above then Y_t is not stationary and can be integrated of order one or even higher. To find out the order of integration the test will be repeated with ΔY_tin place of $Y_t$thus regressing $\Delta\Delta Y_t$on a constant ΔY_t-1 and several lags of $\Delta\Delta Y_t$. ADF test will be used to test the hypothesis that:

Ho: ΔY_t ~ I(1) Vs; H1: ΔY_t ~ I(0)

That is, *Ho:* Y_t *~ I(2) VS; H1:* Y_t *~ I(1)*

This process continued until the order of integration was established. The second step then involved testing for co-integration based on the idea that if two time series (Y_t and X_t) are each ~ *I (1),* then their residual (U_t) will be integrated of order zero (stationary). Where $U_t = (Y_t - \alpha - \beta X_t)$ ..... (3).

The residual (U_t) was then tested for stationarity. The ADF tests applied to these residuals were expected to yield statistics which are large and negative so as to reject the null hypothesis of I (1) in favour of stationarity.

If the first step shows that each time series is integrated of order one, and if the second step results to a stationary residual, then the two time series are said to be co-integrated. This implies that long run (or equilibrium) relationship exists between the two sets of prices. In addition, to make a clear distinction between short-run and long-run integration an Error Correction Model (ECM) was applied. This allowed for derivation of the speed of price transmission from one location/market to another. Within the context of market integration, it is important to consider the speed of adjustment as one dimension of integration.

The error term in the cointegration regression was treated as the equilibrium error. To tie the short-run behaviour of Y_t to its long run value, the Error Correction Model (ECM) was specified as:

$\Delta Y_t = \alpha_0 + \alpha_1 \Delta X_t + \alpha_2 U_{t-1} + \varepsilon_t$ ..... (4).

Where; Δ = first difference operator, ε_t = random error term and $U_{t-1} = (Y_{t-1} - \alpha - \beta X_{t-1})$ ..... (5).

ECM states that ΔY_t depends on ΔX_t and on equilibrium error term, while absolute values of α_2 decide how quickly equilibrium will be restored (speed of adjustment).

Cointegration model specification

$Price\ of\ sugar\ in\ Kisumu_t = \alpha + \beta price\ of\ sugar\ (Nairobi) +\ error\ term$ ……. (6).

$Price\ of\ sugar\ in\ Kisumu_t = \alpha + \beta price\ of\ sugar\ (Garissa) +\ error\ term$ …… (7).

$Price\ of\ sugar\ in\ Kisumu_t = \alpha + \beta price\ of\ sugar\ (Machakos) +\ error\ ter$ ……. (8).

$Price\ of\ sugar\ in\ Nairobi_t = \alpha + \beta price\ of\ sugar\ (Garissa) +\ error\ term$ …… (9).

$Price\ of\ sugar\ in\ Nairobi_t = \alpha + \beta price\ of\ sugar\ (Machakos) +\ error\ term$ …… (10).

$Price\ of\ sugar\ in\ Garissa_t = \alpha + \beta price\ of\ sugar\ (Machakos) +\ error\ term.$ … (11).

Where α and β are parameters to be estimated.

$\Delta price\ of\ sugar\ in\ Kisumu_t = \alpha_0 + \alpha_1 lagged\ price\ of\ sugar\ in\ Kisumu_t + error\ ter$.. (12).

$error\ term_t = (price\ of\ sugar(Kisumu)_t - \alpha - \beta price\ of\ sugar(Nairobi)_t)$ ……. (13).

Δ*Price of sugar in Kisumu*$_t$= α_0+ $\alpha_1\Delta$*Sugar price in Nairobi*$_t$+ $\alpha_2 U_{t-1} + \varepsilon_t$ ……..... (14).

Where α_0, α_1 and α_2 = parameters while U_t and ε_t are error terms.

Table 1 shows the levels and description of variables used in the cointegration model. Variable code and the expected signs are also shown.

Table 1: Description of variables and signs used in cointegration model

Variable code.	Variable.	Measurement of variable.	Expected sign.
Dependent variable.			
K	Price of sugar in Kisumu.	Price of sugar (continuous)	+
ChangeinK	First difference of K.	Price of sugar (continuous)	+/-
G	Price of sugar in Garissa	Price of sugar (continuous)	+
Changing	First difference of G	Price of sugar (continuous)	+/-
N	Price of sugar in Nairobi	Price of sugar (continuous)	+
Changeinn	First difference of N	Price of sugar (continuous)	+/-
M	Price of sugar in Machakos	Price of sugar (continuous)	+

Changeinm	First difference of M	Price of sugar (continuous)	+/-
Independent variable			
Laggedk	One period lag of K	Price of sugar (continuous)	+
Laggedg	One period lag of G	Price of sugar (continuous)	+
Laggedm	One period lag of M	Price of sugar (continuous)	+
Laggedn	One period lag of N	Price of sugar (continuous)	+
Laggedreskn	One period lag of residuals of K with respect to N	Price of sugar (continuous)	+/-
Laggedreskg	One period lag of residuals of K with respect to G	Price of sugar (continuous)	+/-
Laggedreskm	One period lag of residuals of K with respect to M	Price of sugar (continuous)	+/-
Laggedresnm	One period lag of residuals of N with respect to M	Price of sugar (continuous)	+/-
Laggedrsegm	One period lag of residuals of G with respect to M	Price of sugar (continuous)	+/-

Objective four

To establish the existence of causality between the sugar markets, Granger causality tests, enables the understanding of the direction of causality in price changes. Cointegration does not reveal the direction of the causal relationship between variables, but if two variables are found to be cointegrated, it follows that there must be Granger causality in at least one direction (Schimmelpfenning and Thirtle, 1994).Granger's causality test regress a variable y on lagged values of itself and another variable x. Granger's causality model states that if x is significant, it explains some of the variance on y that is not explained by lagged values of y itself. This indicates that x is causally prior to y and is said to dynamically cause or Granger cause y. To

arrive at the conclusion that x Granger cause y, its coefficient in the Granger Causality model must not be zero.

Testing causality between the markets was done using the Granger causality model specified as follows:

$Y_t = b_0 + \Sigma b_j Y_{t-j} + \Sigma c_j X_{t-j} + u_t$…….…. (15).

Where: Y_t and X_t = price of sugar in market Y and X respectively.

b_0, b_j and c_j = parameters to be estimated.

u_t= error term.

From equation (13), if past values of X help determine current values of Y, then X Granger causes Y. The test of H_0: $c_j = 0$ Vs $H_1 : c_j \neq 0$will be carried out with an F test. To test whether Y Granger causes X, the following model was applied as specified in equation (16).

$X_t = b_0 + \Sigma b_j X_{t-j} + \Sigma c_j Y_{t-j} + u_t$…….. (16).

Where: Where: Y_t and X_t = price of sugar in market Y and X respectively.

b_0, b_j and c_j = parameters to be estimated.

u_t= error term.

The magnitude of causality was given by Σc_j…….…….. (17).

Equation (8) above was used to calculate the short run effect of each variable on the other.

The long run effect of (say $X_t$on Y_t) was given by $\sum \frac{c_j}{1-\sum b_j}$…….…….(18).

Granger causality model specification

Price of sugar in Kisumu=$b_0 + \Sigma b_j$*lagged price of sugar in Kisumu +* Σcj *lagged price of sugar in Nairobi+ error term*…….…….…….…….…….…….…….…….…….…….…. (19).

Whereb_0, b_j and c_j are parameters to be estimated.

Price of sugar in Nairobi=$b_0 + \Sigma b_j$*lagged price of sugar in Nairobi +* Σcj *lagged price of sugar in Kisumu+ error term*…….…….…….…….…….…….…….…….…….…. …….. (20).

Price of sugar in Kisumu=$b_0 + \Sigma b_j$ lagged price of sugar in Kisumu + Σcj lagged price of sugar in Garissa+ error term…… …… (21).

Price of sugar in Garissa=$b_0 + \Sigma b_j$ lagged price of sugar in Kisumu + Σcj lagged price of sugar in Kisumu+ error term…….. (22).

Price of sugar in Kisumu=$b_0 + \Sigma b_j$ lagged price of sugar in Kisumu + Σcj lagged price of sugar in Machakos+ error term…… ……. (23).

Price of sugar in Machakos=$b_0 + \Sigma b_j$ lagged price of sugar in Machakos + Σcj lagged price of sugar in Kisumu+ error term…… (24).

Price of sugar in Nairobi=$b_0 + \Sigma b_j$ lagged price of sugar in Nairobi + Σcj lagged price of sugar in Garissa+ error term…… ……. (25).

Price of sugar in Garissa=$b_0 + \Sigma b_j$ lagged price of sugar in Garissa + Σcj lagged price of sugar in Nairobi+ error term…… …… (26).

Price of sugar in Nairobi=$b_0 + \Sigma b_j$ lagged price of sugar in Nairobi + Σcj lagged price of sugar in Machakos+ error term…… (27).

Price of sugar in Machakos=$b_0 + \Sigma b_j$ lagged price of sugar in Machakos + Σcj lagged price of sugar in Nairobi+ error term…… (28).

Price of sugar in Garissa=$b_0 + \Sigma b_j$ lagged price of sugar in Garissa + Σcj lagged price of sugar in Machakos+ error term…… (29).

Price of sugar in Machakos=$b_0 + \Sigma b_j$ lagged price of sugar in Machakos + Σcj lagged price of sugar in Garissa+ error term…… (30).

Table 2: Description of variables and signs used in Granger causality model

Variable code.	Variable	Measurement of variable.	Expected Sign.
Dependent Variables.			
Changeink	First difference of K	Price of sugar (continuous)	+/-
Changeing	First difference of G	Price of sugar (continuous)	+/-
Changeinm	First difference of M	Price of sugar (continuous)	+/-
Changeinn	First difference of N	Price of sugar (continuous)	+/-
Independent Variables.			
Claggedk	First difference of lagged K	Price of sugar (continuous)	+/-
Claggedn	First difference of lagged N	Price of sugar (continuous)	+/-
Claggedm	First difference of lagged M	Price of sugar (continuous)	+/-
Claggedg	First difference of lagged G	Price of sugar (continuous)	+/-
Laggedreskn	Lagged residuals of K	Price of sugar (continuous)	+/-
laggedreskg	Lagged residuals of G	Price of sugar (continuous)	+/-
Laggedreskm	Lagged residuals of M	Price of sugar (continuous)	+/-

CHAPTER FOUR
RESULTS AND DISCUSSIONS

This chapter contains the findings of the study and discussions. Descriptive results of different sugar markets are shown under section 4.1. Section 4.2 contains the cointegration results between the markets under the study while section 4.3 shows Granger Causality results.

4.1 Descriptive results

4.1.1 The determination of price differences and spatial integration

The determinants of price differences and spatial integration are presented in figure 3. The figure shows that road networks, communication systems, geographical distance and purchasing power are the major factors that determine spatial integration and price differences. All the descriptive results under this section were derived from the analysis of the data obtained from the Kenya Sugar Board. Description of the average monthly prices of sugar in all markets under the study is shown under section 4.3.2. Tabular representations as well as graphs were used to show seasonal index of the prices of sugar in all markets.

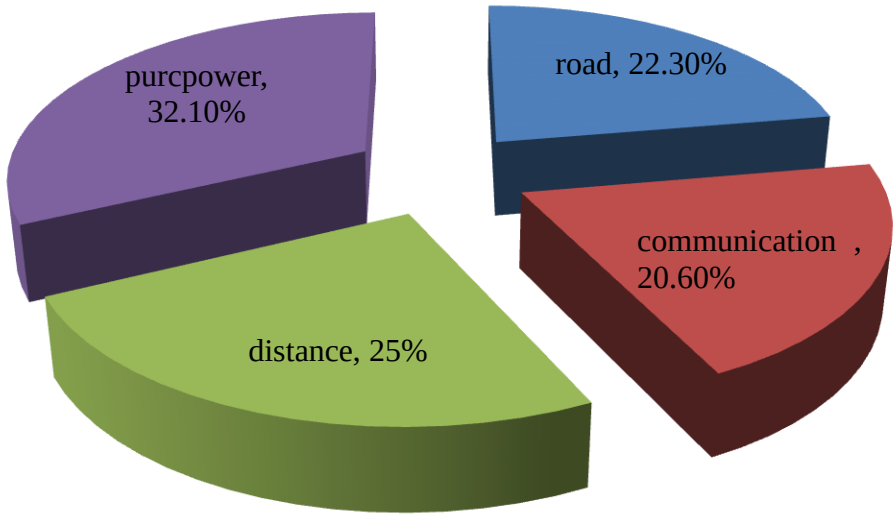

Figure 3: Determinants of price differences and spatial integration

Road network

Road network was found to be one of the major factors that influence spatial integration and price differences in the country. Results in Figure 3 shows that 22.3% of spatial integration and price differences is influenced by road network. Similar to Yogisha (2005), in an integrated market, price of a commodity is responsive to price changes of the same quality products in other markets. The indifference for a particular variety of product in the different markets of the area as a rule should not exceed the cost involved in the transportation and handling of the produce. According to Uma (1967), the regional differences could be reduced by creating competitive conditions through such measures as better transportation facilities, increased market intelligence, and overall improvement in the flow of commodities.

Communication

Communication can be defined as the process through which information is linked up from different markets to different market stakeholders. The importance of communication can be underscored in any efficient transaction between the consumers and the middlemen. Various means of communication are available in Kenya and these entails radio, televisions, communication via the internet as well as the most used mobile communication. Results show that 20.6% of market integration was influenced by communication (Figure 3). For example, in Garissa and Kisumu as well as Garissa and Machakos sugar markets were segmented and the reason was majorly attributed to poor road network system and unavailability of adequate communication channels. Kolur *et al*. (2012) revealed that perfect market information and intelligence flow between the two markets was found to be very crucial in determining market integration. Perfect communication between buyers and sellers result to better negotiation of prices and highly informed buying that thereafter eliminates any form of exploitation of consumers by the sellers.

Markets that enjoy good communication networks such as Nairobi and Kisumu, Kisumu and Machakos were found to be integrated. Mukim *et al*. (2009) argued that high transaction costs in developing countries arise primarily due to poor transport and communications infrastructure, inadequate contract enforcement mechanisms and unstable political environment. Communication therefore affects even the transaction cost thereby increasing the cost of doing

business. Increased transaction cost would mean increased price of the product in question and thus reduced demand of the same product according to the law of demand.

Purchasing power

Purchasing power of a consumer can be defined as the ability to buy a commodity on offer. Purchasing power of consumers in a particular market was found to determine the integration of the two markets in question by 25% (Figure 3). The rationale is that as long as the purchasing power of consumers is deemed low by sellers, they will be reluctant to transport goods to that market. Setiawan (2011) also revealed that international purchasing power parity conditions and interest rate differentials were key factors in determining the integration of different markets in Asian Pacific capital markets.

Distance

Results in Figure 3 revealed that 32.1% of spatial integration and price difference was influenced by the geographical distance between the markets. Distance can be described as the geographical location between two places. In terms of location, Garissa is the furthest from the reference market (Kisumu). Machakos is the second furthest followed by Nairobi. Distance coupled with poor road network contributed greater influence on price differences between various markets. Mukim *et al*. (2009) observed that Transportation and communications are basic and necessary infrastructure for market integration. However, they argued that the markets in India have continued to face problems with regards to such basic infrastructure and that transaction costs can be high owing to an inefficient transport system or because of long distances between markets.

Conclusively, purchasing power of the consumers had higher percentage influence on cointegration of sugar markets. Inadequate transportation infrastructure and poorly developed market information system and low consumer purchasing power were the major factors influencing market integration. Road network and communications were found to have almost same magnitude in influencing spatial integration. Similar observations were made by Eicher and Baker (1982); Wanmali and Idachaba (1987) and Ayieko (1995). From the study, Garissa market and Kisumu market were majorly segmented because of poor road networks and poor communication between the two markets.

4.1.2 Price differentials in the selected markets

The result from Table 3 indicates that highest average monthly sugar price was experienced in Garissa at a cost of Ksh. 205.25 per kilogram. Minimum price of sugar was experienced in Kisumu at a cost of Ksh. 49.16 per kilogram. The lowest price witnessed in Kisumu can be attributed to its proximity with major sugar producing companies in Kenya such as: Mumias Sugar Company, South Nyanza Sugar Company, Muhoroni Sugar Company, Kibos Sugar Company, Sukari Industry as well as Chemelil Sugar Company among other sugar industries. The standard deviation of average monthly sugar prices was minimal in Nairobi market. Nairobi due to its economic role in the country is characterized relatively by information symmetry as opposed to other markets in this study such as Garissa and Machakos. The results presented in Table 3 shows that the highest standard deviation was recorded in Garissa market. The deviation surmounted to Ksh. 34.03 per kilogram. Garissa market therefore presented two scenarios, for instance, the highest maximum price as well as the highest standard deviation was recorded in the same market. These two outcomes were attributed to information asymmetry due to poor communication systems in Garissa and poor arbitrage of commodities due to poor road network also referred to as transport bottlenecks that is prevalent in the region.

Results in Table 3 generally indicate that the minimum price of sugar was slightly above Ksh. 49 whereas the maximum price of sugar was above Ksh. 156 in all markets during the entire period for which the analysis was done. The variation in prices witnessed in various markets under the study was aggravated by different factors ranging from transport cost from the point of sugar manufacture to information asymmetry in various markets.

Table 3: Descriptive results for the prices of sugar in different markets

	N	Minimum	Maximum	Mean	Std. Deviation
Price of sugar in Kisumu	60	49.16	156.16	82.00	23.41
Price of sugar in Garissa	60	62.79	205.25	100.93	34.03
Price of sugar in Machakos	60	49.94	189.00	88.58	31.09
Price of sugar in Nairobi	60	65.90	160.45	91.07	21.71
Valid N (listwise)	60				

Seasonal index in various markets was calculated and the result presented in Table 4. The seasonal index for the price of sugar in Kisumu except between the month of January and February showed a continuous increase until November. Generally from Table 4, the seasonal index for all the markets showed a decline between the month of November and December save Nairobi. It was only in Nairobi that the seasonal index increased continually as from the month of March through December. The continuous increase in Nairobi was pegged on the high demand of sugar in Nairobi which is associated with higher purchasing power as opposed to other markets in the study.

Apart from tabular presentation of seasonal index in different markets under the study, the results were also presented graphically for clear outlook and easy comparison during the analysis. The seasonal index for all the markets are shown as from Figure 4 to Figure 7.

Table 4: Seasonal index for different sugar markets

	Seasonal Index			
	Kisumu	Garissa	Machakos	Nairobi
January	93.77	91.29	95.75	94.67
February	86.13	83.86	87.29	91.47
March	87.77	85.45	87.74	91.93
April	89.44	87.08	87.05	96.30
May	91.89	89.46	90.22	93.71
June	92.99	90.54	89.90	94.28
July	96.85	94.29	99.39	98.70
August	104.38	101.63	105.72	98.99
September	109.08	106.20	110.52	103.33
October	113.10	110.11	116.73	110.69
November	117.38	114.28	116.90	111.21
December	117.22	114.13	112.77	114.71

Results shown in Figure 4 indicates that the general trend of the seasonal index declined from the month of January through February then started increasing steadily to the month of July. However, as indicated in Figure 4, the increase in seasonal index was intense from the

month of July all the way to November. The accelerated increase can be explained by the fact that during the month of July onwards, the supply of cane to the milling factories normally fluctuates downward due to two reasons: first is because of short period of drought and secondly is because of the yearly maintenance of the sugar factories. Most sugar factories in Kenya usually carry out annual maintenance between the Month of June and August. During the maintenance period, shortage of sugar is normally evidence in the country thereby aggravating upward movement of sugar prices witnessed in Figure 4. The seasonal index for the price of sugar in Kisumu was generally above Ksh. 86 per kilogram for all the period that the analysis was done. As compared to minimum price witnessed in Kisumu, it was observed that the low average monthly price was not predominant occurrence in Kisumu.

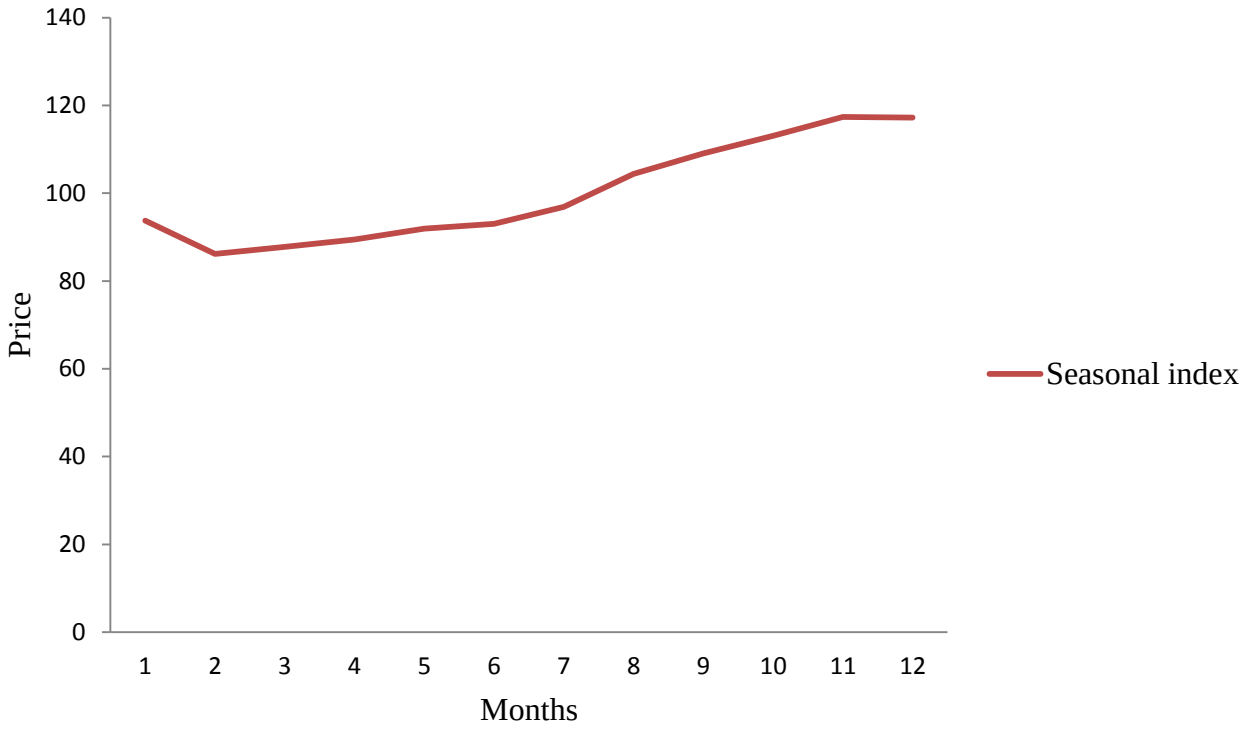

Figure 4: Seasonal index for the price of sugar in Kisumu

Results in Figure 5 shows that seasonal price of sugar in Garissa was highly fluctuating with a minimum record of Ksh. 83.86 witnessed in February and the highest being Ksh. 114.28 recorded in the Month of November. Just like the decreased seasonal index between January and February in Kisumu, Garissa too showed the same trend. The decrease can be explained by the decreased demand of sugar during the same period. Jayasuriya *et al*. (2007) observed that the

extent to which spatially separated markets become integrated depend on trade costs (reflecting both trade barriers across relevant spatial boundaries and transport costs as well as on market structures. The trade cost in Garissa was largely affected by transport cost and this intern might have resulted to higher seasonal index as opposed to other markets under the study.

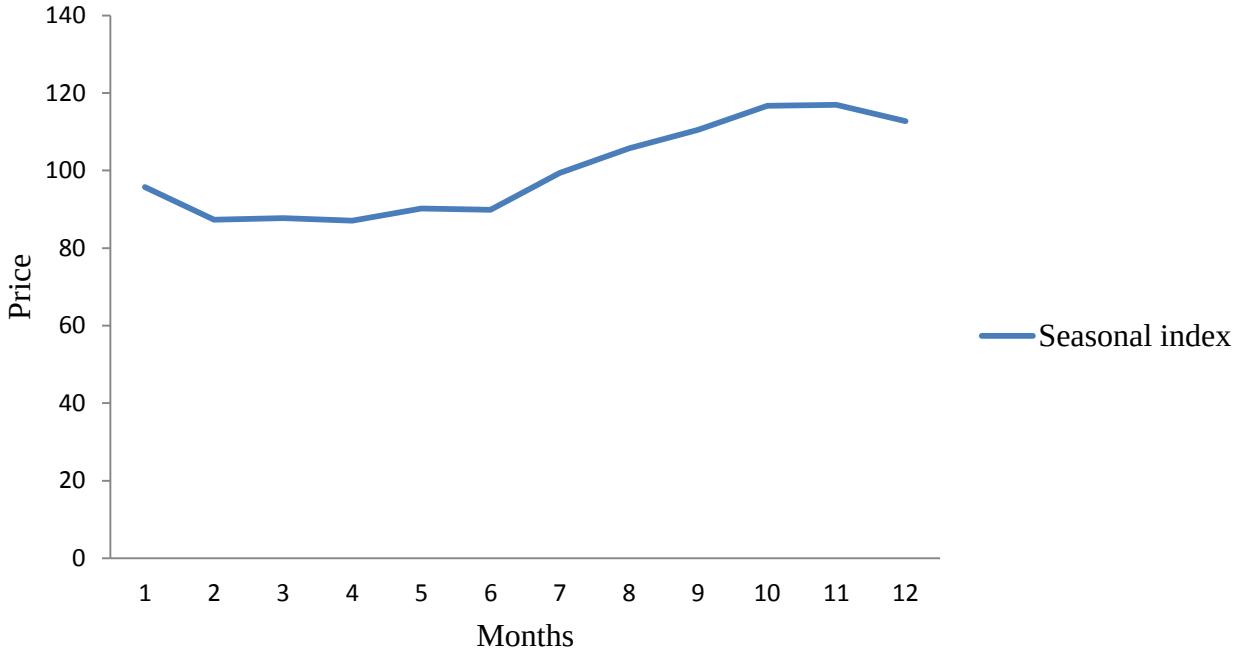

Figure 5: Seasonal index for the price of sugar in Garissa

As presented in Figure 6, curve for seasonal index of Machakos and Garissa almost followed the same trend. However, the seasonal index for Machakos was the highest in January as compared to all other markets under the study. The seasonal index of the price of sugar in Machakos according to the figure above was relatively fluctuating throughout the period except for the month of October for which the curve showed a constant slope of zero. The highest seasonal index in the Month of January can be attributed to relatively high demand for sugar as compared to other markets. Except for the segmentation of Machakos and Garissa, Machakos market was integrated with all other markets under the study. The integration with all markets except Garissa signaled the presence of communication systems and high purchasing power which motivated the middlemen to transport sugar from other markets of the study to Machakos.

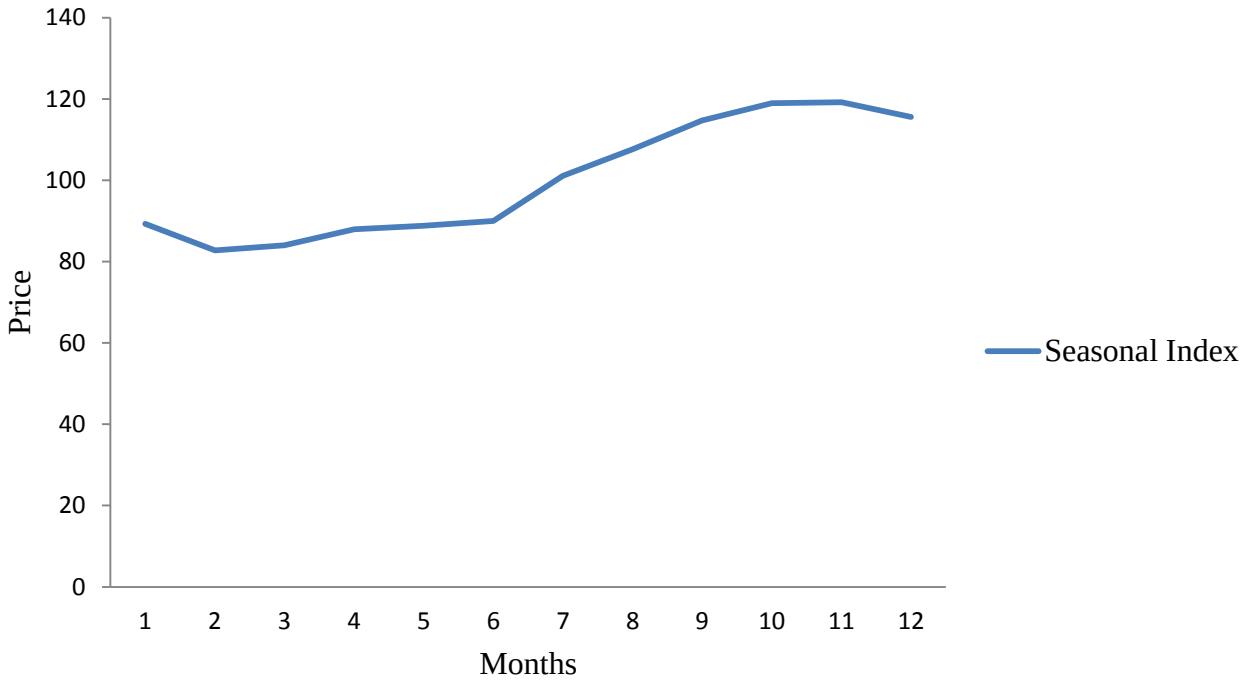

Figure 6: Seasonal index for the price of sugar in Machakos

As shown in Figure 7, the seasonal index curve of Nairobi was almost a straight line. There was no much variation in the seasonal index with a minimum of Ksh. 91.47 and a maximum of Ksh. 114.7 per kilogram in the months of February and December respectively. The little disparity in the seasonal index recorded in Nairobi was attributed to high infrastructural faciulities present in the city. Relatively good road network system, better communication services all trigger adequate access of information by consumers resulting to well informed buying of the commodities not only sugar but also other fast moving goods and services.

However, the seasonal price index of sugar was highest in Nairobi as opposed to all other markets. This was expected because of the high purchasing power of most residence of Nairobi. Furthermore, nearly all ministry headquarters are located in Nairobi thereby perpetuating high demand of sugar in the region. Disposable income of the workers in Nairobi is relatively and far much better than that of workers in Garissa. Conducive environment in Nairobi thus necessitated almost constant increase in seasonal index (Figure 7).

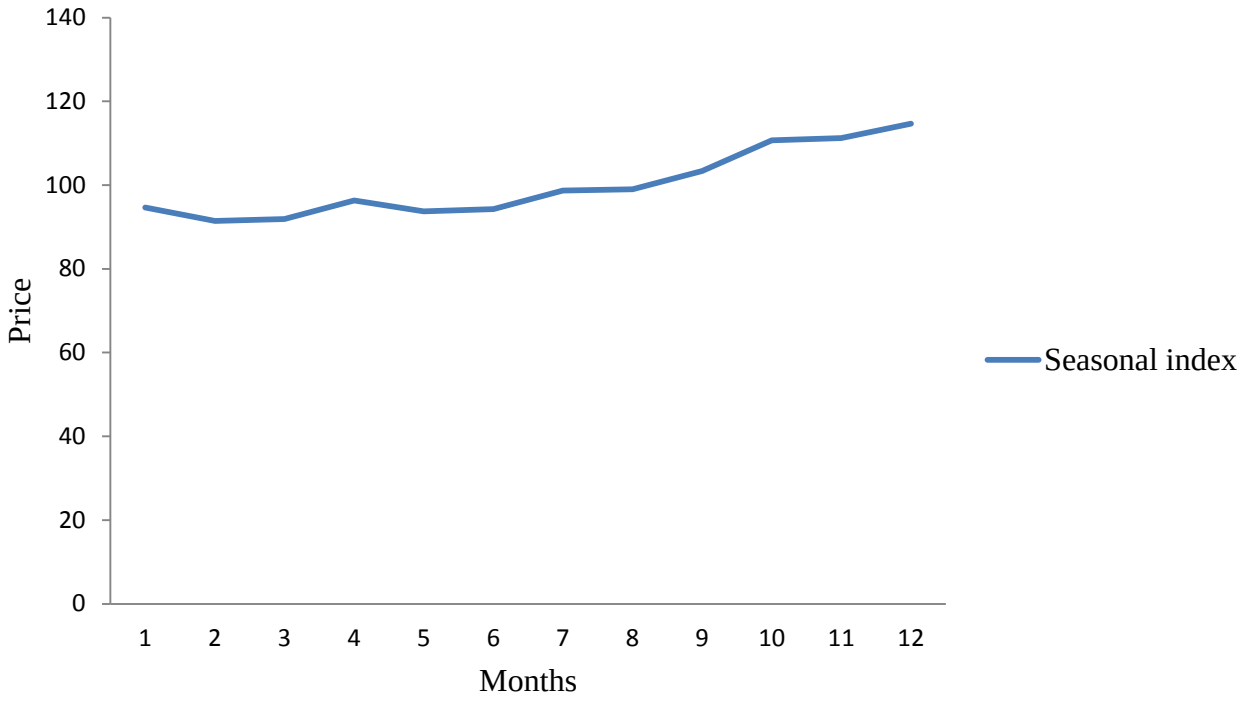

Figure 7: Seasonal index for the price of sugar in Nairobi

4.2 Establishment of the existence or non- existence of integration between the selected sugar markets

To establish the existence or non-existence of integration between the selected sugar markets, several stages were involved where the average monthly sugar prices in each market was subjected to stationarity test. The test is used to show whether prices are stable or unstable. To proceed, unit root test was carried out for all the sugar prices in various markets and the results are presented in Table 5.

Table 5: Unit root test for the price of sugar in Kisumu, Garissa, Machakos and Nairobi

Model		B	Std. Error	Beta	T	Sig.
Kisumu	(Constant)	5.821	3.818		1.250	0.300
	Laggedk	-0.061	0.045	-0.178	1.320	0.900
Garissa	(Constant)	6.535	4.407		1.483	0.144
	Laggedg	-0.054	0.041	-0.172	-1.318	0.193
Machakos	(Constant)	6.670	4.264		1.564	0.123
	Laggedm	0.065	0.046	-0.186	-1.431	0.158
Nairobi	(Constant)	9.391	5.064		1.854	0.069*
	Laggedn	0.096	0.054	0.228	1.767	0.083*

* Significant at 10%, ** significant at 5%, ***significant at 1%

The p-value for the coefficient of the price of sugar in Kisumu was insignificant at the 5% significance level (Table 5). The null hypothesis $Ho: \beta = \gamma = 0$ was therefore accepted. The price of sugar in Kisumu therefore had a unit root. This is interpreted to mean that the prices of sugar in Kisumu were not stationary and that the price of the previous period influenced the current prices of sugar.

The price of sugar in Garissa had a unit root and therefore, non-stationary. The coefficient of the lagged price of sugar was insignificant at 5% level. It means, therefore, that the price of sugar say at time t depended on the price of sugar at time t-1.

Since the null of a unit root was accepted, the average monthly prices of sugar in Machakos had unit root. The coefficient of the price of sugar in Machakos was insignificant at 5% level as shown in Table 5. The average price of sugar in Machakos for example, at time t was a function of the average price at time t-1. The coefficient of the price of sugar in Nairobi was insignificant at 5% level. The null hypothesis of a unit root was therefore accepted. The average prices of sugar in Nairobi were as a result non-stationary.

Stationarity test for all the four markets were all negative. Similar to results obtained by Korir *et al.* (2003), all the test statistics of the price series data were insignificant at 95% confidence level. This implied that the price series were not stationary (had unit roots). However, the Augmented Dickey Fuller (ADF) test statistics for the first differences of the price series data for all markets were significant at 95% confidence level. This showed that differencing the price series data once made it stationary, hence were said to be integrated of order one process, denoted as I (1). Having established that the series were I (1), the second stage in the cointegration test according to Engle and Granger (1987) was applied to determine the cointegration between different markets.

From Table 5, the average prices of sugar in all markets were autoregressive integrated of order one process. First difference of the prices was then obtained to establish the order of integration. The stability test for the first difference of the average monthly prices of sugar in all markets under the study is as presented in Table 6.

Table 6: Stationarity test for the first difference of the price of sugar in Kisumu.

		B	Std. Error	Beta	T	Sig.
Kisumu	(Constant)	0.448	0.966		0.464	0.644
	claggedk	-0.543	0.119	-0.521	-4.569	0.040**
Garissa	(Constant)	0.443	1.094		0.405	0.687
	claggedg	0.408	0.108	-0.452	-3.794	0.030**
Machakos	(Constant)	0.354	1.180		0.300	0.765
	claggedm	0.406	0.107	-0.451	3.776	0.036**
Nairobi	(Constant)	0.421	1.164		0.362	0.719
	claggedn	-0.682	0.127	0.584	5.388	0.046**

* Significant at 10%, ** significant at 5%, ***significant at 1%

From Table 6, the coefficient of the first difference of the average price of sugar in Kisumu was significant at 5% significance level. Therefore, the null hypothesis that $\beta = \gamma = 0$ was rejected since the difference was significantly different from zero. The first difference of the average prices of sugar in Kisumu was stable. The stability of the average prices of sugar in Kisumu at first differencing meant that the price series was autoregressive integrated of order one process. The first difference of the prices of sugar in Kisumu was therefore used to conduct consequent cointegration analysis since they were stable.

It was concluded that the first difference of the average price of sugar in Garissa were stable since the first difference of the lagged price was significant at 5% level (Table 6). The null hypothesis for the unit root was rejected. The constant was insignificant at 5% significance level indicating that neither the demand nor the price of sugar was zero in Garissa market.

The coefficient of the first difference of the lagged price of sugar in Machakos was significant at 5% significance level (Table 6). The null hypothesis for the unit root was then rejected for the first difference of the price of sugar in Machakos. The first difference of the average price of sugar in Machakos was, therefore, stationary. The constant was insignificant at 5% level indicating that price determination of sugar was not dependent on zero prices or zero demand level. The first differences of the prices of sugar in Nairobi were stationary. The coefficient of the first difference of the lagged prices of sugar in Nairobi was significant at 5% level (Table 6) leading to the rejection of the null for the unit root.

Stationarity test for the first difference of the price of sugar in all the four markets indicated that the first difference of the prices were stationary. The results were consistent with those obtained by Korir et al. (2003) where the first difference of the price of bean in Nairobi, Taveta, Arusha, and Moshi were found to be stationary at 5% significance level. It meant that the sugar prices in all markets were integrated of order one process. This showed that to attain the stability of the average prices of sugar in the four markets under the study, only first differencing was required.

4.2.1 Cointegration test for different markets

Having determined the order of integration, the price data was then subjected to the second stage test of cointegration. The markets were then paired to establish whether cointegration existed or not.

Table 7: Cointegration test between Kisumu and Nairobi

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	T	Sig.
	(Constant)	0.140	0.817		0.171	0.865
	laggedreskn	-0.175	0.076	-0.291	-2.299	0.025**

* Significant at 10%, ** significant at 5%, ***significant at 1%

Table 7 shows that the coefficient of the lagged residual of Kisumu with respect to Nairobi was significant at 5% significance level. Since the coefficient of the lagged residuals (laggedreskn) was significant at the 5% significance level, the null hypothesis of a unit root was rejected. It therefore meant that $\beta - \gamma \neq 0$. According to Engle and Granger (1987), the presence of cointegration between the two series is indicative of non-segmentation between the two series. Since the first step yielded non stationarity of the prices of sugar in both Kisumu and Nairobi and the second step resulted in the absence of the unit root in the residuals of regression between the prices of sugar in Kisumu and Nairobi, it was concluded that the two markets were cointegrated.

The constant for the Kisumu- Nairobi model was insignificant at 5% significance level. This indicated that the price of sugar did not reach the zero level. In economics, it is not very easy for the price of any commodity on sale to hit the zero level otherwise there will be no justification for the profit motive by the sellers.

Wei and Xiu (2006) observed that if two same order stationary time series are co integrated, then the causality of the two vectors should also be determined. If one of the two vectors changed then it is important to examine how long they take to return to long-term equilibrium in short-run. In order to appropriately model the full dynamic behavior of two co integrated vectors, there was need to incorporate short-run adjustment factors along with the cointegration equilibrium relationship. This was best done using the error-correction model (ECM) technique. The cointegration relationship represented the foundation of a complete dynamic error correction model. Based on the results obtained in Table 7, an Error Correction Model (ECM) was necessary to explain the relationship between the prices of sugar in Nairobi and Kisumu. It is vital to note at the onset that throughout the study, ECM was only generated

for the pair of markets that were cointegrated. Table 8 presents the Error Correction Model between Kisumu and Nairobi.

Table 8: Error Correction Model (ECM) of Kisumu and Nairobi.

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	T	Sig
	(Constant)	0.375	0.711		0.528	0.600
	changeinn	0.610	0.078	0.693	7.816	0.002**
	laggedreskn	-0.189	0.066	-0.254	2.863	0.006**

* Significant at 10%, ** significant at 5%, ***significant at 1%

From Table 8, the Error Correction Model of Kisumu and Nairobi can be written as;

$\Delta\widehat{K}_t = 0.375 + 0.610\Delta N_t - 0.189e_{t-1}$..... (31).

Where: $\Delta\widehat{K}_t$ is the first difference of the price of sugar in Kisumu at time t, ΔN_t is the first difference of the price of sugar in Nairobi at time t and e_{t-1} is the residuals lagged by one period. In the error correction model, the coefficient of the first difference of the price of sugar in Nairobi as well as the coefficient of lagged residuals of Kisumu with respect to Nairobi were both significant at 5% significance level. The price of sugar in Nairobi and the residuals of Kisumu were, therefore, applicable for price determination in the two markets. The error term was included as an extra variable in the analysis because of its significance. From equation 31, a percentage change in the price of sugar in Nairobi would yield a unit rise in the price of sugar in Kisumu.

Table 9: Cointegration test between Kisumu and Garissa sugar markets.

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	T	Sig
	(Constant)	0.070	0.680		0.104	0.918
	laggedreskg	-0.515	0.117	-0.504	-4.401	0.080*

* Significant at 10%, ** significant at 5%, ***significant at 1%

Table 9 shows the results for cointegration test between Kisumu and Garissa. The coefficient of lagged residuals (laggedreskg) was insignificant at 5% level. The t-value is also large and negative. The null of a unit root of the residuals was therefore accepted meaning the residuals were not stationary. Therefore, it was concluded that Kisumu and Garissa markets were segmented. The constant was insignificant at 5% level (Table 9) indicating that neither the price nor the demand reached the zero level in the two markets. Similar observations were made by Jayasuriya *et al*. (2007) that a number of grain markets in India were highly segmented due to various distortions including infrastructural development as well as the government policies.

Table 10: Cointegration test between Kisumu and Machakos

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	T	Sig
	(Constant)	0.122	0.549		0.223	0.825
	laggedreskm	-0.309	-0.097	-0.388	-3.176	0.002**

* Significant at 10%, ** significant at 5%, ***significant at 1%

The coefficient of the residuals of the price of sugar in Kisumu was significant (Table 10), and hence the null of a unit root was rejected. Kisumu and Machakos sugar markets were therefore cointegrated. Since Kisumu and Machakos markets were cointegrated, it was necessary to generate the model that could precisely explain the relationship in the two markets without distortions. An Error Correction Model was therefore generated and presented in Table 11. In the

Error Correction Model, the residuals of Kisumu with respect to Machakos were included in the analysis as it was necessary in determining the prices in Kisumu-Machakos model.

Table 11: Error Correction Model (ECM) for Kisumu and Machakos

	Coefficients	Standard Error	T	Sig
Intercept	0.312	0.468	0.665	0.508
changeinm	0.498	0.048	10.307	0.005**
laggedreskm	0.514	0.093	-5.517	0.009**

* Significant at 10%, ** significant at 5%, ***significant at 1%

From Table 11, the price of sugar in Machakos was found crucial in determining the prices of sugar in Kisumu. As shown, the coefficient of the first difference of the price of sugar in Machakos was significant at 5% significance level. Consequently, the residual was also significant at 5% significance level. The residual was therefore included as an extra explanatory variable in the model due to its significance. The constant was insignificant at 5% significance level indicating that the prices as well as the demand of sugar in the two markets (Kisumu and Machakos) did not in any occasion throughout the study hit the zero level. No zero average monthly price of sugar was recorded.

The ECM for Kisumu and Machakos was then specified as follows; $\Delta K_t = 0.312 + 0.498M_t + 0.514e_{t-1}$ ……. (32). Where ΔK_t and ΔM_t are the first difference of the price of sugar in Kisumu and Machakos respectively, whereas e_{t-1} is the lagged residuals. From equation 32, a unit rise of the price of sugar in Kisumu was explained by 0.498 percent rise in the price of sugar in Machakos.

Table 12: Cointegration test between Garissa and Nairobi

	Coefficients	Standard Error	T	Sig
Intercept	0.083	0.846	0.098	0.922
Laggedresng	-0.256	0.088	-2.907	0.005**

* Significant at 10%, ** significant at 5%, ***significant at 1%

Table 12 shows that, the null of a unit root was rejected for the residuals of the price of sugar in Garissa and Nairobi. That was because $\beta - \gamma$ was significantly different from zero. Due to stationarity of the residuals in the second stage of cointegration test, it was concluded that Nairobi and Garissa markets were cointegrated. The cointegration of Nairobi and Garissa was exceptional in the study. Garissa market was only found to be integrated to Nairobi. Since the cointegration was unidirectional, the integration can possibly be explained to have accrued from the transport of sugar from Nairobi to Garissa. Error Correction Model was therefore generated to fit the Nairobi-Garissa model. The specification of the ECM is as shown in equation 33.

Error Correction Model for Nairobi and Garissa

$$\Delta N_t = 0.85 + 0.57\Delta G_t + 0.25e_{t-1} \quad \text{..... (33).}$$

Where; ΔN_t , is the first difference of the price of sugar in Nairobi, $\Delta G_t$is the first difference of the price of sugar in Garissa and e_{t-1} is the lagged error term. The correct model for the price of sugar in Nairobi and Garissa was an error correction model due to cointegration of the two markets.

Table 13: Cointegration test between Nairobi and Machakos

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	T	Sig.
	(Constant)	0.103	0.702		0.147	0.884
	laggedresnm	-0.201	0.079	-0.32	2.548	0.014**

* Significant at 10%, ** significant at 5%, ***significant at 1%

The coefficient of the lagged residuals of Nairobi with respect to Machakos was significant at 5% level (Table 13). The null hypothesis for the unit root was rejected hence the error term was stationary. Similar to the observation made by Engle and Granger (1987) that when the first stage in cointegration yielded autoregressive autocorrelation of order one process, and the second stage resulted in stationary residuals then the two markets are cointegrated. Therefore, Nairobi and Machakos sugar markets were cointegrated.

Table 14: Error Correction Model between Nairobi and Machakos

		Unstandardized Coefficients		Standardized Coefficients		
Model		B	Std. Error	Beta	T	Sig.
	(Constant)	0.098	0.711		0.137	0.891
	changeinm	0.643	0.066	0.767	9.784	0.001**
	laggedresnm	-0.200	0.080	-0.196	-2.499	0.015**

* Significant at 10%, ** significant at 5%, ***significant at 1%

From Table 14, the ECM is therefore specified as: $\Delta N_t = 0.098 + 0.643\Delta M_t - 0.2e_{t-1}$ …… (34).

Where; $\Delta N_t$is the first difference of the price of sugar in Nairobi, ΔM_t is the first difference of the price of sugar in Machakos and e_t is the error term. The coefficient of the first difference of the price of sugar in Machakos was significant at 5% significance level. It was therefore paramount in determining the price of sugar in Nairobi. The significance of the one period lagged residuals of the price of sugar in Nairobi with respect to Machakos was also significant at 5% significance level. This led to the inclusion of the error term as an extra explanatory variable in the model. The constant for the ECM was insignificant indicating that zero price levels or demand levels were not realized in the two markets (Nairobi and Machakos). In the ECM presented in equation 34, it can be explained that a 0.643 percentage increase in the prices of sugar in Machakos triggered a percentage increase in the prices of sugar in Nairobi.

Table 15: Cointegration test between Garissa and Machakos

		Unstandardized Coefficients		Standardized Coefficients		
Model		B	Std. Error	Beta	T	Sig.
	(Constant)	5.755	3.849		1.495	0.140
	laggedrsegm	-0.054	0.041	-0.172	-1.318	0.193

* Significant at 10%, ** significant at 5%, ***significant at 1%

The coefficient of the lagged residuals of Garissa with respect to Machakos was insignificant at 5% level. The null of a unit root was therefore accepted for the residuals. Garissa and Machakos were therefore segmented as indicated in Table 15. ECM was not generated because the two markets were segmented.

Many studies concluded that market integration is heavily dependent on infrastructural development (Das and Bhattacharya (2004), Virmani and Mittal (2006) as well as several studies of internal agricultural market integration in the rest of the world including India have indicated considerable imperfections due to several distortions and government interventions. Even Jha *et al.* (2005) concluded that Indian agricultural markets remain highly segmented. Segmentation of Kisumu and Garissa therefore can be inferred to poor road network and communication systems. Possible explanation for the cointegration between Kisumu and Machakos could be largely associated with the relatively good road network joining the two markets. Good road network system facilitated the process of arbitrage thereby resulting to the cointegration of the two markets. Communication services such as mobile phones are also prevalent in the two regions and this could have orchestrated the process through which information regarding the product was submitted within the two markets. The insignificance of the constant barely elucidated the absence of zero price levels and demand levels within the two markets in question. Road network joining the two markets run from Kisumu through Nairobi to Machakos. The road network from Kisumu to Nairobi therefore could have acted as a positive externality for the connectivity of Kisumu and Machakos markets. The study therefore concluded that it was convenient for the middlemen to transport sugar from Kisumu to Machakos thereby explaining the cointegration of the two markets.

Cointegration test for all the markets showed that markets which enjoyed good infrastructural facilities were integrated whereas those markets connected by poor road networks were segmented. Similar observations were made by Mukim *et al*. (2009) that poor transport and communications infrastructure postulated the segmentation of various markets in the Indian wheat markets. Onyuma *et al*. (2006) also observed that inadequate infrastructure and poorly developed market information is a major contributor to market segmentation in Africa.

4.3 Establishment of the existence or non-existence of causality between the sugar markets identified.

After analyzing cointegration results, the study went further to establish the existence or non-existence of causality between the sugar markets identified. The results of the findings of the Granger-causality test are presented in Table 16 to 27. All the markets under the study were paired and the results presented in the respective tables. The significance of all the coefficients was examined at 5% significance level. Data used was obtained from the Kenya Sugar Board.

Table 16: Testing whether sugar prices in Nairobi Granger-Cause prices of sugar in Kisumu

		Unstandardized Coefficients		Standardized Coefficients		
Model		B	Std. Error	Beta	T	Sig.
	(Constant)	0.442	0.922		0.480	0.633
	claggedk	0.229	0.163	0.229	1.405	0.166
	claggedn	0.262	0.151	0.298	1.736	0.088*
	laggedreskn	-0.122	0.091	-0.164	1.336	0.187

* Significant at 10%, ** significant at 5%, ***significant at 1%

The coefficient of claggedn was insignificant at the 5% level (Table 16) meaning the null hypothesis $c_j = 0$ was accepted. The prices of sugar in Nairobi did not Granger cause the prices of sugar in Kisumu. Kisumu was the reference market in this study due to its location. As opposed to all other markets in the study, only Kisumu market had sufficient and nearest access to the sugar producing companies of which most of them are located in the western region of

Kenya. Therefore the results in Table 16 were justified since it was expected that the price of sugar in Kisumu Granger cause the prices of sugar in Nairobi. Since Nairobi and Kisumu markets were cointegrated, it can therefore be deduced from the study that the arbitrage was from Kisumu to Nairobi. Middlemen usually transport products for sale from the point of surplus to the point of deficit and the reverse hardly holds. It was therefore rational to conclude that the prices of sugar in Nairobi did not have any influence in determining the price of sugar in Kisumu.

Table 17: Testing whether sugar prices in Kisumu influence the prices of sugar in Nairobi.

	Coefficients	Standard Error	T	Sig
Intercept	0.282	1.054	0.268	.790
X Variable 1	0.030	0.169	0.181	.857
X Variable 2	0.448	0.188	2.385	.021**
X Variable 3	0.568	0.187	3.035	.044**

* Significant at 10%, ** significant at 5%, ***significant at 1%

Table 17 shows that the coefficient of the first difference of the price of sugar in Kisumu (variable 2) was significant at 5% level. This indicated that prices of sugar in Kisumu Granger caused the prices of sugar in Nairobi. The null hypothesis that $c_j = 0$ was rejected since it was significantly different from zero. The price of sugar in Kisumu was significant in determining the price of sugar in Nairobi.

The price of sugar in Nairobi did not Granger cause the price of sugar in Kisumu. However, in Table 17, the prices of sugar in Kisumu is shown to have Granger caused the prices of sugar in Nairobi. Therefore it was concluded that the causal relationship between Nairobi and Kisumu was unidirectional. The residual of the price of sugar in Kisumu (variable 3) was very paramount in determining the prices of sugar in Nairobi. The intercept in Table 17 was insignificant at 5% significance level indicating that the price of sugar was not equal to zero at any point during the analysis.

Traders who transported sugar to Nairobi from Kisumu factored in the price of sugar in Kisumu, the transport cost and all other transaction costs in determining the price for which they were to

sell sugar in Nairobi. Other transaction costs might have included the cost of communication, cost of negotiating the contract for the case of those who sell to companies and other clients in contractual terms among other costs. Efficient communication was expected between Kisumu and Nairobi market due to availability of communication networks including mobile phones and roads which facilitated mail delivery.

Table 18: Testing Causality between the prices of sugar in Kisumu and Garissa

		Unstandardized Coefficients		Standardized Coefficients		
Model		B	Std. Error	Beta	T	Sig.
	(Constant)	8.894	3.367		2.641	0.011**
	laggedk	0.260	0.155	0.261	1.675	0.099*
	laggedg	0.511	0.113	0.702	4.515	0.060*

* Significant at 10%, ** significant at 5%, ***significant at 1%

The coefficient of the lagged price of sugar in Garissa was insignificant at the 5% level (Table 18). This indicates that prices of sugar in Garissa did not Granger cause the price of sugar in Kisumu. The null that $c_j = 0$ was accepted for the coefficient of the price of sugar in Garissa. Traders in Kisumu did not factor in the prices of sugar in Garissa when setting the price of sugar in Kisumu. The results further show that the price of sugar in Kisumu was significant at 10% significance level in determining the prices of sugar in the same market.

Table 19: Testing whether sugar prices in Kisumu Granger cause the price of sugar in Garissa

	Coefficients	Standard Error	T	Sig
Intercept	20.893	5.311	3.933	0.0002***
X Variable 1	1.249	0.197	6.312	0.0004***
X Variable 2	-0.546	0.267	-2.042	0.0460**

* Significant at 10%, ** significant at 5%, ***significant at 1%

Table 19 shows that the coefficient of the price of sugar in Kisumu (variable 2) was significant at 5% level of significance. The null that $c_j = 0$ was rejected for the coefficient of sugar in Kisumu since it was significantly different from zero. The price of sugar in Kisumu, therefore, Granger -caused the price of sugar in Garissa. The causal relationship between Kisumu and Garissa model was unidirectional. The prices of sugar in Garissa did not Granger cause the prices of sugar in Kisumu whereas the prices of sugar in Kisumu Granger caused the prices of sugar in Garissa. Kisumu being the reference market and also the surplus market under this study, it had significant influence on all the prices of sugar in all markets under the study. Traders on all other markets factored in the prices of sugar in Kisumu in setting the consumer prices.

Table 20: Testing whether price of sugar in Machakos Granger caused the price of sugar in Kisumu

Changeink	Coef.	Std. Err	T	Sig
Claggedk	-0.336	.169	-1.995	0.052*
Claggedm	0.589	.151	3.894	0.000
laggedreskm	-0.403	.175	-2.313	0.025**
Constant	0.547	.700	0.782	0.438

* Significant at 10%, ** significant at 5%, ***significant at 1%

From the results in Table 20, the causal relationship between Kisumu and Machakos markets can be written as; $\widehat{\Delta K_t} = 0.547 - 0.336\Delta K_{t-1} + 0.589\Delta M_{t-1} - 0.403e_{t-1.} \ldots\ldots\ldots (35)$

Where $\widehat{\Delta K_t}$ is the first difference of the price of sugar in Kisumu (changeink**),** ΔK_{t-1} is the first difference of the lagged price of sugar in Kisumu (claggedk), ΔM_{t-1} is the first differences of the lagged price of sugar in Machakos (claggedm) and e_{t-1} is the residuals lagged by one period (laggedreskm). Granger causality in an error correction model was used to specify the model in equation (35) because the price series were cointegrated. The coefficient of the lagged price of sugar in Machakos was insignificant at 5% level. The null hypothesis that the coefficient of the price of sugar in Machakos was zero was accepted. The price of sugar in Machakos did not, therefore, Granger cause the price of sugar in Kisumu.

Table 21: Testing whether prices of sugar in Kisumu Granger caused the prices of sugar in Machakos

	Coefficients	Standard Error	T	Sig
Intercept	0.570	1.093	0.521	0.604
Claggedm	1.101	0.238	4.622	0.002***
Claggedk	0.786	0.266	-2.959	0.005***
laggedreskm	0.053	0.275	0.193	0.848

* Significant at 10%, ** significant at 5%, ***significant at 1%

The price of sugar in Kisumu Granger caused the price of sugar in Machakos because the coefficient of the lagged price of sugar in Kisumu was significant in the model (Table 21). The null hypothesis that the coefficient of sugar in Kisumu was zero was rejected. In Kisumu-Machakos causality model, the coefficient of the first difference of the lagged price of sugar in Machakos was very significant in determining the price of sugar in Machakos. This indicated that traders in Machakos always factored in the previous price of sugar in Machakos in their price determination models. Therefore, no trader was able to set his own price.

It can be deduced from Table 21 that the price of sugar in Kisumu was vital in setting the price of sugar in Machakos. The significance of the coefficient of the first difference of one period lagged price of sugar in Kisumu stood at 0.005. This was very high as it was significant at 1% significance level. The indication was that the price of sugar in Kisumu was significant at 1% significance level in determining the price of sugar in Machakos. It was noted that Kisumu and Machakos were cointegrated. The cointegration between these two markets confirmed that arbitrage occurred. However, the causal relationship was unidirectional whereby only the prices of Kisumu Granger caused the prices of sugar in Machakos.

Table 22: Causality test whether Garissa sugar prices Granger-caused Nairobi sugar prices

	Coefficients	Standard Error	T	Sig
Intercept	0.264	1.050	0.252	0.802
Claggedn	0.196	0.163	1.202	0.234
Claggedg	0.291	0.142	2.057	0.044**
laggedresng	0.289	0.117	-2.477	0.016**

* Significant at 10%, ** significant at 5%, ***significant at 1%

Table 22 shows that the coefficient of the first difference of the price of sugar in Garissa was significant at 5% level. Therefore, it was concluded that the price of sugar in Garissa Granger-caused the price of sugar in Nairobi. The lagged residual of Nairobi with respect to Garissa was also significant at 5% significance level. This was a further indication that the price of sugar in Garissa Granger caused the price of sugar in Nairobi.

The coefficient of the lagged price of sugar in Nairobi (variable 2) was insignificant at 5% as indicated in Table 23. Price of sugar in Nairobi did not Granger cause the price of sugar in Garissa. The coefficient of the price of sugar in Nairobi was not significantly different from zero.

Table 23: Testing whether the price of sugar in Nairobi Granger caused the price of sugar in Garissa

	Coefficients	Std. Error	T	Sig
Intercept	0.393	1.087	0.361	0.719
X Variable1	0.508	0.146	3.465	0.001***
X Variable 2	0.140	0.169	0.830	0.419
X Variable 3	0.003	0.120	0.031	0.974

* Significant at 10%, ** significant at 5%, ***significant at 1%

The average monthly retailing prices of sugar in Garissa were, therefore, independent from the average monthly retailing prices of sugar in Nairobi. The lagged price of sugar in Garissa was highly significant at 1% significance level. This showed that the prices of sugar in

Garissa were highly dependent on the average monthly prices of sugar in the same market. Therefore, it can be deduced that traders in Garissa market were very keen in establishing the price of sugar prevailing in different parts of the market before setting the final price of sugar. All other variables were insignificant in the Nairobi-Garissa model. The rationale was that only the prices of sugar in Garissa were used to set sugar prices in the same market.

Possible explanation could be that traders in Garissa did not bother to factor in the prices of sugar in Nairobi due to facility differences between the two markets. For example, Nairobi is endowed with better road networks within the county than Garissa. Communication networks offered by different service providers are also well advanced in Nairobi as opposed to Garissa. Furthermore, the purchasing power of Nairobi residence is high as compared to that of Garissa due to easy job accessibility. Population pressure in Nairobi also provides a conducive environment to business opportunities due to market availability.

The study also observed that price of sugar in Machakos Granger caused the price of sugar in Nairobi (Table 24). Since the coefficient of variable 2 (first difference of the lagged price of sugar in Machakos) was significant at 95% confidence level, the null hypothesis that $c_j = 0$ was rejected for Nairobi-Machakos model. Therefore, it meant that price determination models by various sugar dealers in Nairobi factored the prices of sugar in Machakos.

Table 24 : Testing whether Machakos prices Granger caused the prices of sugar in Nairobi

	Coefficients	Standard Error	T	Sig
Intercept	0.339	1.039	0.326	0.746
X Variable 1	-0.034	0.195	-0.173	0.863
X Variable 2	0.405	0.163	2.489	0.016**
X Variable 3	-0.244	0.123	-1.981	0.053*

* Significant at 10%, ** significant at 5%, ***significant at 1%

However, the coefficient of the lagged first difference of the price of sugar in Nairobi (variable 2) was insignificant at 5% level implying that the price of sugar in Nairobi did not Granger cause the price of sugar in Machakos (Table 25). This implies that the price of sugar in

Machakos did not depend on the price of sugar in Nairobi. According to KSB (2012), the consumption of sugar was higher in Nairobi as compared to Machakos. That was contrary to the law of demand and supply that states that the higher the price the lower the demand and vice versa. The prices of sugar in Nairobi were relatively higher than the prices of sugar in Machakos in absolute terms. However, consumers of sugar in Nairobi did not take into account the high prices of sugar in Nairobi and went ahead to consume more sugar as compared to consumers in Machakos. The demand behavior could be explained by the disposable income which is relatively high in Nairobi due to job accessibility than Machakos. The significance of variable 1 indicated that the causation relationship was from Machakos to Nairobi.

Table 25: Testing whether prices of sugar in Nairobi Granger cause the prices of sugar in Machakos

	Coefficients	Standard Error	T	Sig
Intercept	0.403	1.151	0.350	0.727
X Variable 1	0.821	0.180	4.553	0.002***
X Variable 2	0.345	0.216	-1.595	0.116
X Variable 3	0.010	0.136	-0.075	0.940

* Significant at 10%, ** significant at 5%, ***significant at 1%

The coefficient of the price of sugar in Machakos (variable 2) was significant at the 5% level hence the price of sugar in Machakos Granger caused the price of sugar in Garissa (Table 26). The causal relationship existed between the price of sugar in Machakos and Garissa. Traders of sugar in Garissa according to the study factored the price of sugar in Machakos in determining the average monthly price of sugar in Garissa.

Table 26: Testing whether prices of sugar in Machakos Granger cause the prices of sugar in Garissa

	Coefficients	Standard Error	T	Sig
Intercept	0.432	1.031	0.419	0.677
X Variable 1	0.082	0.230	0.356	0.723
X Variable 2	0.526	0.213	2.469	0.016**

* Significant at 10%, ** significant at 5%, ***significant at 1%

Table 27 indicates that the price of sugar in Garissa did not Granger cause the price of sugar in Machakos. Coefficient of variable 2 (the price of sugar in Garissa) was not significantly different from zero at the 95% confidence level. Furthermore, the null hypothesis that the coefficient of the price of sugar in Garissa was zero was accepted. The Granger causality results for all the paired markets indicated that there was no cyclic relationship between the monthly average prices of sugar in all markets. The observations made in the study were in consistent with observations made by Engle and Granger (1987), which showed that if two series are individually I (1), and cointegrated, a causal relationship will exist in at least one direction.

Table 27: Testing whether the price of sugar in Garissa Granger cause the price of sugar in Machakos

	Coefficients	Standard Error	T	Sig
Intercept	0.314	1.162	0.270	0.788
X Variable 1	0.383	0.240	1.596	0.116
X Variable 2	0.254	0.259	0.979	0.332

* Significant at 10%, ** significant at 5%, ***significant at 1%

CHAPTER FIVE
CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

After a thorough research was done on market integration of different sugar markets, the study concluded that market integration in the sugar sector is majorly influenced by infrastructural facilities such as road networks and communication channels. Other factors that yielded higher influence on market integration were purchasing power of the consumers in the different markets and geographical distance between the markets. It also came out from the study that different traders are cognizant of previous prevailing prices in the market whenever they are setting new prices. However, the price of sugar in the reference market (Kisumu) played a pivotal role in determining the price of sugar in all markets under the study.

The Granger causality results exhibited the importance of price determination in the presence of symmetric information. The markets in the study which enjoyed relatively sufficient information circulation almost Granger caused the prices of sugar in all other markets. For example, Nairobi market based on its exposure to information circulation acted as major price causation market throughout the study. It was noted that markets which were located further away from the surplus region exhibited higher average monthly prices of sugar as opposed to those located near the sugar belt region. The demand of sugar in Nairobi was relatively low from the year 2009 through 2011. This was the opposite of the expectation of the study. However, the explanation of the low demand of sugar in Nairobi was not only explained by higher average prices of sugar but also consumers' knowledge on side effects of sugar. The target market of sugar in Nairobi is composed of individuals and households who are well educated. Education informed most consumers in Nairobi thereby culminating to decreased demand in in the market.

The average prices of sugar in the four markets were all autoregressive autocorrelated of order one process. The prices, therefore, were made stationary after first differencing. This scenario explicitly showed that sugar traders were very concerned with the immediate prevailing previous sugar prices. However, the study observed that only the previous prices within the markets as opposed to across the markets were highly significant in market price determination. Cointegration results indicated that Garissa market was only integrated to Nairobi market. The

study concluded that the possibility of arbitrage between these two markets was as a result of economies of scale. Traders in Nairobi were deemed to be capable of transporting sugar to nearly all other markets under the study save Kisumu due to benefits that would accrue from economies of large scale. Significant contributor to arbitrage between the markets was pegged on the availability of disposable income of which Nairobi still takes the lead.

5.2 Recommendations

Infrastructural development was paramount in the study as it largely affected market integration nearly in all markets under the study. Poor infrastructure, namely transport and communication services, gives rise to large marketing price deviations because of the high costs of delivering products to destinations. They may also hinder the transmission of price signals because of non-competitive behaviour amongst traders. On the other hand, infrastructural development can play an important role in supporting the integration of sugar markets, facilitating competition, encouraging investment and allowing a more efficient allocation of resources and enhancing market oriented production. Therefore, the government of Kenya in conjunction with international development partners should magnanimously underscore the due importance of infrastructural development. This can be achieved by channeling appreciable amount of the national budget to the development of roads and communication networks in the country especially in the major markets.

In order to ameliorate market integration of not only sugar but also of other crucial products in the country, it is incredible that self-employment can be of invaluable effect to raising the consumers' purchasing power. The rise in purchasing power may simply mean increased disposable income that, in turn, aggravates purchase of commodities in question thereby motivating traders to transport goods to such markets. The future of sugar markets in Kenya, therefore, largely depends on both government interventions on infrastructural improvement or rather development and individualistic measures to increase disposable income hence accelerating commodity movements in the country.

The price differential in markets under the study postulates that there is need to effectively design communication network system in order to disseminate necessary information to sugar traders. This will increase efficiency and effectiveness in sugar market.

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ANNEX 1: COMPUTED AVERAGE MONTHLY PRICES OF SUGAR FOR THE YEAR 2008

	Re-computed average monthly prices of sugar in Ksh/Kg 2008			
	Kisumu	Garissa	Machakos	Nairobi
January	56.70	69.00	57.74	65.90
February	56.86	67.34	59.22	69.10
March	55.24	72.21	58.32	68.10
April	54.30	64.48	56.04	70.00
May	53.46	69.22	53.14	70.20
June	52.66	68.48	52.60	72.40
July	49.16	62.79	49.94	72.00
August	55.22	65.15	55.78	77.40
September	53.10	64.47	55.52	80.20
October	54.42	72.50	56.20	84.90
November	59.58	76.70	59.00	89.20
December	62.22	79.80	63.20	86.60

Source: Kenya Sugar Board Data, 2013

ANNEX 2: COMPUTED AVERAGE MONTHLY PRICES OF SUGAR FOR THE YEAR 2009

Re-computed average monthly prices of sugar in Ksh/Kg 2009				
	Kisumu	Garissa	Machakos	Nairobi
January	59.44	73.55	59.50	79.40
February	56.56	70.00	60.08	79.50
March	59.18	72.10	62.40	80.00
April	64.18	75.20	67.30	89.50
May	69.60	78.00	70.20	87.30
June	72.20	83.22	76.42	88.10
July	77.42	102.21	91.00	87.30
August	81.26	103.37	89.86	78.40
September	84.54	104.15	93.18	76.80
October	84.74	103.39	89.30	76.10
November	83.06	105.00	90.98	76.10
December	82.80	102.00	89.60	80.00

Source: Kenya Sugar Board Data, 2013

ANNEX 3: COMPUTED AVERAGE MONTHLY PRICES OF SUGAR FOR THE YEAR 2010

Re-computed average monthly prices of sugar in Ksh/Kg 2010				
	Kisumu	Garissa	Machakos	Nairobi
January	76.88	101.97	83.92	81.00
February	77.22	96.00	79.08	86.10
March	76.86	96.00	79.68	87.70
April	78.70	92.48	77.72	90.50
May	80.44	97.00	82.32	88.90
June	82.28	93.68	84.22	89.00
July	82.14	97.43	85.76	75.10
August	82.86	103.87	85.78	71.10
September	82.76	100.29	85.78	71.00
October	80.48	100.34	85.28	74.30
November	77.04	95.05	81.22	74.50
December	77.38	95.00	80.34	88.90

Source: Kenya Sugar Board Data, 2013

ANNEX 4: COMPUTED AVERAGE MONTHLY PRICES OF SUGAR FOR THE YEAR 2011

Re-computed average monthly prices of sugar in Ksh/Kg 2011				
	Kisumu	Garissa	Machakos	Nairobi
January	73.66	96.13	75.94	83.00
February	72.88	93.52	74.42	87.80
March	73.86	90.28	75.62	97.90
April	80.38	92.42	84.12	86.60
May	80.96	93.81	84.74	90.40
June	82.80	100.41	89.00	91.00
July	95.20	134.00	123.22	120.63
August	117.24	158.53	148.68	124.82
September	124.04	183.98	168.46	124.82
October	138.44	205.25	189.00	159.90
November	156.16	196.61	185.64	160.34
December	153.12	175.00	167.12	160.45

Source: Kenya Sugar Board Data, 2013

ANNEX 5: COMPUTED AVERAGE MONTHLY PRICES OF SUGAR FOR THE YEAR 2012

Re-computed average monthly prices of sugar in Ksh/Kg 2012				
	Kisumu	Garissa	Machakos	Nairobi
January	117.80	151.11	118.40	121.74
February	89.64	121.44	90.88	94.00
March	94.72	120.00	96.20	94.90
April	89.16	122.50	104.50	98.90
May	92.30	125.30	102.80	89.90
June	91.38	115.94	96.44	88.80
July	93.18	114.00	97.82	93.90
August	91.42	112.00	96.54	99.00
September	102.80	114.74	105.00	99.84
October	105.64	111.10	107.12	108.78
November	105.44	127.00	111.16	106.22
December	105.12	127.34	115.50	106.34

Source: Kenya Sugar Board Data, 2013