

**AN ANALYSIS OF THE EFFICIENCY OF RURAL FOOD
MARKETS IN THE EASTERN CENTRAL HIGHLANDS OF
KENYA**

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**A THESIS SUBMITTED IN FULFILMENT OF THE REQUIREMENTS FOR
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DECLARATION

I, Ngare Lucy Wangare declare that this thesis is my original work and has not been presented for the award of a degree in any other university or for any other award

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DEDICATION

To my dear sons: Bob and Sollow; your encouragement keeps me strong

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TABLE OF CONTENTS

DECLARATION	ii
DEDICATION	iii
ACKNOWLEDGEMENTS	iv
TABLE OF CONTENTS	v
LIST OF APPENDICES	ix
LIST OF TABLES	x
LIST OF FIGURES	xi
ABBREVIATIONS AND ACRONYMS	xii
ABSTRACT	xiii
CHAPTER 1	1
INTRODUCTION	1
1.1 Background to the Study Problem.....	1
1.2 The Status of Food Markets in Kenya.....	3
1.3 Research Problem.....	7
1.4 Purpose and Objectives of the Study.....	8
1.5 Hypotheses	9
1.6 Justification for the Study.....	9
1.7 Theoretical Framework	11

1.8 Organization of the Thesis	16
1.9 Chapter Summary.....	17
CHAPTER 2	18
LITERATURE REVIEW.....	18
2.1 Introduction	18
2.2 Market Efficiency.....	18
2.3 Review of Theoretical Approaches	19
2.3.1 Structure Conduct Performance Model	20
2.3.2 Market Integration	22
2.3.2.1 Correlation of Prices	23
2.3.2.2 Causality Testing and the Central Market Hypothesis	25
2.3.2.3 Cointegration Tests	28
2.3.2.4 Asymmetric Price Transmission.....	33
2.4 Review of Related Studies	35
2.5 Chapter Summary.....	41
CHAPTER 3	43
RESEARCH METHODOLOGY.....	43
3.1 Introduction	43
3.2 Description of the Study Area	43
3.3 Sampling Procedure	45

3.4 Data Collection Procedures	48
3.5 Data Analysis	48
3.6 Empirical Models	48
3.6.1 Correlation Analysis	50
3.6.2 Testing for Unit Roots	50
3.6.3 Granger Causality Test	52
3.6.4 Vector Error Correction Model.....	53
3.6.5 Asymmetric Price Transmission.....	55
3.6.6 Market Structure	57
3.6.7 Marketing Margins	59
3.7 Chapter Summary.....	60
CHAPTER 4	61
RESULTS AND DISCUSSION	61
4.1 Introduction	61
4.2 Description of Maize and Bean Prices	61
4.3 Description of Sampled Traders.....	62
4.4 Price Correlation.....	63
4.5 Causality.....	67
4.6 Market Integration.....	70
4.6.1 Unit Root Tests for the Maize and Beans Retail Price Series	71

4.6.2 Vector Error Model Estimation of Maize and Beans Retail Prices	74
4.7 Asymmetric Price Transmission	84
4.8 Market Structure and Performance.....	90
4.8.1 Traders Marketing Strategies.....	90
4.8.2 Trader Size Distribution.....	92
4.8.3 Market Concentration	93
4.8.4 Product Differentiation	95
4.8.5 Barriers to Entry in the Trade	95
4.8.6 Marketing Margins	98
4.9 Chapter Summary.....	100
CHAPTER 5	101
Summary of Findings, Conclusions and Recommendations.....	101
5.1 Introduction	101
5.2 Summary of Findings and Conclusions.....	101
5.3 Policy Implications and Recommendations	104
5.4 Contribution to Knowledge	106
5.5 Suggestions for Further Research.....	108
REFERENCES.....	110

LIST OF APPENDICES

Appendix 3.1: Trader Questionnaire.....	123
Appendix 4.1: Maize and Beans Price Trends	137
Appendix 4.2 Descriptive Statistics for Prices (1994-2009).....	139
Appendix 3.2: Questions for Key Focus Group Discussion	141

LIST OF TABLES

Table 3.1 Sample Size Selection for Traders	47
Table 4.1 Correlation of Maize Prices	64
Table 4.2. Correlation of Beans Prices.....	65
Table 4.3. Pair wise Granger Causality for Maize	67
Table 4.4. Pairwise Granger Causality for Beans	69
Table 4.5. Unit Root Test for Maize Price Series	72
Table 4.6 Unit Root Test for Beans Retail Price Series	73
Table 4.7 Cointegration Test Results for Maize	75
Table 4.8 Cointegration Test Results for Beans	76
Table 4.9 Siakago Response Model for Maize Retail Prices	78
Table 4.10 Ishiara Response Model for Beans Retail Prices	81
Table 4.11 Asymmetric Price Transmission in the Maize Market.....	85
Table 4.12 Asymmetric Price Transmission in the Beans Market.....	88
Table 4.13 Sale of Commodities by Trader Type	93
Table 4.14 Trader Concentration	94
Table 4.15 Marketing Margins for Maize and Beans	99
Table 4.2a Descriptive Statistics for Maize Price Series	139
Table 4.2b Descriptive Statistics for Beans Price Series	140

LIST OF FIGURES

Figure 1.1: Potential Price Interactions Between Two Markets	15
Figure 3.2: Map Showing the Study Area	44
Figure 4.1A: Trend in Maize Price Series for Mbeere.....	137
Figure 4.1B: Trend in Maize Price Series for Meru South	137
Figure 4.1C: Trend in Beans Price Series for Mbeere	138
Figure 4.1D: Trend in Beans Price Series for Meru South	138

ABBREVIATIONS AND ACRONYMS

ACTESA:	Alliance for Commodity Trade in Eastern and Southern Africa
ADF:	Augmented Dick-Fuller test
APT:	Asymmetric Price Transmission
COMESA:	Common Market for Eastern and Southern Africa
ECM:	Error Correction Model
GDP:	Gross Domestic Product
GoK:	Government of Kenya
HH:	Hirschman-Herfindahl test
OLS:	Ordinary Least Squares
PP:	Phillips-Peron test
SAP:	Structural Adjustment Programme
SCP:	Structure, Conduct and Performance
SSA:	Sub Saharan Africa
TAR:	Threshold Auto Regression

ABSTRACT

Agricultural markets offer opportunities for households to access incomes and food. Efficient food marketing systems assume a competitive structure thus enabling food distribution from surplus to deficit areas. Liberalization of agricultural markets in developing countries, Kenya included in the late 1980's and early 1990's aimed at achieving a market oriented economy. Earlier studies on agricultural market reforms have reported varied impacts on market efficiency, thus the need to analyze efficiency of rural markets in the eastern central highlands of Kenya so as to inform policy makers. This study analyzes the efficiency of maize and beans markets in the central highlands of Kenya by examining causality, market integration, asymmetric price transmission, structure and performance of the markets. The study used both primary and secondary data. Secondary data consisted of monthly retail prices for maize and beans for a period of fifteen years from nine markets. The results from time series price data analysis was used to determine whether price movements between the maize and beans markets exhibit integration which was used as an indicator of market efficiency. Primary data was from a survey of 252 traders in Mbeere and Tharaka-nithi sub counties who were selected using multistage sampling. These traders were interviewed using a semi-structured questionnaire in august 2009. Information from the survey was used to evaluate the activity of traders and unearth the factors that promote or inhibit efficiency of the markets. Data processing and analysis used the following techniques: Survey data was analysed using SPSS 16 while time series data was analysed using EvIEWS 7. The results from price analysis showed that there is a long run relationship between the markets in the study area. Causality between markets revealed that Siakago and Ishiara were the central markets for maize and beans respectively. The markets were cointegrated with stronger cointegration relationships observed between markets closer to each other and between markets located in different production potential areas. However, short run price adjustments were found to be very slow for all the markets, ranging between 8 and 39 months for maize and between 2 and 59 months for beans. There are asymmetries in price transmission, with markets far apart recording higher asymmetries. An analysis of the structure and performance of traders showed that the markets are efficient, as evidenced by the low trader concentration levels for retailers and medium concentration for the wholesalers. Although there was no collusive behavior among retailers, some wholesaler reported that they set prices collusively. The study concluded that although the markets are integrated, efficiency was still low. There was a clear indication of lack of improved market infrastructure, market information and credit facilities which may have contributed to low efficiency. A more organized market infrastructure and provision of market information may improve price transmission and encourage efficiency of the supply chain thereby raise rural income and food supply.

CHAPTER 1

INTRODUCTION

1.1 Background to the Study Problem

The performance of agricultural markets has long been recognized as a critical component in the development process by economists, planners and policy makers. Efficient markets allow farmers to allocate the resources in accordance with the comparative advantage of their production areas and to intensify production (Kimenyi, 2002; Hau and von Oppen, 2004). Thus an efficient marketing system is an important means of raising farmers' income and of promoting economic development of a country (Tamimi, 1999). In Kenya, efficient markets can play a great role in bridging consumption gap caused by structural deficiency in the production of major cereals and pulses. This is because efficient markets would enhance food distribution from surplus to deficit areas.

Food markets in Kenya have been completely liberalized as part of the Structural Adjustments Programmes (SAPs) that began in the early 1980's. Prior to this the government intervened in production, pricing and distribution. Market liberalization has led to the emergence of smallscale grain traders in response to increased market opportunities (Nyoro et al., 1999; Omamo and Mose, 2002). Liberalization and the associated transfer of distribution and marketing roles to the private sector, means that markets have grown in importance as key factors

influencing the success or failure of efforts to improve food production and consumption in Kenya.

Liberalization was expected to increase competition in the markets, and as a result, motivate more efficient use of resources and encourages innovation. Despite the economic and social importance of the food markets to the Kenyan economy, studies show that the impact of liberalization has been mixed, with some market participants gaining and others losing (Mukumbu, 1994; Ngugi, 1997; Karanja, 2002; Wambugu, 2005; de Groote et al., 2006; Mose, 2007; Nzuma, 2007). The key challenge is to move beyond market liberalization to the issue of how to design efficient markets to catalyze smallholder productivity and income growth (Jayne et al., 2002).

The concept of market efficiency derives from the idea of a perfectly competitive market. A perfectly competitive market is one which has a large number of buyers and sellers, perfect flow of information, homogeneous products, and no barriers to entry and exit of market participants (Handerson and Quandt, 1971). The perfectly competitive market is idealistic in the developing economies today. Attempts to attain competitive conditions are appropriate for increasing welfare and developing new ideas and knowledge (Bressler and King, 1970).

Market efficiency is categorised into operational efficiency and exchange efficiency components (Warrack, 2008). Operational efficiency is concerned with cost while exchange efficiency refers primarily to price. With respect to exchange efficiency, an efficient marketing system means that, consumer preferences are

transferred without distortion to producers who will use such price information to make production decisions which are allocatively efficient (Harris-White, 1995). Thus for a market to be efficient, prices must incorporate all available information in order to maximize welfare gains and further, the marketing system must not attract rent.

In the Kenyan rural food markets, maize and beans are mainly traded as grain. Traders in these markets perform specific set of functions, mainly exchange and facilitating functions. Open air markets play a fundamental role in economic growth, food availability and affordability in the local markets. There is however little knowledge about market efficiency in the eastern central highlands of Kenya. This has been compounded by lack of studies on food markets efficiency in the region. Studies on market efficiency in Kenya have largely explored the relationship between rural and urban markets. There is a gap of knowledge on the relationship between rural markets located in different production zones. This study employs the industrial organization and price theories to generate information that will be useful for policy making, to enhance food security and reduce poverty and food insecurity among the rural poor in Kenya.

1.2 The Status of Food Markets in Kenya

According to Wambugu et al. (2011), from the period after independence to the 1980's, Kenya's agricultural sector performed well and was an important driver of economic growth. However, the gains were not sustained thereafter and this was attributed to the negative impacts of the donor-instigated Structural Adjustment

Programmes (SAPS). Since then, Kenya's declining performance of the agricultural sector in terms of growth has been a major concern facing policy makers in Kenya.

Despite the declining performance, agriculture has continued to support the livelihoods of the majority of the population. Agricultural policy in Kenya therefore revolves around the main goals of increasing productivity and income growth. Thus, like in many other developing countries, there is emphasis on formulation of Poverty Eradication Strategy Papers (PESP) and development efforts with the ultimate goal of reducing poverty. The government of Kenya launched the Economic Recovery Strategy for Wealth and Employment Creation (ERSWEC) in April 2003, which identified agriculture as one of the key productive sectors of the Kenyan economy.

The majority of Kenyans are food insecure and one of the reasons is inadequate strategic reserves in major food commodities and poor distribution mechanisms (Alila and Atieno, 2006). The Strategy for Revitalizing Agriculture (SRA) (2004-2014) recognizes this and that to improve small holder farm productivity and increase farm households' incomes, it is important to transform Kenya's agriculture into a profitable, commercially oriented and internationally competitive economic activity.

Liberalization with a view to creating more efficient agricultural markets was a well intentioned policy. Although the reform programs did not have the desired effects especially in terms of increasing agricultural production (Nyoro and Jayne, 2001), studies on price integration have reported increased private sector participation (Omamo and Mose, 2002) and market integration (Ngugi, 1997; Wambugu, 2005).

This suggests a need to analyse agricultural markets to better understand the circumstances under which market liberalization is efficiency enhancing. Creation of an environment conducive to spatial and temporal market integration is gaining more importance in the modern world because the impact of open-market reforms has become more pronounced with the advent of the regional integration.

In Kenya, just like in most other Sub Saharan Africa (SSA) countries, food production is largely undertaken by subsistence producers. Governments have fundamentally transformed the food economies over the past two decades. Despite accumulation of empirical analyses showing that the reforms have generated impressive achievements, the conclusions have remained controversial and contested by policy makers. The major challenge facing policy makers is how to design marketing systems to better serve as a catalyst for farmer productivity growth particularly for smallholders.

Maize and beans are produced mainly for domestic consumption in Kenya and are among the staple food crops grown throughout the country. The use of markets has intensified over the last three decades as agriculture has become more market oriented. Maize is important in small holder farm income accounting for 26 percent of farm income in Kenya (COMESA ACTESA, 2010). In high agro ecological zones, maize accounts for as high as 70 percent of farm income. As urban population increases in Kenya, more and more consumers depend on agricultural markets for their daily food requirement. General population growth, increased per capita income and

improvement in infrastructure imply that the volume of food commodities traded in domestic agricultural markets will continue to increase tremendously.

Most of the Kenyan food marketing systems are mainly segmented into two channels; the formal and informal marketing systems (Jayne et al, 2007). The formal marketing channels link commercial farmers and international suppliers to large scale food trading, processing and retailing firms. This marketing system is often characterized by large trade volumes, well specified grades and standards, accessible market information and a legal system to accommodate more sophisticated contracting arrangements and facilitation of contract disputes. The informal marketing system on which most small-scale farmers rely are generally characterized by low percentages of production sold to the market resulting in relatively thin markets and high transaction costs per unit traded.

Trading in agricultural commodities is almost entirely in the spot market with little, if any, alternative institutional marketing arrangements like forward contracts and commodity exchanges (Nyoro and Jayne, 1999). Small holders often do not participate much in the staple food markets and for those who do so, have a very low market share (Jayne et al, 2005). According to Ellis (2005), the farmers in semi arid areas have even lower proportions of output marketed.

According to Jayne et al. (2005) agricultural production instability is a common feature in Kenya. The central highlands of Kenya depend mostly on rain fed agricultural production. This means that farmers plant and harvest at the same time

therefore a concern for policy makers about the ability of the marketing system to contain price instability. Sales of maize and beans begin almost immediately after harvest and are often stored and sales extended over a long period. Muturi et al. (2001) found out that sale of subsistence crops is mostly done at a time money is needed or immediately after harvest, thus farmers are generally unable to target their sales at the time prices are highest.

1.3 Research Problem

The long process of liberalization of agricultural markets was mainly aimed at reducing imposed market imperfections such as monopolistic public trade, entry barriers and subsidies. Market liberalization was therefore in favour of a more market oriented economy resulting in entry of private traders. The entry of private traders was expected to fill the void left by the withdrawal of the public sector by mobilizing resources necessary to fund marketing activities and also increase market efficiency to the benefit of the producers and consumers.

The reform experience in Kenya has varied widely, with clear progress in some areas and mixed results in others. In Kenya, empirical studies on agricultural markets reforms have reported varied impacts on production, competition and market integration. Policy makers and researchers have debated the reasons and impacts of successes and failures of the liberalization of food markets. With no recent studies done on these agriculture markets it is important to determine whether the results are

still valid, since efficient markets are the key to new opportunities generated by free trade and economic growth.

Studies on food market efficiency in Kenya have focused on how the regional markets are integrated. However, fewer attempts have been made in trying to analyse the performance of rural markets and examine how they are adjusting to price shocks in their neighbouring markets. Documented information on rural food markets in the eastern central highlands of Kenya is limited, thus the implication of entry by private sector into agricultural marketing after exit of monopolistic parastatal marketing boards is not well understood. To address this problem, the study seeks to find out whether the rural marketing system in the eastern central highlands of Kenya is efficient, that is, whether producers and consumers are benefitting from the gains expected from free trade.

1.4 Purpose and Objectives of the Study

The purpose of this study was to examine the efficiency of rural markets in the eastern central highlands of Kenya using Meru south and Mbeere sub counties as case studies.

The specific objectives of the study were;

1. To assess the direction of causality between the markets.
2. To assess the degree of spatial integration of maize and beans markets.
3. To evaluate the speed of price transmission between the markets.
4. To evaluate the structure and performance of the maize and beans markets in the central highlands of Kenya.

1.5 Hypotheses

In order to analyze market efficiency, the following hypotheses were tested:

1. There are no central markets in the eastern central highlands of Kenya
2. The markets in the eastern central highlands of Kenya are not integrated.
3. Price transmission between the markets is asymmetrical.
4. Markets in the eastern central Kenya highlands are not competitive.

1.6 Justification for the Study

The agricultural marketing policy in Kenya has been dominated by two major challenges. The first is to keep prices high enough to provide incentives for producers and secondly, keeping them low enough to ensure poor consumers' access to food. For this to occur well functioning markets are necessary. This study analyzes the efficiency of maize and beans markets in eastern central highlands of Kenya. Maize is the main staple commodity in Kenya (GoK, 2010) and therefore important for income and food security while the common bean is the most important pulse and second to maize as food crop (Katungi et al., 2010). The main cause of shortfalls in maize and beans production is due to a variety of biotic and abiotic factors. Lack of guarantee for markets for maize and beans has compounded the problem as farmers have no incentive to invest in productivity increasing practices.

The eastern central highlands of Kenya are characterized by diversity of climate, soils and agroecological zones. This allows farmers to engage in the production of a variety of food crops, industrial crops, cash crops, and livestock. It

also provides an opportunity for trade between markets in different zones. According to Goletti and Christina-Tsigas (1995), dissimilarities in production in different areas are among the main factors of market integration. This study therefore seeks to establish the ability of the markets to facilitate movement of food commodities from high production to low production areas. Documented information on rural food markets in the region is limited, thus the implication of entry by the private sector into agricultural marketing after the exit of monopolistic parastatal marketing boards is not well understood.

In low agro ecological potential and areas remote from major regional markets, smallholder agriculture is less likely to function as a driver of growth, yet it performs vital food security and welfare functions. Efforts by various stakeholders to development and implement various soil moisture and fertility improving interventions have enabled farmers in the study area to increase production of grain legumes and cereals. Analysing market efficiency can shed light on the ability of the market system to alleviate food shortages by stimulating transfer of foodstuffs between markets. A central question is the extent to which the rural environment in the eastern central highlands of Kenya is characterized by competitive markets. The answer has direct implications for the allocation of resources and for the design of appropriate economic policy. Kherallah et al. (2002) asserts that management of reformed market requires an understanding of the operation of local market, the strategies and responses of private traders, and how both relate to the changes in the institutional and policy environment of markets.

In Kenya where majority are employed in agriculture and where considerable budget shares are devoted to food expenditures, often leaves producers and consumers vulnerable to prevailing market conditions. Since market performance is influenced by past policy choices and private sector behavior, while in turn influence future market activities, studying market efficiency has relevant importance to the policy makers particularly at the county governments because it allows for the assessment of whether specific policies enhance the efficiency of local markets. A high degree of market efficiency implies that commodities easily flow from production to demand markets. In addition, prices are transmitted and therefore efficient resource allocation occurs and thereby avoiding distortions of production and marketing.

This study aims at contributing to the existing knowledge of efficiency of food marketing systems and providing policy recommendation on how to improve the efficiency of rural food markets, to catalyze smallholder productivity and income growth. Since the understanding of agricultural markets in developing countries is severely limited without direct monitoring of trading activities (Barett, 1996), this study will employ time series econometric methods of spatial price analysis and compliment with investigating the activities of traders in order to produce relevant policy recommendations.

1.7 Theoretical Framework

The analysis of agricultural markets has traditionally focused on the structure, conduct and performance (SCP) approach. The SCP emphasizes the concepts of

market competition and hence market efficiency. Following the SCP approach, the degree of market integration serves as a measure of efficiency, in which the degree of competition and the development of infrastructure are considered (Baulch, 1997). When markets are competitive, consumer preferences are transferred to producers who use the information to make production decisions that are allocatively efficient (Harris, 1979).

In a competitive market, market integration is the outcome of an exchange process between actors in different markets who aim to take advantage of price differences that exceed transaction costs. Market imperfections such as entry and exit barriers, insufficient market information and poor market infrastructure hinder the integration of markets (Asche et al., 2004; Ahmadi-Esfahani, 2006). Studies on transmission of price signals are grounded on concepts that relate to competitive pricing behavior and the law of one price (LOP). The LOP assumes that under perfect competition, the difference in prices between spatially separated markets cannot be greater than arbitrage cost (García-Enríquez et al., 2012). Assuming no obstacles to trade, Rashid (2002) stated that LOP implies price relationship between a market pair as;

$$p_t^i = z_t^{ij} + p_t^j + \mu_t \quad (1.1)$$

Where p_t^i and p_t^j are prices in two different markets, μ_t is an i.i.d error term.

z_t^{ij} is usually left out to account for transfer costs. LOP requires that $z_t^{ij} = 0$.

The classical paradigm of the LOP and the predictions on market intergration provided by the spatial price determination models postulate that price transmission is complete with equilibrium prices of a commodity sold on competitive markets differing only by transfer cost. Changes in supply and demand conditions in one market will affect trade and therefore prices in other markets and equilibrium is restored through spatial arbitrage. Thus trade occurs in spatially integrated markets if;

$$p_t^i + z_t^{ij} \leq p_t^j \quad (1.2)$$

Where p_t^i denotes the price of a good in market i in period t , p_t^j denotes the contemporaneous price of the good in market j in period t , and z_t^{ij} denotes the transfer costs between market i and j in the same period. If the spatial price differential is less than the transfer cost, spatial arbitrage condition is violated and the markets are not efficient but may be integrated to some extent if trade is occurring (García-Enríquez et al., 2012; Stephens et al., 2012). If markets are efficient, competition is expected to equalize the spatial price differentials and transfer costs. Violation of the spatial arbitrage condition is an indication of the existence of impediments to trade between markets and should be considered an evidence for the lack of perfect market integration (Baulch, 1997). Conditions that may lead to lack of integration include transportation bottlenecks, non-competitive pricing practices, government controls and price support activities and licensing requirements (Baulch, 1997). If spatial price differential is less than transaction costs and is given as:

$$p_t^i + z_t^{ij} > p_t^j \quad (1.3)$$

The spatial price differential is less than transaction cost and this represents autarky market condition where no profitable arbitrage opportunities exist between the two markets. The prices in the two markets are independent due to very high transaction costs and shocks are not transmitted across the markets. The absence of market integration arising from policies and transaction costs has important implications for economic welfare since it results in a reduction in price information available to market actors and consequently may lead to decisions that contribute to inefficient markets.

The LOP thus plays an important role in investigating market relationships since market integration is complete when it holds (Barrett, 2010). Figure 1.1 presents the LOP between two markets where prices are normalized at P . If there is a supply shock in market 1 that shifts supply curve to $S1'$, this causes the price to decrease while the quantity demanded increases. If the goods are perfect substitutes, the demand schedule in market 2 is shifted down to $D2'$. The fall in price is just enough to equilibrate prices in both markets at P' .

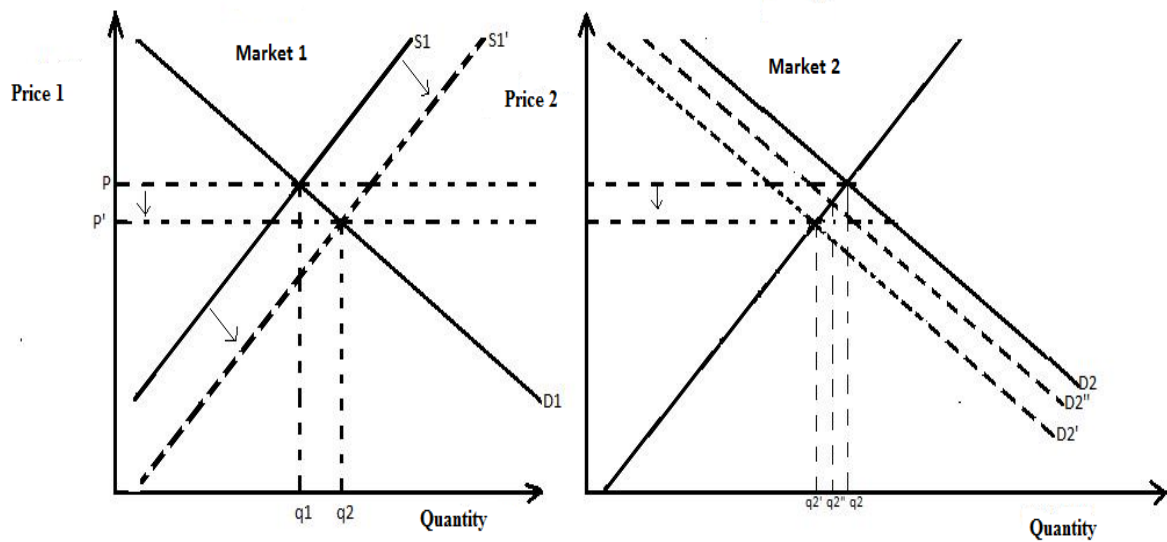


Figure 1.1: Potential Price Interactions Between Two Markets

Source: Adopted from Asche et al. (2004)

The impact of the influence of the shock in market 1 on market 2 occurs in a two ways: if there is no substitution effect, the demand schedule does not shift and there is no price movement in market 2. If there is a substitution effect the demand schedule in market 2 shifts down and the price in this market shifts in the same direction as the price in market 1. At most, the price in market 2 can shift by the same percentage as the price in market 1 thereby satisfying the LOP.

The market integration approach evaluates market efficiency by using prices and margins to test for pricing efficiency. The approach evaluates market efficiency by evaluating the degree of inter-market relatedness using price movements across markets. Prices summarize an enormous amount of information about the availability

of resources, production possibilities and consumer preferences (Goossens, 1995). Market integration is a good indicator of market efficiency in two ways. If high consumer prices are not transmitted to surplus regions, production may be lowered to own consumption levels, reducing marketed surplus. Secondly, market integration can shed light on the ability of the market system to alleviate food shortages by stimulating interregional transfers of foodstuffs.

1.8 Organization of the Thesis

The thesis consists of five chapters. The first chapter is an introduction to the study. The chapter provides a background to market efficiency and possible sources of inefficiencies. In general, the chapter introduces the problem under investigations, objectives that will guide the study and the theoretical framework.

Chapter two presents a review of the approaches used to analyze market efficiency. It gives the strengths and weaknesses of the various approaches, which provides a guide to the choice of the analytical model to be used. Chapter three further provides a detail of the analytical models used in the study. The chapter also describes the study area and discusses the sources of data and data collection methods.

The results from the analytical models are presented in chapter four. The findings are used to draw conclusions and outline recommendation for further research, which are presented in chapter five. The chapter also discusses the implications of the findings to policy and suggests the areas that need further research.

1.9 Chapter Summary

In this first chapter, an overview of food and agricultural markets is presented. The chapter further discusses the changes that have occurred in the food marketing systems in Kenya, while focusing on the nature of food markets in the central highlands of Kenya. The broad economic problem of market efficiency is introduced which is followed by a description of the research problem. The chapter offers the justification for focusing on maize and beans as the food crops for the study. Finally, the chapter provides the theoretical framework for analyzing market efficiency which is derived from the idea of perfectly competitive market and the LOP.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter reviews studies that have analyzed the efficiency of markets. The chapter starts by introducing the concept of market efficiency. This is followed by a description of the different measures of market efficiency, including their procedures, strengths and weaknesses. Finally, a description of past studies that have analyzed efficiency of agricultural markets is presented. The chapter concludes by evaluating the strengths and weaknesses of various approaches to market efficiency which is used to justify the choice of the approaches used.

2.2 Market Efficiency

An efficient commodity market is one that will establish prices that are interrelated spatially by transfer and transaction costs and inter temporally by storage costs (Bressler and King, 1970). According to Cramer and Jensen (1982) market efficiency is measured by the ratio of output to input with a high ratio indicating high efficiency. The output of a market is measured from consumer satisfaction with the goods and services while inputs are the various resources used by the marketing firms. Effective and efficient marketing systems induce the production of goods in quantities that result in maximum returns to consumers after deduction of marketing charges and production costs (Kohls and Uhl, 1985). Since consumer satisfaction cannot be

measured directly, marketing efficiency is determined by operational (technical) and exchange (pricing) efficiencies (Warrack, 2008).

Technical efficiency is concerned with the performance of physical marketing functions to achieve maximum output per unit of input. According to Warrack (2008), the physical marketing functions add form, place and time utility. Abbot and Makeham (1981) note that technological changes like new packaging methods can be evaluated to determine whether they reduce marketing costs per unit of output by preventing quality deterioration. Price efficiency is concerned with price transmission between producers and consumers to reflect product demand. Pricing efficiency aims at improving the operation of buying, selling and pricing aspects of the marketing process and is affected by marketing costs and the nature and degree of competition in an industry (Kohls and Uhl, 1985). Cramer and Jensen (1982) identify improvement of market news and information, and competition as important for enhancing pricing efficiency of a market.

2.3 Review of Theoretical Approaches

There are two main approaches of analyzing the efficiency of markets that have been applied in literature. The Structure-Conduct-Performance (SCP) model is used to establish whether the structure of the market tends to conform to the general criteria for competitiveness: Large number of market buyers and sellers, freedom of entry to establish a business in the market and access by suppliers to information on prices (Handerson and Quandt, 1971).

The market integration approach is used to determine whether price movements and price-cost relationships reflect a state of competitiveness in the market. Market integration therefore studies the degree of co movement of prices in spatially separated markets (Goodwin and Piggott, 1999). A high degree of market integration suggests that the markets are efficient. Spatial integration is therefore an aspect of market efficiency by shifting products from areas of surplus production and low prices to areas of scarcity and high prices. The analysis of market efficiency can take place at several points in the marketing channels.

2.3.1 Structure Conduct Performance Model

The SCP model is used for the analysis of market power-profitability relationship (Aleksandrova and Lubys, 2004). The model suggests that there exists a relationship between structural characteristics of a market and the behavior of the market participants and that their behavior in turn influences the performance of the markets (Scott, 1995). According to Scherer and Ross (1990), the SCP approach is classified into four categories of variables

- (i). Basic conditions are the external factors such as physical, legal, social and economic environment, and supply and demand characteristics which are exogenous to the market.
- (ii). Market structure consists of characteristics of the organization of a market which seem to influence strategically the nature of competition and pricing within the market.

- (iii). Market conduct is the pattern of behavior which enterprises follow in adapting to the markets in which they sell or buy
- (iv). Market performance represents the result of market structure and conduct that are relevant to the attainment of economic and social goals. The indicators are product quality, margins at different trading levels and price integration between markets.

The SCP approach postulates that as market structure deviates away from perfect competition, the extent of competitiveness of the market will decrease, which is likely to impede market efficiency (Scott, 1995; Onyuma et al., 2006).

The SCP model while emphasizing the concepts of market competition and efficiency has a number of limitations. The criteria of establishing the level of market efficiency based on the number of firms in a market is based on the neoclassical perfectly competitive market assumptions. The neoclassical paradigm embodies powerful assumptions about perfectly competitive and complete markets, absence of transaction costs and full availability of information to all market participants. These assumptions are hardly fulfilled especially in developing economies (Goossens, 1995).

The criterion that observed marketing margins should be consistent with costs tells very little on whether the marketing system is performing efficiently. According to Tecgüç (2013), if barriers to entry are sufficiently low, the threat of entry can force existing monopolies/oligopolies to behave as if they were operating in a competitive market, thus it is not enough to measure market efficiency on the basis of share of

larger firms. The assessment of market performance based on costs and margins also fail to incorporate the long run dynamic issues of how incentives can be structured within the rules of economic exchange so as to reduce the costs at the various production and marketing stages (Jayne, 1997).

Establishing whether competition exists based on the number of firms in the market is also a limitation especially in the presence of scale economies. The high costs of transportation between a market in a high production region and a market in a demand region may result in very low producer prices in the remote production region which in turn depress the marketable surplus. According to Nyoro et al. (1999), the existence of small surpluses limits the number of traders that can profitably operate in such an area, particularly in the presence of scale economies in marketing activities. Tecgüç (2013) adds that sometimes the benefits of oligopolies outweigh their potential costs when they deliver lower prices to consumers because they enjoy economies of scale. Therefore, high market concentration would not necessarily point to lack of competition or artificial barriers to entry, nor would a large number of traders each handling very small volumes indicate that the market is efficient.

2.3.2 Market Integration

The concept of market integration, defined on the basis of the econometric concept of cointegration is used to describe the extent to which demand and supply shocks arising in one market are transmitted to other markets (McNew and Fackler, 1997). Market integration thus refers to the extent to which events in one market have

an impact on events in another market. It is concerned with the free flow of goods and information and thus price (Barett, 1996) which are related to the concept of market efficiency. The concept of market integration is multidimensional; implying similarities in price variations, standardization of measures and common trade habits (Wyeth, 1992). This section considers various measures of integration which are derived from price time series data. Simple bivariate correlation, correlation of price differences and cointegration coefficients capture the price co movement aspect of market integration. Causality and symmetric price transmission capture the direction and speed of price transmission respectively.

2.3.2.1 Correlation of Prices

In the sixties and seventies, the methodological work on the measurement of pricing efficiency in agricultural commodity markets adopted bivariate correlation coefficients of price series data (Jones 1972; Lele, 1972). Correlation of price series at different markets is related to the idea that integrated markets exhibit prices that move together. The magnitude and significance of the correlation coefficients have been used to indicate the level of market integration. Due to its simplicity, correlation analysis remains the most common approach to measuring market integration (Goletti et al., 1995). Asche et al. (2012) further explains that bivariate approaches indicate that the markets belong to a larger market area which can be used for multivariate system analysis.

Studies based on the use of bivariate correlation have been challenged, the most prominent concern being that parallel movements in prices can occur for several reasons other than the integration of markets. For example, they can occur because of the common exogenous trend (e.g. inflation), common periodicity (e.g. seasonality) or autocorrelation and heteroscedastic residuals in the regression with non-stationary price data (Basu, 2006). Price correlation assumes instantaneous price adjustment and cannot capture the dynamic nature of a price adjustment (Ravallion, 1986) and thereby overestimate segmentation in case of natural lags in the price response between the markets. In addition, price correlation treats a pair of markets at a time and cannot be used for evaluating the market system as a whole (Delgado, 1986). Despite the limitations, correlation coefficients continue to be used as a measure of market integration.

In the mid-eighties, attempts were made to improve upon the price correlation method. The most significant contribution to market integration method came from Ravallion (1986) who proposed a dynamic model of spatial price differentials to test for short versus long-run integration. The model involves correlating price in one region with lagged own prices and contemporaneous and lagged prices in another market. In this model, the price series for each market is permitted to have its own autoregressive structure and a dynamic relationship with market prices in the other market. Price differences help to interpret market integration as interdependence of price changes. In addition, differencing removes trends and quite often induces stationarity in an otherwise non-stationary series hence solves problems of spurious

correlations (Harriss, 1979). Correlation of price differences is therefore a superior technique to correlation of price levels.

Although this method mitigates the major methodological limitations of the simple bivariate correlation method, it still involves serious problems that result in inefficient estimators. The model has been criticized for not addressing the issues of transaction costs and non-stationarity of price data, which according to Fackler (1996) can cause problems in drawing inferences from estimated parameters. Conclusions on general market performance are made on the pricing efficiency while the impact of market structure and behavior, and the impact of basic conditions on the general market performance are neglected. González-Rivera and Helfand (2001) assert that it is pertinent to inquire what the necessary conditions are to increase the degree of integration.

2.3.2.2 Causality Testing and the Central Market Hypothesis

Cointegration implies Granger causality in at least one direction. Granger causality implies that there exists a relation between the current value of one value and the past values of others (Granger, 1986). Granger causality is a useful approach in determining whether price movements follow well defined paths, that is, start around a demand or production centre and then spread around the other markets.

The central market hypothesis borrows from the concept of causality, which means contributing to predictability (Golleti and Babu, 1994) or simply precedence (Madalla, 2005). Causality testing means that if A and B are observed as time series,

it's possible to establish whether A precedes B, or B precedes A, or they are contemporaneous (Madalla, 2005). Thus if past prices of one market A can be used to forecast the prices in another market B, then market A prices are said to cause market B prices. Causality could be unidirectional where A causes B (or vice versa) without the reverse being true, it could be bidirectional where A causes B and the reverse is true or there could be independence where no series granger causes the other (Gujarati and Sangeetha, 2007).

If market A prices cause prices of several other markets, then market A can be interpreted to be a central market. Ravallion (1987) defines a central market as a central area that dominates price formation. Thus a central market is one whose past prices can be used to forecast prices in other markets. Prices in the dominant market are not exogenous to those in the peripheral market. Thus there is a central market if prices in that market Granger cause prices in other markets in a unidirectional way. The presence of central markets would invariably mean that there is radial transmission of prices and price changes.

Several tests have been developed and used to test for causality among economic time series including Granger causality test and Sims' test (Madalla, 2005). The Granger causality test assumes that the past is key to the present. Considering two series, Y_t and X_t , the series X_t fails to Granger cause Y_t if a regression of Y_t on lagged X 's and lagged Y 's, the coefficients of the latter are zero (Madalla, 2005). The Sim's test assumes that the future cannot cause the present, so that regressing Y on lagged,

current and lead values of X , if X is to cause Y , then the sum of coefficients of the lead X terms must be statistically equal to zero (Gujarati and Sangeetha, 2007). The Sim's test assumes that X_t fails to cause Y_t in the Granger sense if in a regression of Y_t on lagged, current, and future X 's, the latter coefficients are zero (Maddala, 2005).

Ravallion's (1986) method assumes a radial spatial market structure between a group of local markets and a single central (urban) market, and price formation in the local markets is mainly influenced by trade with the central market. This method allows for autocorrelation, distinct short run and long-run dynamics and common inflationary and seasonal components between local and central markets. However, this method has its weakness: The assumption of radial market structure does not always hold due to inter-seasonal flow reversals and direct trade links between regional markets (Barett, 1996). The method assumes constant inter-market transfer costs that are either additive or proportional, and if transfer costs are more complex or time varying, inference is biased against market integration (Barett, 1996).

The error correction representation has been used for testing the direction of causality between cointegrated series (Alexander & Wyeth, 1994). The link between cointegration and error correction is that two cointegrated series can be represented using an error correction mechanism – the short term disequilibrium in one period is corrected in the next period. Cointegration implies that the system follows an error correction representation and conversely, an error correction system has cointegrated variables (Engle and Granger, 1991). The error correction mechanisms are more

stringent as compared to Granger and Sim's test, because they include use of longer lags to capture the dynamics of short-run adjustment towards long-run equilibrium.

2.3.2.3 Cointegration Tests

Most of the empirical work based on time series data assumes that the underlying time series is stationary (Gujarati, 2007). A time series is stationary if its mean and variance do not vary systematically over time. On the contrary, many economic time series are non stationary or have a unit root (Engle and Granger, 1987). A data series is said to be non stationary when it violates the stationary requirement so its mean and variance are non constant over time. According to Granger and Newbold (1974) since integrated series have a tendency to wander, a regression of one on the other will yield significant results even if the series are independent. Ordinary Least Squares (OLS) regressions on non stationary series produce spurious results, and t and f statistics that cannot be relied on for inference.

Cointegration techniques not only provide measures of market integration, they also overcome the problem of non-stationarity among economic time series data. Economic variables such as prices, interest rates and income may drift from their equilibrium levels when stochastic shocks enter the system. Such shocks could arise from policy reforms or structural changes occurring within the market (Hendry and Juselius, 1999). These patterns of divergence are a short run phenomenon, because the economic forces will bring the series back to equilibrium whenever they depart from it.

Tests of cointegration reconcile the presence of unit root in individual series by testing the stationarity of their linear combinations (Granger and Newbold, 1974). Thus cointegration allows the verification of the presence of a long run equilibrium relationship between non stationary series. The idea behind cointegration analysis is that economic variables, even if they drift apart in the short-run, in the long run move together because of common economic forces such as the market mechanism and the government intervention (Engle and Granger, 1987).

To test for cointegration, Engle and Granger (1987) proposed that one would first need to estimate cointegration between price series by OLS and then analyze the residuals from the regression. If the series are cointegrated, then OLS is a consistent estimator of the cointegration parameter, and the residuals should not contain a unit root, i.e. it should be stationary. The problem with the Engle and Granger approach is its inability to incorporate more than one cointegrating relationships (Delgado, 1986; Myers, 1994). Also prices can simultaneously influence one another leading to an endogeneity problem in the Engle and Granger framework (Stock and Watson, 2003).

Johansen (1988) solved the problem of inability to account for more than one cointegrating relationships by extending the cointegration analysis into a multivariate format. Johansen's multivariate cointegration analysis draws inference about the strength of integration among markets. The basic idea came from an earlier study by Stock and Watson (1987), who demonstrated that if a set of n economic variables is integrated with exactly $n-1$ cointegrating vectors, then these variables must share a

unique common trend. This implies that for a set of geographically separated markets to be integrated, the corresponding price series must have a common trend. Godwin (1992) suggests that a system of n spatial prices should have at least one cointegrating vector and the number of cointegrating relationships should indicate the strength of market integration. Therefore a fully integrated market requires exactly $n-1$ cointegrating vectors and any number less than $n-1$ would imply weak integration (Stock and Watson, 1987).

Gonzalez and Helfand (2001) supported Johansen's method of analysis and proposed a three step method. The first step involves identifying the set of markets that are cointegrated using Johansen's (1988) method; the second step involves estimation of cointegration coefficients; and the third step involves estimating persistence profile adopted from Pesaran and Shin (1996) to analyse how each market responds to price shocks resulting from changes in demand and supply conditions of the other markets. The final part measures the amount of time it takes for a market to move back to equilibrium if disturbed by changes in the underlying demand and supply conditions.

Engle-Granger's two step model of cointegration is an adaptation of Ravallion's radial spatial market integration model in a cointegration framework. Following Ravallion, an *a priori* assumption is made regarding a central market. Pairwise cointegration tests are carried out using Engle and Granger (1987) two-step cointegration method. Price series are first tested for the order of integration. If all the

series are found to be of the same order, a long run relationship between the central market and the peripheral markets is estimated using OLS regression. The test for cointegration is carried out as a test of unit root on the saved residuals. If residuals are found to be stationary, price series are considered cointegrated. A reduced form dynamic equation with error corrections terms is then estimated to analyze the causal relationships among prices. The major weakness of this methodology is that it can only be applied to market pairs only other than consider a multivariate system.

Delgado's (1986) variance decomposition approach tests market integration for the marketing system as a whole instead of a pairwise test of market integration. This method disaggregates analysis by season and controls for heteroskedasticity present in the price series before testing for market integration. It implicitly assumes constant transport and transaction costs for any two markets within a system for a given season. The spatial integration between pairs of markets for a given season is indicated by the equality between the spatial price spread and the constant transport and transaction costs during that season, subject to random noise. Although the method was an improvement upon the earlier cointegration methods, Barrett (1996) noted that the approach is based on a test of contemporaneous price relationships and does not allow for dynamic relationships.

Several studies have used Parity Bound Models (PBM) which rely on exogenous transaction cost data to estimate market integration (Fafchamps and Gavian, 1996; Negassa et al., 2003; Negassa and Myers, 2007). This maximum

likelihood based estimator addresses discontinuity or reversal in trade flows resulting from an underlying seasonal shift in demand and supply conditions, but it depends on very restrictive assumptions about transaction costs. The PBM estimates the probability of being in spatial price regimes that are consistent with the equilibrium notion that all spatial arbitrage opportunities are being exploited. Transfer costs are included explicitly in the notion of spatial equilibrium underlying the PBM and if transfer costs are unavailable the PBM requires an assumption about the way transfer costs evolve over time. In the event of unavailability of time series data, transaction costs are estimated either by maximizing a likelihood function or from cross section data and, in both cases, a critical assumption is that the transaction costs remain constant for the sampled period of time.

The PBM has been criticized on many grounds, notably from Fackler (1996) who provided three major critiques: First, there is no link between economic theory and the distributional assumptions used in the switching regime models. Second, the model handles only a limited number of markets. Third, the result may be misleading because the approach considers short-run deviations from equilibrium as inefficiency whereas it may actually represent traders' responses to lags in information and commodity flows. Barrett (1996) further acknowledges that transaction costs are difficult to measure due to some unobservable components such as sunk costs, risk premia and variable returns to scale. Underestimation of transaction costs will bias PBM results away from finding market segmentation attributable to excessive transaction costs. Brümmer, von Cramon-Taubadel and Zorya (2009) suggest Markov-

Switching VECM as an alternative approach if the transition variable cannot be measured reliably and/or if the theoretical underpinning of the variable is weak.

Threshold auto-regression (TAR) method developed by Balke and Fomby (1997) and Enders and Granger (1998) attempted to address transaction costs and price asymmetry across spatially separated markets. Conceptually, threshold models are related to more conventional regime switching models, such as the PBMs, which can distinguish autarky, arbitrage failure and efficient arbitrage among markets. In the threshold models, regime switch is triggered when a forcing variable crosses a predefined threshold between a pair of markets. Enders and Granger (1998) showed that in addition to transaction costs, TAR models can also analyze asymmetries in price adjustment. Although this is an important improvement to earlier methods, these models have to rely on very restrictive assumptions of constant mean transaction costs over a certain period of time. According to Barrett (1996) transaction costs may not be constant in the long run and may even be non-stationary. In addition, the usefulness of the model is limited to longer time series. However, unavailability of time series data on transaction costs is a serious constraint in market cointegration analysis.

2.3.2.4 Asymmetric Price Transmission

It is commonly asserted that traders use market power to employ pricing strategies which result in complete and rapid transmission of cost increases but slower and less complete transmission of cost savings (Kinnucan and Forker, 1987). It is sometimes alleged that only price increases are transmitted to consumers, whereas

traders are the main beneficiaries of price decreases. If the market system were efficient, then the price increases should be transmitted to the same extent as price decreases (Goletti and Christina-Tsigas, 1995). According to Kinnucan and Forker (1987) asymmetric price transmission (APT) exists because of normal inertia in the food marketing system associated with storing, transporting and processing the farm product; costliness of repricing items at retail; market imperfections such as diversity in market structure and differences in information transmissions and assimilation at different exchange points; the nature of price reporting and collection methods.

The literature on asymmetric price responses has mainly focused on vertical integration, specifically on the relation between farm, wholesale and retail prices (Kinnucan and Forker, 1987). In this study, the ideas of this literature are applied to study horizontal market integration. Cointegration analysis methods are germane to the study of APT because many prices series tend to be non-stationary and, hence, are susceptible to spurious regression. According Meyer and Cramon-Taubadel (1994), the case of cointegration between non-stationary series P_{it} and P_{jt} , an error correction model (ECM), extended by the incorporation of asymmetric adjustment terms provides an appropriate specification for testing APT.

APT is related to the efficiency of the market system because it shows how much time is needed for price changes to be transmitted from one market to another. This is important to policy makers, governments and international organizations planning for food distribution and price stabilization. According to Tecgüç (2013),

oligopolistic traders often manipulate prices leading to higher profits at the expense of others in the value chain. Thus it is important to study price transmission between markets in order to investigate their competitiveness. The major weakness of APT model is that it only detects APT but does not identify the causes (Tecgüç, 2013). Furthermore, symmetric price adjustments may indicate the flexibility of pricing mechanism and not necessarily imply a well functioning marketing system (Goletti and Christina-Tsigas, 1995).

2.4 Review of Related Studies

Maize and beans are the most important agricultural enterprises in Kenya owing to their economic importance as widely grown crops, main staple and source of income for the majority of small scale producers in Kenya. Several research studies have investigated policy implications occasioned by public sector reforms or biophysical and socioeconomic constraints to increased production and incomes. This section reviews empirical studies that have analysed efficiency of agricultural markets.

Korir et al. (2007) carried out a study to gauge the efficiency of beans marketing system by assessing the degree of market integration between regional markets in Kenya and Tanzania. Pearson's bivariate correlation coefficients and Johansen's cointegration techniques were used to analyse the extent of market integration. An analysis of wholesale bean prices revealed that bean markets in the study area were integrated. While the results shed light on the nature of beans markets, the study failed to explain the weak cointegration between the markets since other

factors may have caused it. The study also failed to specifically analyse the speed and direction of price adjustment between the markets which are important in analyzing the strength of cointegration. The present study will, in addition to price transmission, investigate the structure and performance of the markets in order to understand factors that may be causing market inefficiency.

Onyuma et al. (2006) used market integration to analyse market efficiency. Data on marketing activities and prices for fresh pineapples were collected for 39 weeks in 5 producing markets and 3 consumption markets in Kenya. Variance and covariance measures were adapted from Ravallion (1986) to measure market integration. The model assumed an autoregressive distributed lag relationship between commodity prices in the local market and those in the reference market. The types and levels of market integration were determined by significance of the regression coefficients and the index of market concentration. The results showed high integration between consumption markets, low integration between producing and consuming markets and weak or no integration between the rural producing markets. The major determinant of pineapple market integration was information flow between producing and consuming markets. This study has similarities with the present study in that it analysed both price movements as well as the factors that may have caused them. However, the integration model used in the study failed to capture the long run price relationships between the markets which will be applied in the present study.

Basu (2006) examined market integration with the help of cointegration test on the prices of potato of Hooghly District in West Bengal. The analysis was made at two levels, wholesale and retail markets. Market integration was then tested using Johansen and Juselius (1990) cointegration analysis. The procedure for testing cointegration was based on the Error Correction Model (ECM) representation. The number of cointegrating vectors was tested by the trace statistic and maximum eigen value statistic which is an important indicator of the extent of co-movement of the prices. The author concluded that potato markets at wholesale and retail are integrated. However, the authors failed to analyse the long run and short run price adjustments. Since the adjustments are important in determining the extent of market integration, this study will consider the analysis of adjustment parameters which are an important indicator of market efficiency.

Yu et al. (2006) studied the long run interdependence between major edible oil prices and examined the dynamic relationship between vegetable and crude oil prices. Data consisting of 378 weekly observations was collected for major tradable oils prices, including soybean, sunflower, rapeseed and palm oils, along with one weighted average world crude oil prices. To explore the dynamic interdependence among edible and crude oil markets, a multivariate time-series model was employed. In addition, a geographical modeling analysis, directed acyclic graphs were adopted to determine the contemporaneous relationships among the markets. The results suggested a long run cointegration among the five oil prices. The edible oil markets were found to be well linked in contemporaneous time with palm oil market initiating the new information.

Although the study analysed both integration and causal relationships among the prices, the authors only considered price relationships. Since market relationships are influenced by other factors such as the structure of the markets, the present study will also consider the structure and conduct of market participants to further explain the causal relationships.

In Ghana, Ihle et al. (2009) carried out a study to assess spatial price transmission between domestic tomato markets to ascertain whether spatial price transmission veritably depends on direct trade between markets or whether other forces drive market integration. A regime dependent vector ECM was used for analyzing the major tomato markets in Ghana and to study their adjustment behavior to deviations from long-run equilibrium for periods with and without trade. The results showed evidence of market integration in the absence of trade flows suggesting that physical trade may not be the only mechanism playing a crucial role in market integration. The findings were similar to a study by Stephens et al. (2012) who found that inter market price adjustments for tomatoes in Zimbabwe occurred both in trade and non-trade periods. Although the results from the study pointed to presence of other factors that might have caused the observed integration, the study did not attempt to identify the factors that actually integrated the markets. The present study will therefore consider the activities of traders which are believed to influence price movements between the markets.

Abdulai (2000) examined price linkages between principal maize markets in Ghana. The study employed threshold cointegration models developed by Enders and Granger (1998) to examine the relationship between wholesale prices of maize in three principal maize markets in Ghana. The main objective was to determine whether the price transmission between the central market and two local markets were symmetric or asymmetric. The findings indicated that major maize markets in Ghana were well integrated. The wholesale maize prices were found to respond more swiftly to increases than decreases in central market prices. The study had a number of weaknesses; the author had to analyze two markets at a time, assume constant transfer costs between the markets and a radial price transmission model. The present study will employ a multivariate approach to analyse the markets as a system. Given the unavailability of transaction cost data, the study will analyse price data and augment it with data on trader activities to evaluate market efficiency.

Weitzel and Bayaner (2007) in a study to analyse spatial price transmission among 28 Turkish provinces applied a bivariate threshold vector error correction model (TVECM). To estimate the restricted bivariate TVECM, a three step procedure was applied. First the time series were tested for stationarity using the ADF unit-root test. Once non-stationarity was confirmed, each possible price pair was tested for cointegration applying the Johansen's (1988) method. The use of ECT from the linear estimate generated by Johansen method and to apply a search procedure only over the threshold parameter. The results indicated that the wheat markets are integrated; the degree of market integration decreases in the outer provinces of Turkey. While the

methodology captured both integration and asymmetric price transmission, the showing of threshold in price transmission between most of the cointegrated provinces shows that the authors should have considered investigating market structure.

Van Campenhout (2007) used weekly maize price data on seven geographically separated markets in Tanzania to estimate the changes over time in transaction cost and the speed of adjustment between the markets. The study applied a TAR model extended to allow for a time trend in both the threshold and adjustment parameter. The study concluded that transaction costs are markedly higher between the reference market (Iringa) and the markets to its east. For all the market pairs, the transaction costs had decreased over time. While the study provided policy recommendations to improve speed of price adjustment, the analysis was bivariate in nature, yet markets are known to form part of a much broader market system. A multivariate approach would have been more appropriate, which will be applied in the current study.

Ngugi (1997) used weekly retail prices of maize in 13 markets to analyse the implications of liberalization for market efficiency in Kenya. The correlation of price differences and the cointegration techniques were used to measure market integration. An ECM was used to measure causality among markets and to examine occurrence of central markets. The results showed that there were more integrated markets in the post- than in the pre-liberalization period. There was increased unidirectional causality in the post-liberalization period. The author concluded that market liberalization had

increased market efficiency. The study however failed to quantify the structural factors that may affect the efficiency of maize markets in Kenya. The study applied bivariate analysis whereas trade can flow from one market to another via a third market thus a multivariate approach would have been more suitable.

2.5 Chapter Summary

This chapter reviewed studies that have addressed the issue of market efficiency. The chapter also discussed the various methods that have been applied to analyze market efficiency. The reviewed studies provide an overview of practical application of different methods used in analysis of market efficiency. The methods have widely been used to analyze efficiency of agricultural markets in many countries. They are linked to economic theory and the studies were able to provide important policy recommendations for improving the working of food markets.

From the reviewed studies, spatial price behavior in food markets is an important indicator of overall market efficiency. However, since a similarity in price movements among markets may be the result of arbitrage or of collusion among traders (Lutz et al., 1995), a price analysis needs to be supported by an analysis of both market structure and conduct. Goossens, (1995) asserts that markets may be more or less efficient in particular areas, times, commodities, functions and scale of operation. It is therefore important to combine various types of data analyses, to establish the sources of apparent inefficiencies. This study focused on analyzing efficiency by applying the concept of price co integration. To interpret the results of price

integration analysis correctly, studies at actor and market level were used to analyse the existing state of competition, information flow and the state of infrastructure which are believed to influence market efficiency.

This study will investigate market efficiency by first applying correlation analysis to indicate level of price comovement between the markets. This study recognizes the weaknesses of correlation coefficient approach and therefore analysed long run and short run price relationships by applying cointegration methods. Johansens cointegration which is a multivariate cointegration approach will enable the analysis of the efficiency of the markets as a system by looking at the strength of market connectedness and also derive both long term and short term price adjustments. An ECM will then be applied to determine the speed and direction of price transmission between the markets. Finally, an analysis of structure and conduct of the market will be used to explain the nature of competition and policy recommendations will be derived based on analysis of trader activities affecting efficiency. The next chapter specifies the empirical models used in estimating market efficiency.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 Introduction

This chapter presents the procedure used to collect data from the field. The chapter first describes the study area. This is followed by theoretical modeling of pricing efficiency. The chapter then presents the research methods that were used in the study, the sources of data and sampling techniques. Finally the chapter specifies the empirical models used to analyze the primary and secondary data.

3.2 Description of the Study Area

The central highlands of Kenya which comprises counties in central and eastern regions are very diverse in terms of agro ecological zones, soils, potential for agricultural production and farming systems. This study focused on Tharaka-nithi County, representative of the densely populated high-potential area, and Embu County representative of the low-potential area; similar agro ecological diversity also exists within individual counties. The two districts will represent the whole of the central highlands of Kenya and the highlands of East Africa.

The diversity in climate and soils provides opportunities for agricultural production and trade. Maize and beans are among the main staple food crops grown for subsistence and sale. Muturi et al. (2001) found that although farmers have

multiple outlets for their farm produce, selling at farm gate and selling in local markets predominate in the region. Numerous retail traders and small wholesalers operate in local and regional markets. Wholesalers are also involved in spatial arbitrage between markets at an interregional level. The state does not intervene as an active buyer or seller of cereals in the region.

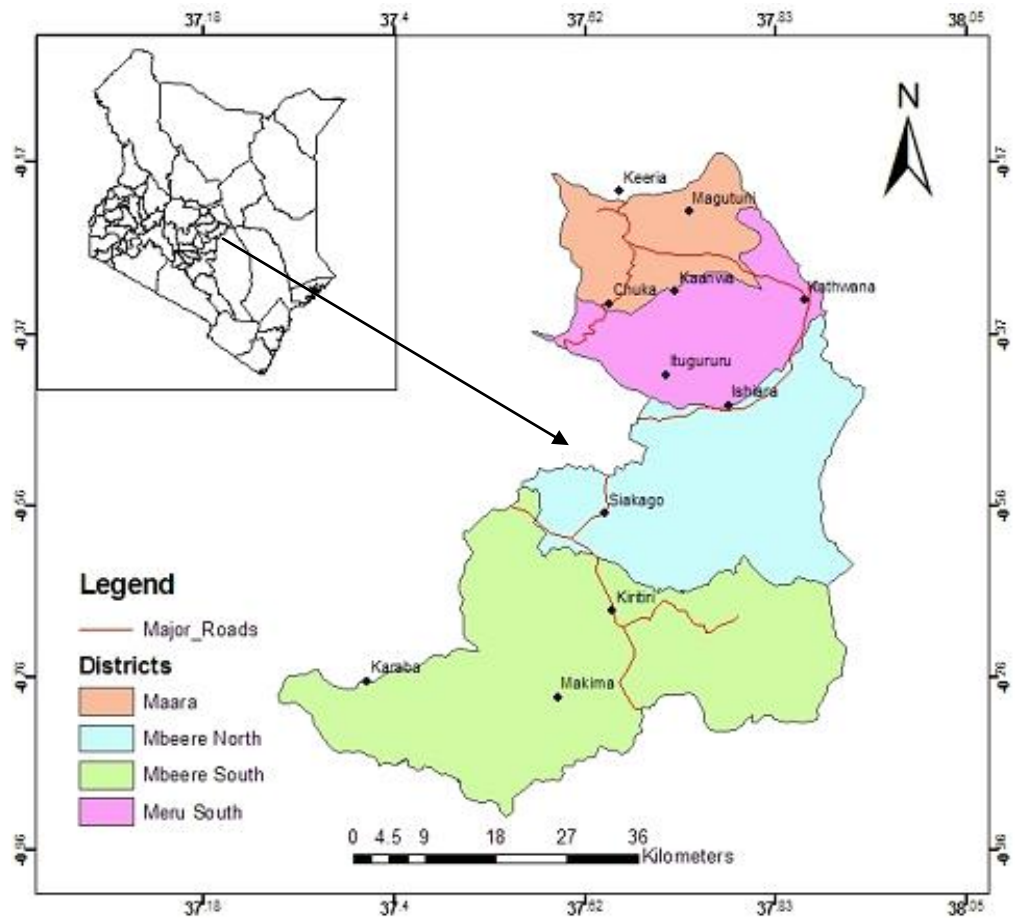


Figure 3.2: Map Showing the Study Area

Source: Field survey, 2009

A focus group discussion (FGD) was carried out in the study area in the year 2009 (Appendix 3.2) to get a general view of agricultural production and marketing as well as concretize ideas before actual data collection. Two broad types of food markets were identified: formal and informal. Formal markets have a definite location and are regulated by local government authorities. The informal markets have no official form of organization or authorities. Most of the formal markets are centralized whereby agricultural produce is delivered to the market where individual consumers, retailers, wholesalers and middlemen buy the produce. On the other hand, informal markets are decentralized and wholesalers, retailers, middlemen and individuals buy directly from farms or at small selling points within the production area, thus the farmer is both the producer and marketer of his produce. This study will focus on the formal markets.

3.3 Sampling Procedure

Multistage random sampling was applied to select a sample of traders. The study area selected were Embu and Tharaka-nithi counties in the eastern central highlands of Kenya. Two sub counties were selected by stratifying the selected counties by agro ecological zones. One sub county was selected from high potential zone (Meru south) and one from a low potential zone (Mbeere). Meru South sub-county lies between the Upper Midland Zone two (UM2) and Upper Midland Zone three (UM3) agro ecological zones, on the eastern slopes of Mt. Kenya at an altitude of 1,500 m above sea level with an annual mean temperature of 20⁰C and a total annual rainfall of 1,200–1,400 mm (Jaetzold et al., 2007). Mbeere sub-county lies in

the Lower Midland between Agro-ecological Zones 4 and 5 on the eastern slopes of Mount Kenya at an altitude of between 700 to 1200 m above sea level (Jaetzold et al., 2007) with the mean annual temperature ranging from 20.7 to 22.5°C.

From the selected sub counties, ten markets were used for primary and secondary data collection namely Kiritiri, Karaba, Makima, Ishiara, Siakago, Chuka, Magutuni, Kaanwa, Kathwana, Itugururu. The other markets in the in the selected sub-counties were excluded from the survey when a reconnaissance survey showed that they were not under the control of the local government authorities, which would have made it hard to compile time series price data.

The target population used for primary data collection consisted of maize and beans traders. The desired sample size was selected using equation 3.1 (Kothari, 2004):

$$n = \frac{Z^2 pqN}{e^2(N-1) + Z^2 pq} \quad (3.1)$$

Where:

n=desired sample

Z=1.96 the value of the standard variate at 95% confidence interval under normal curve

P= sample proportion, assuming a conservative sample

$$q=1-p=0.5$$

e = 9% acceptable margin of error

N= the estimated population comprising the number of maize and beans traders from the selected markets in the 2 counties

Systematic random sampling was used to select 252 maize and beans traders in the ten selected markets. The actual sample distribution is indicated in table 3.1.

Table 3.1 Sample Size Selection for Traders

Market	Sample size
Chuka	32
Ishiara	32
Kiritiri	32
Siakago	24
Kathwana	24
Itugururu	24
Kaanwa	24
Karaba	20
Makima	20
Magutuni	20
Total sample	252

Source: Field survey (2009)

3.4 Data Collection Procedures

The study made use of primary and secondary data collected between August and December 2009. Secondary data on monthly retail prices of maize and beans was compiled from the respective sub counties' ministry of agriculture annual reports and statistical abstracts from the Kenya National Bureau of Statistics for the ten¹ selected markets in Mbeere and Meru south subcounties to compile a time series for the period from January 1994 to December 2009. Price data was used to analyse market cointegration, causality and asymmetric price transmission. In addition, primary data on marketing was collected from traders in the 10 selected markets in Meru South and Mbeere sub counties using a semi structured questionnaire (Appendix 3.1). The information was used to analyse the structure and performance of the markets.

3.5 Data Analysis

Data analysis was carried out using SPSS16 to generate output for market structure and performance. Eviews7 was used for time series analysis on price data.

3.6 Empirical Models

A cointegration model was used to study long run relationships among price series, to pursue the objective of market efficiency and to test the hypothesis that the markets are integrated. In order to study the interdependence of prices between market

¹ Itugururu market was later dropped because of missing data points in time series data

pairs, Goodwin and Schroeder (1991) suggest that the relationship can be expressed by a linear relation:

$$P_{i,t} = \alpha_0 + \alpha_1 P_{j,t} + \mu_t \quad (3.2)$$

Where $P_{i,t}$ denotes the retail commodity price at time t and market i , $P_{j,t}$ denotes the commodity price at time t and market j , α_0 , α_1 , are parameters to be estimated and μ_t is the error term. Commodity prices are usually non-stationary. However, this does not pose a problem as the error term μ_t is stationary for this implies that price changes in a market i do not drift far apart in the long run from another market j , or are cointegrated.

The concept of cointegration may be presented as follows: If a series X_t is non stationary but its first difference is stationary, then it is said to be integrated of order one or simply integrated and could be represented as $X_t \sim I(1)$. Otherwise if X_t is stationary it is said to be integrated of order zero and denoted as $X_t \sim I(0)$. If two time series X_t and Y_t are both $I(1)$ then in most cases the linear combination $Y_t - \alpha - \beta X_t = \epsilon_t$ is also $I(1)$. But, it is possible that ϵ_t is stationary, or $I(0)$. This will happen if the ‘trends’ in X_t and Y_t cancel out when $\epsilon_t = Y_t - \alpha - \beta X_t$ is formed. If and only if this is the case then X_t and Y_t are said to be cointegrated with β as the cointegrating parameter/coefficient.

In general a pair of series X_t and Y_t are said to be cointegrated if they are individually $I(d)$ (where d is the order of integration), but there exists a linear combination of them, $\epsilon_t = Y_t - \alpha - \beta X_t$, that is $I(0)$ (Engle and Granger, 1991). The task of

cointegration analysis is therefore two fold. The first part is to find out if each of a pair of time series is stationary and if either or both are not stationary, to difference the series until stationarity is achieved. Secondly, if and only if the two series have the same order of integration, to regress one on the other and find out if they are cointegrated.

3.6.1 Correlation Analysis

The coefficients of bivariate correlation of prices in spatially separated markets provide the classical tool for measuring market integration. Correlation coefficients range between +1.00 and -1.00. The higher the coefficient the higher the degree of integration. A correlation coefficient of 1.00 could imply perfect market integration resulting from perfectly competitive markets (Harriss, 1979), unless *a priori* knowledge provides reasons for suspecting a monopolists dominance and/or manipulation of the market. A negative coefficient indicating a negative linear relationship between markets would imply some degree of segmentation and the absence of market integration.

3.6.2 Testing for Unit Roots

Cointegration approach requires that the economic variables be non stationary. The unit root test separates and tests for order of economic integration i.e. the number of times the series needs to be differenced before transforming it into a stationary series. The finding of a unit root in time series data indicates non-stationarity. The Augmented Dick-Fuller (ADF) and Phillips Perron (PP) tests were used to test for unit

roots. The ADF test is a parametric test (predetermined parameters) and it has low power, whereas the PP test statistic is based on a non-parametric modification of the Dickey-Fuller tests (Basu, 2006; Pesaran and Pesaran, 2009). Hence, more importance is given to the PP than ADF test. According to Dickey and Fuller (1979), the test is based on the statistics obtained from applying the Ordinary Least Squares (OLS) method to following regression equation:

$$\Delta P_t = \delta + \phi_1 \Delta P_{t-1} + \phi_2 \Delta P_{t-2} + \dots + \phi_m \Delta P_{t-m} + \vartheta_t \quad (3.3)$$

Where ϑ for $t=1, \dots, n$ is assumed to be Gaussian white noise, Δ is the difference operator; m is the number of lags; and δ 's and ϕ 's are parameters to be estimated. The null hypothesis is that cointegration coefficient, $\delta_1=0$, that is, there is a unit root in P_t (P_t is non-stationary) (Dickey and Fuller, 1979; Fuller, 1976). If the unit-root null is rejected for the first difference of the series but cannot be rejected for the level, then we say that the series contains one unit root and is integrated of order one, $I(1)$.

The number of lagged terms m is chosen to ensure the errors are uncorrelated. Several selection statistics are available including sequential likelihood ratio tests and the information criteria such as Akaike Information Criteria (AIC), Hannan and Quinn Information Criteria (HQIC) and Schwarz Information Criteria (SIC). According to Ivanov and Kilian (2005), the likelihood ratio tests underperform the information criteria. The performance of the information criteria mostly depends on the frequency

and size of the data. For monthly data, as sample size increases, the AIC tends to dominate both HQIC and SIC. Thus AIC was used for the study.

3.6.3 Granger Causality Test

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

$$\Delta P_{it} = \alpha + \beta_1 \Delta P_{it-1} + \beta_2 \Delta P_{it-2} + \dots + \beta_{m_i} \Delta P_{it-m_i} + \gamma_1 P_{jt-1} + \gamma_2 P_{jt-2} + \dots + \gamma_{n_j} P_{jt-n_j} + \mu_t \quad (3.4)$$

Where Δ is the difference operator; m_i and n_j are the number of lags; the β 's, δ and γ are parameters to be estimated and μ_t is the error term. The error correction mechanism is provided by the sum of the third and fourth terms with their joint coefficient representing the error correction term (Engle and Granger, 1991). The length of the lags is chosen using AIC. Following Goletti and Babu (1994), the null hypothesis of causality from market j to market i can be tested as follows:

$$H_0: \gamma_1 = \gamma_2 = \dots = \gamma_{n_j} = 0$$

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

The Ravallion model assumes that there is one central market that dominates other markets. However, According to Ahmadi-Esfahani (2006), in many developing

countries, there are several markets that are interlinked and bypass the central market. Thus the model will be applied for each pair of markets, rather than estimate one model for all the markets where only one market is identified as a central market.

Estimating equation 3.2 has a simultaneity problem and cointegration tests can give conflicting results due to direction of causality (Asche et al., 2012). Since economic theory does not give indications about the direction of relationship, Asche et al. (2012) adds that this problem can only disappear if one market is exogenous which is considered to be a central market. Thus the central market will be identified before carrying out cointegration analysis.

3.6.4 Vector Error Correction Model

If the series to be investigated are integrated of the same order, the next stage is to investigate whether they are cointegrated with each other and this can be done either through the Engle and Granger (E-G) (1987) two step procedure or the Johansen's (1988) maximum likelihood procedure. In the E-G approach, a linear regression using OLS is estimated and the residuals tested for stationarity. However this approach is limited only to single equation estimation due to its bivariate nature. Additionally, E-G approach does not reveal information about the long run component of the system, therefore not possible to conduct hypothesis tests on the unknown parameters of the cointegrating space.

This study uses the Johansen's (1988) multivariate approach, based on the Maximum Likelihood Estimation (MLE) of the error correction model. The Johansen

cointegration test is based on a Vector auto-regression (VAR) system. Generally, VAR models are tools for analysing a set of interrelated variables. Given a price vector P_t it is carried out using the following representation:

$$P_t = \sum_{i=1}^n \Gamma_i P_{t-i} + \mu + \varepsilon_t \quad (3.5)$$

Where P is a $M \times 1$ vector of series at time t , Γ_i a $M \times M$ matrix of coefficients relating series changes at lagged i period to current changes in series, μ is a $M \times 1$ vector of constants, and ε_t is a $M \times 1$ vector of independent identically distributed (i.i.d) errors. The system of equations represented in (3.5) can be written in error correction form developed by Johansen (1988) and Johansen and Juselius (1990) as:

$$\Delta P_t = \sum_{i=1}^{p-1} \Gamma_i \Delta P_{t-i} + \Pi P_{t-1} + \mu + \varepsilon_t \quad (3.6)$$

Where P denotes the vector of endogenous variables, Γ_i the matrix of short run coefficients and Π the matrix of long run coefficients, ε_t is the vector of independently normally distributed errors. The matrix Π contains the cointegrating vectors and a set of loading vectors which determine the weight of the cointegrating vectors in each single equation. By means of normalization, the cointegrating vectors can be identified from the estimated Π matrix.

To determine the number of cointegrating relationships r , the Johansen's procedure provides two likelihood ratio tests: the trace statistic (TR) and maximum eigen value (MAX) test (Johansen and Juselius, 1990). The Trace statistic tests the

null hypothesis of r cointegrating relations against the alternative of n cointegrating relations, where n is the number of endogenous variable for $r=0, 1, \dots, n-1$. The maximum eigenvalue statistic tests the null hypothesis of r cointegrating vectors against the alternative of $n+1$ cointegrating vectors.

The focus of Johansen's (1988) method is therefore on the matrix Π and its rank, for the rank of Π also represents the number of cointegrating relationships in the system (r). When r is equal to zero then there are no cointegrating relations and the model is just a VAR in differenced data. When all the markets are fully cointegrated, then $r = n - 1$. If the number of cointegration relationships is lower than $n-1$ then the markets are partially integrated (García-Enríquez et al., 2013). The Johansen ML approach possesses several advantages that make it appropriate method to evaluate spatial market integration. It has capacity to deal with models conformed by numerous endogenous variables (Bugueiro, 2010), thus allowing estimation and testing of multiple cointegrating vectors.

3.6.5 Asymmetric Price Transmission

If tests prove that equation 3.2 is not a spurious regression, then P_{it} and P_{jt} are referred to as being cointegrated and equation 3.2 can be considered an estimate of the long-term equilibrium relationship between them. In the next step, an ECM that relates changes in P_{it} to changes in P_{jt} as well as the error correction term (ECT) – the lagged residuals from the estimation of equation 3.2 – is estimated (Meyer and von Cramon-Taubadel, 2002). The ECT measures deviations from the long run equilibrium

between P_{it} and P_{jt} , so including it in the ECM allows P_{it} not only to respond to changes in P_{jt} but also to ‘correct’ any deviations from the long run equilibrium that may be left over from previous periods.

Tweeten and Quance (1969) used a dummy variable technique to estimate irreversible supply functions. Translating equation 3.2 for supply analysis into the context of APT:

$$P_{it} = \alpha + \beta^+ (P_{jt} - P_{j,t-1}) + \beta^- (P_{j,t-1} - P_{jt}) + \gamma (P_{jt} - P_{j,t-1}) + \delta (P_{j,t-1} - P_{jt}) + \epsilon_{it} \quad (3.7)$$

Where D^+ and D^- are dummy variables with: $D^+=1$ if $P_{j,t} \geq P_{j,t-1}$ and $D^+=0$ otherwise; $D^-=1$ if $P_{j,t} \leq P_{j,t-1}$ and $D^- =0$ otherwise. As a result, two input price adjustment coefficients are estimated; these are β^+ for increasing price phases and β^- for the decreasing price phases.

Houck (1977) proposed another variable splitting technique that includes first differences of the increasing and decreasing phases of $P_{i,t}$:

$$P_{it} = \alpha + \beta^+ (P_{jt} - P_{j,t-1}) + \beta^- (P_{j,t-1} - P_{jt}) + \gamma (P_{jt} - P_{j,t-1}) + \delta (P_{j,t-1} - P_{jt}) + \epsilon_{it} \quad (3.8)$$

Ward (1982) extended Houck’s specifications by including lags of the exogenous variables:

$$P_{it} = \alpha + \beta^+ (P_{jt} - P_{j,t-1}) + \beta^- (P_{j,t-1} - P_{jt}) + \gamma (P_{jt} - P_{j,t-1}) + \delta (P_{j,t-1} - P_{jt}) + \epsilon_{it} \quad (3.9)$$

Where m and n are the lag lengths. Based on comparisons of individual β -coefficients in equation 3.9 they analyze the speed of price transmission in specific periods, and based on the sums of these coefficients they analyse its magnitude.

Von Cramon-Taubadel and Loy (1996) suggest that the $\Delta P_{j,t}$ in equation 3.9 can also be split into positive and negative components to allow for more complex dynamic effects (i.e. positive and negative deviations from the long-term equilibrium – ECT^+ and ECT^-) makes it possible to test for APT. The ECM, including lagged changes in $P_{i,t}$ takes the following form:

$$\Delta P_{i,t} = \alpha + \sum_{k=1}^{k=m} (\beta^+ D^+ \Delta P_{j,t-k+1}) + \sum_{k=1}^{k=n} (\beta^- D^- \Delta P_{j,t-k+1}) + \varphi^+ ECT_{t-1}^+ + \varphi^- ECT_{t-1}^- + \gamma_t \quad (3.10)$$

Asymmetric transmission implies that $\varphi^+ \neq \varphi^-$

3.6.6 Market Structure

Market structure was assessed from the analysis of market concentration. Concentration refers to the percentage of total transactions accounted for by a given number of participants in a given market. Market concentration is used as a measure of competitiveness in the market. A competitive market is expected to have a low concentration due to the presence of many buyers and sellers (Koch, 1980).

The Hirschman-Herfindahl (HH) index approach was used to measure the level of concentration in each market. The HH index is given by the sum of the squared market shares of a firm:

$$HHI = \sum S_i^2 \quad (3.11)$$

Where S_i is the market share of the i^{th} firm. The value of HH equals one when there is only one firm in the industry and tends towards one when there are few firms in the industry thus greater degree of inequality in markets shares. As the HH index tends to zero, it signifies increased competition, an indication that it is more difficult for a single firm to exercise market power.

The Hirschman-Herfindahl (HH) index approach was used to measure the level of competition in each market. The value of HH takes a value of between zero and one with one indicating only a single firm in the industry (pure monopoly), tends towards one when there are a few firms and/or greater degree of inequality (monopsony) in markets shares and zero indicating pure competition. A HH index <0.1 indicates an unconcentrated index, a HHI of between $0.1 < HHI < 0.18$ indicates moderate concentration and a HHI above 0.18 indicates high concentration (de Fátma and de Oliveira, 2007). The market share based on the average monthly value of maize and beans sold by wholesalers and retailers was used to measure concentration index. The reciprocal of the HH index gives the number equivalent of equally sized traders in the market. A large reciprocal indicates many equally sized traders and thus a highly competitive market.

During entry and exit from an industry, different firm sizes emerge. Efficient firms remain while inefficient ones exit. Trader size distribution was analysed by looking at moments of firm size, as adopted from Mose and Burger (2006). Skewness

captures whether the trader size distribution is symmetric or asymmetric around its mean. Positive values of skewness indicate a pile up of scores on the left of the distribution that is assigning more of the probability to the left of the mean, that is more towards smaller firms and the converse is true. If firm size distribution is normal, the values of skewness should be zero (Field, 2004). The Kolmogorov-Smirnov (K-S) test was used to test for normality of the distribution. If the K-S test shows that $p > 0.05$, then it indicates that the firm sizes are normally distributed but if K-S test shows $p < 0.05$, then it indicates that the firm sizes are not normally distributed. The K-S test therefore gives a general picture of the distribution of the traders in the markets. The trader output (sales*unit price) per month of maize and beans was used to measure firm size.

3.6.7 Marketing Margins

Market performance was assessed by considering marketing margins. When there are several participants in the marketing chain, the margin is calculated by finding the price variations at different segments (Mendoza, 1995).

$$TGMM = \frac{P_s - P_b}{P_s} \times 100 \quad (3.12)$$

Where TGMM is the total gross marketing margin, P_s is the selling price, P_b is the buying price. Based on the data on concerning the selling and buying prices, and total marketing costs one can calculate the marketing margin. A margin of 5% is acceptable for storable goods in the African context (Goossens, 1995).

3.7 Chapter Summary

This chapter presented the methods used in data collection and analysis. The chapter discussed data collection techniques, characteristics of the sampled area as well as how and where primary and secondary data were collected. Finally, the analytical techniques and models that were used for data analysis are presented. The next chapter presents the empirical results generated from the specified models and a discussion of their implication to maize and beans marketing in the eastern central highlands of Kenya.

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Introduction

This chapter presents the results derived from the estimation of the models developed in chapter three as applied to maize and beans markets in the eastern central highlands of Kenya. First, the description of prices and sampled traders are presented. Next, the results from the application of cointegration techniques to maize and beans markets are reported. In the last section, the results from structure and performance of the markets are reported.

4.2 Description of Maize and Bean Prices

The time series price data was recorded in Kenya shillings per kilogram (Kshs/kg). During the 15-year period the average maize prices were higher in Mbeere markets than Meru south sub county markets(appendix 4.2). The mean maize price was highest in Makima and Karaba markets at Kshs. 19/kg and lowest in Magutuni at Kshs 13/kg. Markets in Mbeere are located in low production zones of Embu county hence the observed high prices. Kathwana market is located in the drier parts of Tharaka-nithi county and this may explain the high price in relation to the other markets in Meru south sub county. Likewise, beans prices were higher in Mbeere markets. Karaba recorded the highest mean price of Kshs 45/kg and the lowest price was recorded in Magutuni at Kshs 21/kg. With respect to coefficient of variation, Kiritiri ranks highest among the maize markets maize prices. This shows how volatile

the maize prices are relative to other markets. Kathwana market ranks highest in volatility while Siakago has the least beans price volatility in terms of CV.

The maize and beans price trends are presented in appendix 4.1. Visual inspection shows that monthly prices for maize and beans in the study area are volatile. The graphs reveal that the logarithmic value of maize prices had an upward trend. This suggests non stationarity of the maize price series data. The beans prices appear upward trended though marginally at first then rose rapidly from the year 2007. The beans price series also suggest non stationarity. Since the plots suggest mean non stationary property in maize and beans in the selected markets, price series were subjected to unit root tests.

4.3 Description of Sampled Traders

The survey revealed that the traders in the selected markets usually reside in the same area where they conduct their business. Most of them operate in up to three different markets, often neighbouring markets, which have different market days. The study considered two distinct types of traders: wholesalers and retailers. In addition, other categories of marketing agents, identified as millers, lorry traders and brokers existed in the same markets but usually trade as either wholesalers or retailers. The wholesalers are the traders who buy cereals in bulk from brokers and small village markets and break down the volumes for resale to small scale retailers. The small scale retailers operate in shops, market stalls and open air markets.

The traders in the two sub counties had almost similar characteristics. However, differences were found in the levels of education, age and number of years the traders have been in the business between wholesalers and retailers. Most of the traders had formal education with only 3.2 percent of the traders reported having no education. The rest had primary (43.1 percent), secondary (49 percent) and college/university (4.7 percent) education. Most of the traders having secondary and college/university level of education were the wholesalers. Women comprised the majority of trader populations in Mbeere (85.5 percent of total) and Meru South sub counties (76.4 percent of total). The average age of the traders was 38.5 years and they had been doing the business for an average of 8.5 years. Most of the wholesalers' were older than retailers and they had been in the business for a much longer period.

4.4 Price Correlation

The coefficients of correlation for price levels of maize are reported in table 4.1. All the correlation coefficients are positive and significant at 0.01 level. This suggests that the market pairs are integrated. The highest level of price integration for maize exists between Chuka and Kaanwa markets with a correlation coefficient of 0.979 and lowest between Kiritiri and Kathwana with a correlation coefficient of 0.157. Positive and significant correlation coefficients are an indication of market efficiency. Market pairs close to each other such as Chuka and Kaanwa, Makima and Karaba showed higher correlation coefficients than those far from one another such as Kiritiri and Kathwana, Chuka and Kathwana.

Table 4.1 Correlation of Maize Prices

	Siakago	Karaba	Makima	Ishiara	Kiritiri	Kathwa	Magutuni	Chuka	Kaanw
Siakago	1								
Karaba	.699**	1							
Makima	.625**	.910**	1						
Ishiara	.678**	.788**	.810**	1					
Kiritiri	.302**	.572**	.620**	.461**	1				
Kathwana	.373**	.416**	.376**	.309**	.157*	1			
Magutuni	.403**	.560**	.575**	.458**	.304**	.552**	1		
Chuka	.505**	.685**	.678**	.571**	.402**	.257**	.666**	1	
Kaanwa	.540**	.701**	.691**	.587**	.388**	.254**	.659**	.979**	1

** Correlation is significant at the 0.01 level (2-tailed).

Source: Author's computations (2013)

Correlation of maize prices being highest between markets that are close to one another means that prices are quickly transmitted to the markets where transportation cost was lower. Shorter distances lead to lower transaction cost making it profitable to move commodities between markets thus integrating them (Balkucs, Bojnec and Fertó, 2014; Goletti and Babu, 1994; Iregui and Otero, 2012). This confirms that distance is a factor that explains the strong relationship between markets that are close to one another

The coefficients of correlation for beans prices are reported in table 4.2. All the correlation coefficients are positive and significant at 1 percent level. The highest correlation coefficient was found to be between Karaba and Makima with a correlation

coefficient of 0.828 while the lowest is between Kathwana and Kiritiri with a correlation coefficient of 0.328.

Table 4.2. Correlation of Beans Prices

	Siakago	Karaba	Makima	Ishiara	Kiritiri	Kathwa	Magtuni	Chuka	Kaanw
Siakago	1								
Karaba	.666**	1							
Makima	.488**	.828**	1						
Ishiara	.766**	.685**	.526**	1					
Kiritiri	.669**	.665**	.538**	.674**	1				
Kathwana	.474**	.415**	.340**	.422**	.328**	1			
Magutuni	.715**	.474**	.397**	.631**	.520**	.678**	1		
Chuka	.742**	.718**	.640**	.751**	.752**	.525**	.623**	1	
Kaanwa	.795**	.552**	.401**	.675**	.588**	.617**	.797**	.782**	1

**Correlation is significant at the 0.01 level (2-tailed).

Source: Author's computations (2013)

Similar to the results for maize, beans markets closer to one another showed higher levels of price correlation. Positive and significant correlation with the markets in high production areas of Meru south and those in Mbeere mean that there is also a strong price relationship between markets in different production zones. Goletti and Babu (1994) found that production shocks consisting of factors such as adverse

weather conditions enhanced market integration. These results suggest that bean markets are integrated which is an indicator of market efficiency.

Correlation of prices can be exploited to earn extra returns for market participants. When correlation is positive and statistically significant it could suggest that price changes in one market are more likely to be positive (or negative) if the other market's price changes were positive (or negative). A positive correlation can be exploited by a strategy of selling to the paired market during periods of positive price changes. Negative and significant correlation of prices suggest evidence of price reversals and will be consistent with markets where a positive price change is more likely to be followed by negative price changes in another market and vice versa. Since there were no negative correlations of maize and beans prices, negative changes cannot be exploited to earn extra income.

Correlation of prices shows the degree to which price formation for agricultural commodities in one market is related to the process of price formation in other markets. The results of correlation analysis show that markets in the eastern central highlands of Kenya are integrated with each other. Most of the interviewed traders were reported to operate in more than one market, mainly those nearer to one another. This may have caused the high correlation coefficients due to the flow of price information between the markets. Generally, maize prices reported higher correlation coefficients than beans prices, meaning that beans markets are less

integrated. This may point to the availability of other legumes (cowpeas and green grams) in the markets which often substitute beans in consumption.

4.5 Causality

Pairwise Granger causality tests were conducted for maize and beans price series, applied to a maximum of two lags. The tables presented show causality results which were significant at 5% level. Table 4.3 presents results of granger causality tests for pairs of maize markets.

Table 4.3. Pair wise Granger Causality for Maize

	Siakago	Karaba	Makima	Ishiara	Kiritiri	Kathwa	Magtuni	Chuka	Kaanwa
Siakago		→	→	→	→	→	→	→	→
Karaba	-		→	→	-	-	→	→	-
Makima	-	→		→	→	-	-	-	-
Ishiara	-	→	→		-	-	→	-	-
Kiritiri	-	-	-	→		-	-	-	-
Kathwana	-	→	-	→	-		-	→	-
Magutuni	→	→	→	→	-	-		→	→
Chuka	-	-	-	-	-	-	→		→
Kaanwa	-	-	-	-	-	-	→	→	

→ Direction of causality

- Causality not significant at 5%

Source: Author's Survey (2013)

Causality was bi directional for most of the maize markets in the eastern central highlands of Kenya. For instance Magutuni, Chuka and Kaanwa markets caused each other in a bidirectional way. Bidirectional causality are as a result of

changes in seasonality and consequently, changing the demand-supply relations of the market pairs. Some markets showed unidirectional causality. Ishiara market showed granger non causality with Siakago, Kiritiri, Kathwana but was caused by them. Unidirectional causality means that price changes in Ishiara are initiated by other markets. On the other hand, Chuka and Kaanwa did not cause Kathwana while Kathwana did not cause Chuka and Kaanwa. In such markets price changes in any one of the markets cannot be used to predict price changes in the other markets.

Causality test on maize price series showed that Siakago unidirectionally caused all the other markets. Thus Siakago is a central market since it granger causes the other markets but not vice versa. This means that maize price changes start at Siakago and then spread to the other markets. Therefore the null hypothesis that there are no central markets in the eastern central highlands of Kenya can be rejected. Siakago market is located in a low production area and can be classified as a consumption zone. The results are similar with findings by Goletti and Babu (1994), Mendoza and Rosegrant (1992) and Wambugu (2005) who concluded that central markets are found in consumption zones.

The results for Granger causality in the beans markets are presented in table 4.4. The results show causality was less between market pairs for beans than maize markets, a tendency towards fewer central markets.

Table 4.4. Pairwise Granger Causality for Beans

	Siakago	Karaba	Makima	Ishiara	Kiritiri	Kathwa	Magtuni	Chuka	Kaanwa
Siakago		→	→	-	→	→	→	→	→
Karaba	-		-	-	→	-	-	-	→
Makima	-	-		-	→	-	-	-	→
Ishiara	→	→	→		→	→	→	→	→
Kiritiri	-	-	→	-		-	-	→	→
Kathwana	-	-	-	-	-		-	→	→
Magutuni	-	-	-	-	-	-		→	→
Chuka	-	→	→	-	-	-	-		-
Kaanwa	→	-	-	-	-	-	-	-	

→ Direction of causality

- Causality not significant at 5%

Source: Author's Survey (2013)

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

The results from pairwise Granger causality test show that, just like in the case of maize, the central markets for beans was found in a consumption zone. Since causality for these markets goes in one direction, this can be interpreted as price leadership for the price that does not adjust. The distinct central market of Ishiara is not located in a high production zone meaning that demand markets are important in beans price formation. From the results, the hypothesis that there are no central markets for beans can therefore be rejected.

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

4.6 Market Integration

This section reports the results from the application of cointegration analysis which tests for market integration by taking the presence of stochastic trends in the price series into account. The cointegration procedure, will allow the identification of both the degree of integration and its direction between the markets. The first step in

cointegration analysis is to determine whether the price series are stationary or not, and then investigate their order of integration.

4.6.1 Unit Root Tests for the Maize and Beans Retail Price Series

Tables 4.5 and 4.6 present the results for testing for unit roots in maize and beans retail price series respectively. The price series were first transformed into logarithms. The number of lags included in the test was selected using the Akaike's information Criterion (AIC). Two tests were used to test for stationarity: The Augmented Dick-Fuller (ADF) test and the Phillips Perron (PP) test.

Table 4.5 shows that ADF and PP unit root tests for all the maize price levels could not reject the hypothesis of unit roots at 5 percent critical level. When the price series are differenced once, they all become stationary and the null hypothesis of unit roots is rejected. Thus, the maize price series for the markets under consideration are integrated of order one.

Table 4.5. Unit Root Test for Maize Price Series

Series	Augmented Dickey-Fuller			Phillips-Perron test		
	Levels series	First Differences	Lags	Levels series	First Differences	I (d)
Siakago	-3.122	-10.667	1	-3.422	-15.782	I(1)
Karaba	3.274	-11.156	1	-3.500	-15.529	I(1)
Makima	-3.344	-11.521	2	-2.34	-14.565	I(1)
Ishiara	-3.294	-10.490	1	-2.963	-14.615	I(1)
Kiritiri	-3.464	-6.396	4	-3.367	-14.894	I(1)
Kathwana	-2.576	-4.691	12	-3.382	-14.676	I(1)
Magutuni	-0.208	-6.888	12	-3.298	-15.586	I(1)
Chuka	-2.259	-3.898	11	-3.189	-12.998	I(1)
Kaanwa	-2.596	-11.678	12	-3.030	-11.678	I(1)

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

Source: Author's computation (2013)

The bean price series were also tested for unit roots using ADF and PP tests. The AIC were used to determine the lag length and the results presented in table 4.6. The results show that for all the beans price levels, the null hypothesis for unit roots cannot be rejected at 5 percent for all markets. When the price series are differenced once, the null hypothesis of unit roots is rejected at 5 percent level, suggesting that the price series have a constant mean and variance which are independent of time. The beans price series are therefore integrated of order one.

Table 4.6 Unit Root Test for Beans Retail Price Series

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

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

Source: Author's computation (2013)

The results of the ADF and PP unit root test for the maize and beans price series indicate that all the maize and beans retail price series are integrated of order one. This means that each price series has a random walk and integrated of the same order. This is a necessary but not sufficient condition for cointegration (Granger, 1986), thus the need to carry out cointegration analysis for the variables. It is sufficient to conclude that each of these markets were integrated with the others, or at

least shared the common trends with the other markets. Therefore all the markets are included in the subsequent cointegration analyses.

4.6.2 Vector Error Model Estimation of Maize and Beans Retail Prices

The existence of long term cointegration relationship in maize and beans retail prices in different markets was tested using the Johansen's MLE method. Prior to adopting Johansen's MLE procedure, the optimal order of lag was determined using AIC. Given a lag order of one, the maize price responses were estimated for Siakago, while the beans price series were estimated for Ishiara, which were found to be central markets for maize and beans respectively. Cointegrating coefficients (β), adjustment coefficients (α) as well as a series of trace statistics and maximum eigenvalues were conducted. The tests were conducted in order to examine whether a long-run cointegration relationship exists between the price series, and to reveal by statistical evidence if the selected markets conform to a common market.

In the maize model, the trace test indicates that at five percent significance there are three cointegration equations. The maximum eigenvalue test indicates that there is one cointegrating equation. This means that there is at least one cointegrating relationships that can be established for the Siakago model as shown in Table 4.7.

Table 4.7 Cointegration Test Results for Maize

Hypothesized	Trace	0.05	Max-Eigen	0.05
No. of CE(s)	Statistic	Critical Value	Statistic	Critical Value
None	296.0179	228.2979	93.48848*	62.75215
At most 1	202.5294	187.4701	51.07624	56.70519
At most 2	151.4532*	150.5585	43.60665	50.59985
At most 3	107.8465	117.7082	36.48323	44.49720
At most 4	71.36331	88.80380	25.35320	38.33101
At most 5	46.01011	63.87610	21.79009	32.11832
At most 6	24.22002	42.91525	12.96302	25.82321
At most 7	11.25700	25.87211	8.410425	19.38704
At most 8	2.846577	12.51798	2.846577	12.51798

*Indicates the level of rejection of null hypothesis

Source: Author's computations (2013)

The results show evidence of a long run relationship or interdependence among the maize price series which implies that the markets are integrated. The prices do not drift apart in the long-run, but rather they move in tandem along the time being part of a system of maize prices. Since the long-run cointegration relation was found among the maize price series, the estimation of cointegration vectors was undertaken.

Table 4.8 represents cointegration relationship of the beans market. The trace test for the beans price series indicates that at 5 percent significance there are three

cointegration equations. The maximum eigenvalue test indicates that there is one cointegration equation between the eight variables considered. This means that there is at least one cointegrating vector in Ishiara beans price response model.

Table 4.8 Cointegration Test Results for Beans

Hypothesized	Trace	0.05	Max-Eigen	0.05
No. of CE(s)	Statistic	Critical Value	Statistic	Critical Value
None	274.1779	228.2979	69.87756*	62.75215
At most 1	204.3004	187.4701	53.54751	56.70519
At most 2	150.7529*	150.5585	45.31181	50.59985
At most 3	105.4410	117.7082	31.94800	44.49720
At most 4	73.49304	88.80380	26.34058	38.33101
At most 5	47.15246	63.87610	18.72857	32.11832
At most 6	28.42389	42.91525	15.87850	25.82321
At most 7	12.54539	25.87211	9.655256	19.38704
At most 8	2.890136	12.51798	2.890136	12.51798

*Indicates the level of rejection of null hypothesis

Source: Author's computations (2013)

Due to the results of the two tests, it can be concluded that there is a long run relationship between the beans markets. This implies that the beans markets in the highlands of central Kenya are integrated. Although the prices are very volatile, they seem to move together and gravitate towards a long-run equilibrium. The results for

rank test for both maize and beans however, show that the number of cointegration equations was lower than $n-1$. According to García-Enríquez (2013), this means that the markets are not perfectly integrated. The results compare with those of Asche et al (2012) who found sorghum markets in Tanzania to be highly integrated, although the markets were inefficient in the short run. Various factors related to difficulties in arbitrage could possibly cause incomplete transfer of price changes between the markets, including barriers to trade and incomplete information.

The Johansen's cointegration tests results (ranks) showed long term cointegration relationships. However, they fail to estimate the adjustments made between the markets when there are price shocks. To capture the adjustments, obtaining the VECM estimation results with the estimates of the adjustment parameters is important. Since μ_t in equation 3.2 is stationary, the prices contain stochastic trends that have a long-run proportionality, with the cointegrating parameter β measuring the long run equilibrium relationship between them. Since the price series were converted into logarithms, the parameter is interpreted as the elasticity of price transmission.

Estimates of adjustment parameters (α) in the VECM specification show how one market adjusts to the long run equilibrium when its retail price changes in the market or other markets. Positive and significant values show how retail prices in the adjusting markets are quickly adjusting to the high price shocks in the other market. On the other hand, negative values show how the high retail prices in adjusting

markets quickly fall back towards the retail prices of the other market. Coefficients closer to 1 in absolute terms indicate that the retail price adjustment in a given market is very quick.

The long-run cointegrating relationship in the maize market is summarized in table 4.9. The table presents both cointegration and adjustment coefficients for the Siakago response model.

Table 4.9 Siakago Response Model for Maize Retail Prices

Normalized cointegrating coefficients (standard error in parentheses)								
SIAK	CHUK	KATH	KAAN	MAGU	KARA	KIRI	ISHI	MAKI
1.000	-4.069	-1.504	-5.445	-2.712	-3.803	1.523	-1.037	2.404
	(2.014)	(0.311)	(1.729)	(0.493)	(0.813)	(0.606)	(0.462)	(0.919)
Adjustment coefficients (standard error in parentheses)								
-0.036	-0.029	0.125	-0.026	0.126	0.030	-0.003	-0.041	-0.015
(0.024)	(0.010)	(0.019)	(0.011)	(0.021)	(0.017)	(0.017)	(0.019)	(0.019)

Source: Authors computations (2013)

From the model, it is possible to derive a cointegration equation between Siakago and the other markets as follows:

$$sia = 4.07chk + 1.5kat + 5.45kaa + 2.71mag + 3.8kar - 0.52kir + 0.04ish - 2.4mak \quad (4.1)$$

This means that a 1 percent increase in the level of Chuka price results into an increase in Siakago price by 4.07 percent. A 1 percent increase in the level of prices in

Kaanwa results into a 5.5 percent increase in Siakago price. This indicates that Siakago market is strongly cointegrated with Kaanwa and Chuka in the long run. The results further suggest that a 1 percent increase in the level of Karaba prices will result into a 3.8 percent increase in the level of Siakago prices. A 1 percent increase in Ishiara prices results in a 0.04 percent increase in Siakago prices. The results imply that long run cointegration between Siakago and the markets in Meru south sub County are relatively stronger than between Siakago and markets in Mbeere sub county. Kiritiri and Makima had negative elasticities meaning that an increase in prices in the markets resulted in a drop in Siakago prices.

The observed elasticities are likely to be as a result of production differences. According to Goletti and Babu (1994) production differences enhance market connectedness. Price response of Siakago to markets in Mbeere was mostly lower than with markets in Meru South. This observation may be as a result of the Mbeere markets being situated in a low production area which made them to have a lower influence on Siakago prices. Meru south is a higher agricultural production area therefore markets in the area had a stronger relationship with Siakago. Influence of production differences is confirmed by a low cointegration coefficient for Kathwana (1.5 percent) which is situated in the low production zones of Meru south. The low and sometimes negative price response between Siakago and markets in Mbeere but positive with all markets in Meru South market imply that the prices respond to production differences. Since maize is expected to flow from high production zones of Meru south, the elasticity is positive. In Mbeere where production potential is

relatively lower, price changes in these markets may have resulted in lower adjustment of Siakago prices.

Coefficients for adjustment parameters show that maize retail prices adjust slowly to both price increases and decreases. The slow speeds of adjustment imply that it takes a long time to get back to its equilibrium path if disturbed by external forces. For instance Siakago prices adjust to lower retail prices in Ishiara (-0.04), Kiritiri (-0.003), Makima (-0.014) and higher prices in Kaanwa (0.026), Karaba (0.03), Kathwana (0.124), and Magutuni (0.125). Thus if price in Siakago is higher than expected value from its long run relationship with Ishiara, the price will take 24 months to converge to its long-run equilibrium. Prices in Kaanwa will take 39 months for the market to reach equilibrium. The highest speed of adjustment in the maize markets is observed between Siakago and Kathwana (8 months) while the lowest speed of adjustment was observed between Siakago and Kaanwa markets (39 months). The adjustment coefficients for Kiritiri and Makima were not significant.

The results from short run adjustment parameters show that Siakago prices reported mixed price adjustments to markets in high production areas of Meru south. Siakago prices also reported higher speed of adjustment to markets that were closer than those that were farther away. For instance, it took a longer time to adjust to Chuka and Kaanwa prices but a shorter time to adjust to Kathwana prices. Although speed of adjustment is generally lower for all the markets, distances between the markets may have caused the observed differences in adjustment coefficients. Iregui

and Otero (2013) explain that distance (and thus transportation cost) is a factor that helps explain the speed at which prices adjust to shocks in other markets. Slow speeds of adjustment means that the effect of exogenous factors that cause prices to change will continue to be felt in the markets for long periods of time.

The long-run cointegrating relationship in the beans market is summarized in table 4.10. The table presents both cointegration and adjustment coefficients for the Ishiara response model.

Table 4.10 Ishiara Response Model for Beans Retail Prices

Normalized cointegrating coefficients (standard error in parentheses)								
ISHI	CHUK	KAAN	MAGU	KATH	KIRI	MAKI	SIAC	KARA
1.000	-0.336	-0.664	-0.232	0.597	-0.366	-0.091	0.357	-0.577
	(0.170)	(0.191)	(0.097)	(0.092)	(0.140)	(0.159)	(0.132)	(0.143)
Adjustment coefficients (standard error in parentheses)								
-0.465	0.078	0.105	-0.111	-0.417	0.017	0.261	-0.301	0.288
(0.103)	(0.057)	(0.055)	(0.139)	(0.151)	(0.070)	(0.104)	(0.116)	(0.127)

Source: Author's computations (2013)

The long run relationship between Ishiara and the other markets were as follows:

$$ish = 0.34chk + 0.66kaa + 0.23mag - 0.60kat - 0.36siak + 0.58kar + 0.37kir + 0.09mak \quad (4.2)$$

The long run elasticities in the Ishiara beans prices response model show that prices in Siakago and Kathwana had a negative long run relationship while the other markets had positive relationships. This means that high beans retail prices in Siakago and Kathwana adjust back to the lower retail prices in Ishiara. All the other markets adjust back to higher retail prices in Ishiara. Kathwana had the highest coefficient (-0.6) while Magutuni had the lowest (0.23). Thus just like in the maize model, short distance between Ishiara and Kathwana markets may have led to high response of prices. However, production differences recorded mixed responses. Kiritiri market which is situated in a low production area had a higher coefficient than Magutuni and Chuka which are located in high production areas of Meru south.

Coefficients of adjustment (α) show that Ishiara beans retail prices respond slowly to price changes in the other markets. This means that it takes a long time for prices to adjust back to equilibrium if disturbed by external forces. The highest speed of adjustment is between Ishiara and Kathwana whereby, if Ishiara prices are lower than expected value from its long relationship with Kathwana, it will take two months for the market to reach equilibrium. The lowest speed of adjustment was observed between Ishiara and Kiritiri where it takes 59 months for the market to get back to its equilibrium path if disturbed by external forces.

Apart from Kiritiri which had the lowest speed of adjustment, prices in Mbeere generally had higher adjustment speeds than those in Meru south meaning that markets in Mbeere adjusted faster to price changes in Ishiara than their counterparts in

Meru south. The high speed of adjustment is likely to be as a result of effects of distance between the markets, other than production differences. For instance, Kathwana is nearer to Ishiara than the other markets in Meru South and had the highest speed of adjustment (2 months). Siakago market is the nearest to Ishiara and thus recorded the highest adjustment speeds (3 months) compared to the other markets in Mbeere.

Results from cointegration analysis show that maize and beans markets in Meru South and Mbeere are cointegrated. The maize and beans models considered showed that cointegration relationship and adjustment parameters were greatly influenced by distance and production differences. This is not surprising since, based on economic theory one would expect maize to move from high production (Meru south) to low production (Mbeere) regions. Traders from the study area that were interviewed (annex 3.1) cited poor road infrastructure as one of the main constraints to product movement between markets. Thus markets closer to one another reported relatively higher adjustment parameters.

Maize and beans are the major crops grown in the study area for both food and income. Their importance to households means that the commodities are highly transacted between the markets in the region thus the prices tend to converge in the long run. Maize markets recorded stronger cointegration relationships than beans, meaning that arbitrage opportunities are being exploited causing higher market integration. Beans have substitutes like greengrams and cowpeas which are also

widely produced and consumed in the study area, including the dry areas of Mbeere. Thus beans recorded lower cointegration coefficients and price changes were mainly influenced by distance between markets and not production potential.

4.7 Asymmetric Price Transmission

This section analyzes how prices in one market change in response to price changes in other markets. To test whether there are any asymmetries in price adjustment, the error correction model is differentiated among positive and negative values of the error correction term (ECT). A positive value of the ECT implies that the observed price in a market is higher than the equilibrium price that is determined by the prices in the other markets. Therefore, a positive value of the ECT means that the price in the market would be expected to adjust downwards. A negative value of the ECT has the opposite interpretation. Test for asymmetric price transmission between maize market pairs are presented in Table 4.11.

Table 4.11 Asymmetric Price Transmission in the Maize Market

	Makima	Ishara	Karaba	Kiritiri	Siakago	Kathwana	Kaanwa	Magutuni	Chuka
Makima ECT +		-0.072**	-0.06	0.079*	-	-0.111*	0.061*	0.026	-0.147
Makima ECT -		-0.005	0.047	-0.097**	-	0.993***	-0.007	0.077	-0.051
Ishara ECT+	-		-0.024	0.044	-	-0.043	0.009	-0.015	-
Ishara ECT-	-		-0.059	-0.048	-	0.009	-0.003	0.116***	-
Karaba ECT +	-0.014	-0.06			0.068**	0.009	0.014	0.01	0.012
Karaba ECT -	0.075	0.098**			-0.048	0.04	-0.021	0.003	0.019
Kiritiri ECT +	0.076	-0.072*	-0.031		0.118*	0.08	0.058*	0.044	0.068
Kiritiri ECT -	0.026	0.035	0.07		-0.089	-0.059	0.03	0.025	-0.051
Siakago ECT +	-0.15*	-0.067	0.018*	-0.057		-0.235*	0.011	-0.071	-0.066
Siakago ECT -	0.337*	0.027	-0.1***	-0.059		0.244	0.009	0.185***	-0.034
Kathwana ECT+	-0.104*	-0.127**	-0.011*	0.083*	0.096		0.034	-0.024	0.272
Kathwana ECT-	0.349**	0.186*	0.082**	-0.185**	-0.105		-0.005	0.109**	0.107
Kaanwa ECT +	-0.02	-0.015	-0.009	-0.008	-0.113**	-0.054		0.403***	-0.098**
Kaanwa ECT -	0.037	0.021	-0.01	-0.024	0.073*	0.074		-0.211**	0.12*
Magutuni ECT +	0.014	-0.029	0.002	-	-0.073	-0.023	0.133*		-0.042
Magutuni ECT -	0.057	0.033	-0.025*	-	-0.003	-0.02	-0.22***		0.003
Chuka ECT +	-0.241	-0.094	-	-	-0.05	-0.549***	0.014	-0.014*	
Chuka ECT -	0.192	0.043	-	-	-0.016	0.197	-0.006	0.103**	

***1% significance, **5% significance, *10% significance

Source: Author's computations (2013)

Table 4.11 presents estimates for the coefficient of price adjustments between maize market pairs. Prices in the markets respond asymmetrically to price changes in the other market. Analyzing overall price adjustment without taking the level of significance into account, most of the markets adjust their price faster to price increase than to price decreases in the other markets. The difference in upward and downward prices is lower for markets that are closer to each other than those that are farther apart.

In the case of Makima, asymmetric price changes were significant for Siakago and Kathwana. The prices in Siakago market adjust upwards by 34 percent and downwards by 15 percent in one month in response to price changes in Makima. The price of maize in Makima market with respect to Kathwana was the most asymmetric relationship with a 35 percent upper adjustment of the error correction term but a downward adjustment of 10 percent. The coefficients for the other price adjustments with respect to Makima were not significant.

At Ishiara, Karaba and Kiritiri markets, prices adjust faster to price increase than they decrease. At Kathwana market, the price changes in response to Ishiara adjusted upwards by 19 percent and downwards by 13 percent of the ECT in one month. The prices in Kathwana also adjusted downwards by 8 percent in the following month as predicted by Kiritiri market and upwards by 19 percent. This observation points to tendency of uncompetitive behaviours among the market actors. Although transport bottlenecks are widely mentioned in literature as one of the main factors

causing APT, the results for APT between Kathwana and Ishiara point to the fact that transport is not the only factor causing APT.

Asymmetric price changes do occur within the beans prices. Results in table 4.12 indicates that analyzing overall price adjustments without taking significance into account, retail beans prices in most market pairs adjust faster to price increases than to price decreases in the adjusting markets.

Table 4.12 Asymmetric Price Transmission in the Beans Market

	Makima	Karaba	Siakago	Kiritiri	Ishiara	Kathwana	Kaanwa	Magutuni	Chuka
Makima ECT +		-0.022	0.06*	-	-0.202***	-0.046	-	-0.002	0.033**
Makima ECT -		-0.03	-0.223*	-	0.07	-0.008	-	-0.013	-0.062**
Karaba ECT +	-0.215***		-0.074	0.01	0.085	0.015	0.125***	0.007	-0.024
Karaba ECT -	0.186***		-0.02	-0.014	-0.165**	-0.053*	-0.013	-0.03	0.035
Siakago ECT +	-0.1	-0.054		0.021	-0.061	-0.1	0.105***	-0.044*	0.08***
Siakago ECT -	0.039	0.085		-0.012*	0.003	-0.039	-0.016**	0.044	-0.137**
Kiritiri ECT +	0.004	0.011	0.01		-	-0.154**	-	0.073*	0.11***
Kiritiri ECT -	0.006	0.008	-0.008		-	0.096*	-	-0.042	-0.089*
Ishiara ECT+	0.139***	0.07	0.079*	-0.061**		0.014	0.043*	0.031	-0.006
Ishiara ECT-	0.003	0.044	-0.015	-0.004		0.007	-0.035**	-0.047	0.007
Kathwana ECT+	-0.004	-0.061*	0.045	0.009	0.032		-	0.023*	0.035**
Kathwana ECT-	0.051	0.115**	0.045	-0.001	-0.05		-	-0.009	-0.018
Kaanwa ECT +	-0.012*	-0.07**	-0.007	0.002	0.115***	0.582***		0.004	-0.01
Kaanwa ECT -	0.024***	0.124***	0.017*	-0.003	-0.104*	-0.132**		-0.003	0.035
Magutuni ECT +	-0.039	0.024	0.009	-0.094	-0.093**	0.009	-		-0.05
Magutuni ECT -	0.018	-0.005	0.014	0.057	0.194***	-0.012	-		0.107*
Chuka ECT +	-0.016	-0.011	-0.001	-0.11*	-0.005	-0.057***	0.242***	0.018	
Chuka ECT -	0.009	0.0003	0.026	-0.011	0.008	0.005	-0.023*	-0.045	

***1% significance, **5% significance, *10% significance

Source: Author's computations (2013)

Karaba market had all its upward price adjustments being faster than downward price adjustments. At Karaba market, the upward retail price of beans adjustment is the most asymmetric relationship with respect to Kaanwa at 12% which almost doubles the 7% of ECT that it adjusts downwards in one month. Makima, Ishiara, Kathwana and Chuka markets had mixed price adjustments depending on the adjusting markets. As table 4.12 shows, beans retail prices in Kaanwa adjust upwards by 10% and downward by 11% in response to price changes in Ishiara. At the same time, Magutuni prices adjust upwards by 19% and downwards by 9% in response to changes in Ishiara prices.

The results from analysis of maize and beans price series show that in most cases the positive values of ECT were lower than the corresponding negative values of ECT. This means that price transmission were higher for rising prices and lower for falling farm prices. The premise of full price transmission corresponds to that of standard competition model, where the law of one price is supposed to regulate spatial price relations. Thus in most markets, consistent with Kinnuccan and Forker (1987), increases in price were passed through more fully than decreases in price.

Price transmission is closely related to market efficiency. According to Scherer and Ross (1990), the common source of asymmetric response is market power. Tekgüç (2013) found out that milk processing firms in Turkey abused marketing power by fixing prices. Thus non competitive traders in food markets in the eastern central highlands of Kenya may have collusively reacted more quickly to shocks that

squeeze their marketing margins than to shocks that raise them, resulting in asymmetric short-run transmission. Prices are expected to adjust symmetrically if there is more competition.

Factors such as deficiencies in transportation, communication and commercialization can explain asymmetries in price transmission (Iregui and Otero, 2012). For instance, Bakucs, Bojnec, and Fertő (2014) found symmetric price transmission between wheat markets in Hungary and Ukraine and attributed it to the developed infrastructure, geographical closeness and competitive markets. These constraints are experienced by traders in the study area and this may have contributed to the asymmetries in price transmission. Knowledge of APT can be applied in case of forecast in increase or decline in prices. The speed and direction of price transmission in a market can be used to calculate the expected corresponding percentage change in price by other markets.

4.8 Market Structure and Performance

4.8.1 Traders Marketing Strategies

There are two broad types of markets for food crops in the region: formal and informal. The formal markets have a definite location and are regulated by the local authority. Informal markets, usually at small selling points within the production area, have no official form of authority and no fee is charged. The informal markets act as buying points for the formal markets. On average, the informal 'village markets' and farm gate are the most preferred sources of commodities for rural market traders. They

either buy at the farm gate or in the village markets, either directly or through intermediaries (brokers). Here the traders mostly buy directly from farms or small selling points where farmers mostly act as their own selling agents and act as both producers and marketers of their produce.

Although retail traders have multiple outlets for their commodities, on average, selling to household consumers predominate. Selling to schools and markets away from the village is emerging as an important option especially for the wholesalers. This is probably because they deal in larger volumes of commodities and can supply many markets economically. None of the interviewed traders exported their commodities.

The traders conduct their business individually rather than in groups. Most of the traders (74 percent) believe that there are no policies governing collective marketing. This is probably the reason why only 22 percent are involved in collective marketing. A variety of reasons were given for not marketing collectively. The reason cited by most of the traders is that they lacked organized marketing groups that can be used as avenues for collective marketing. Acting independently is probably the reason why most of the retail traders are limited to selling to household consumers at the rural markets. Selling in far away (regional) markets, hospitals and schools requires supplying large amounts and most of the traders have no financial ability as individuals. However, wholesalers have been able to supply these alternative market outlets.

No anticompetitive practices were noted among the retail traders. The pricing is determined by the market forces, which indicated a uniform price in each particular market. This competitive pricing may explain the finding of market integration in maize and beans markets. However, the wholesalers admitted that they inquire from each other before setting the prices collectively, although they did not collude on the quantities to sell. Both wholesalers and retailers conducted their businesses individually with minimal integration with other actors in the supply chain. Some of the retailers were found to be horizontally integrated. Survey results indicated that 26 percent of the retailers sold to the other retailers thus also getting involved in wholesaling. The common practice of operating in more than one market increased information flow and enabled them to take advantage of positive price differences that may exist between them thus integrating the markets.

4.8.2 Trader Size Distribution

The amount of maize and beans sold per month was used to determine the trader size distribution in marketing maize and beans and the results presented in Table 4.13. The size of maize and beans traders was positively skewed around the mean. The retailers had a K-S test value of 0.2 and 0.3 for maize and beans respectively while wholesalers had a value of 0.5 and 0.2 for maize and beans respectively.

Table 4.13 Sale of Commodities by Trader Type

Commodity	Trader type	N	Kgs sold			K-S test
			Mean+ s.e	Min	Max	
Maize	Retailer	193	1264 (112)	1067	270000	0.2
	Wholesaler	24	7182 (2942)	8798	1649700	0.5
Beans	Retailer	179	1094 (128)	1500	288000	0.3
	Wholesaler	24	6741 (2831)	11999	2249775	0.2

Source: Author's survey (2009)

These results imply the tendency towards more, smaller traders than larger ones. The Kolmogorov –Smirnov test of $p > 0.05$ indicates that the firm sizes are normally distributed, indicating a tendency towards a competitive market. Many small traders are expected to increase competition thus making the markets more efficient. Free entry in maize and beans markets explains the large number of small traders who sell varying amounts. The wholesalers generally handle larger amount of both commodities than the retailers. This point to the possibility of factors hindering the entry of larger wholesalers.

4.8.3 Market Concentration

Market concentration was used to measure the level of competitiveness in the market. The volume of maize and beans traded by wholesalers and retailers was used to analyse market concentration and reported in Table 4.14. These results show that concentration was higher among the wholesalers than the retailers.

Table 4.14 Trader Concentration

Trader Category	Commodity	HHI	N	% of n
Retailer	Maize	0.01	74.00	38.34
	Beans	0.02	63.00	35.20
Wholesaler	Maize	0.17	6.00	25.00
	Beans	0.15	7.00	29.17

Source: Author's survey (2009)

Both maize and beans retailers had a HH index of 0.01 and 0.02 respectively. This indicates that the retail food marketing is competitive and reveals the absence of major barriers to entry into the retail trade. Wholesalers had a medium HH index of 0.17 and 0.15 for maize and beans respectively. This reflects the possibility of less competition among the wholesalers. The result implies that wholesale traders in the region's rural markets consist of a few large firms – with the possibility of some degree of market power – and a number of smaller firms. A higher percentage of n value for retailers than for wholesalers also confirms higher level of competition which is consistent with the findings that maize and beans retail prices are integrated.

Lower level of competition in wholesaling than retailing, means that there exists a form of barrier to entry in the maize wholesale trade. The fact that the markets under consideration are small rural markets, the volumes traded may not be high enough as to attract many sellers. It could also mean that wholesalers avoided the poor

state of the roads connecting most of the rural markets. This may have resulted in a few large wholesalers having a market share in the sampled markets.

4.8.4 Product Differentiation

Product differentiation is a strategy in market segmentation. The idea of market segmentation is that any market is likely to consist of submarkets which need a strategy to out-compete rivals. Maize and beans can be described as generally homogenous even though a few variations based mostly on variety and qualities exist. Not much sales promotion was carried out apart from sorting and grading. Variety, absence of rotten or infection by pests is mostly used to determine the quality needed. High quality cereals fetch higher price at both wholesale and retail level.

4.8.5 Barriers to Entry in the Trade

Barriers limit the number of potential market participants and thus directly influence competition in the trade. The issues that were considered important in determining the conditions of barriers to entry into maize and beans marketing pertain to the institutional, technical, financial and risk factors associated with the business.

In Kenya, though cereals are marketed under a free (liberalised) market system with minimum government intervention, a number of constraints still exist. Institutional and legal barriers to entry include government rules and regulations regarding the conditions set before trading in cereals. This includes the licensing requirements by the local government authorities. The traders with stalls are required to pay annual licenses while those without pay on a daily basis according to the

number of bags or per lorry load brought into the markets. The traders also cited harassment from police manning roadblocks and council officials that often cause delays in transport as one of the major problems that they face. Sometimes rent seeking from the public officials cause the traders to incur more costs that were not planned for. Those importing are required to pay certain statutory duties and levies on imports of cereals. All these may be translated as a barrier to entry especially by small traders with small capital base who may be intending to enter into the trade.

Technical barriers relate to the flow of information and the constraints that could be hampering it. Access to information regarding the sources and outlets of commodities, prevailing market prices and the cost structures in every market channel are important in making markets more efficient. Most of the traders got information from colleagues when they go to the market (83 percent), friends and relatives (39 percent), print and electronic media (16 percent) and through mobile phones (8 percent). Although the information received is considered available and accessible by 75 percent of the traders, high dependence on other traders for information through word of mouth raises questions of reliability.

Financial barriers relate to capital and credit availability especially initial capital investment. Lack of access to adequate capital was found to be one of the major barriers to entry and expansion of business by the traders. Results from the survey indicated that only about 31 percent of the traders had access to some form of credit. The main sources of credit were cooperative societies and commercial banks.

The available credit is considered by the traders to be inadequate for their needs. It also requires collateral in form of land title deeds, livestock, cooperative shares and household assets. These make commercial borrowing risky and act as a barrier to entry into the trade, particularly wholesaling whose capital requirements are higher than retailing. Business expansion and inter seasonal storage is also limited by capital constraints. Access to credit and ability to raise adequate funds conferred undue protection upon those who were already established in the business.

Majority of the traders were literate and had attained at least primary school level of education. Although 93 percent confirmed that they had never received any training in commodity trading and processing, the formal education enhances their skills required to carry out the trade. Educational level is therefore not a barrier to cereal trade in the study area. It also appeared that the traders did not have any cohesive tactics against established rivals or new entrants.

The finding of constraints in maize and beans marketing mean that the markets in the eastern central highlands of Kenya are not perfectly competitive. Contrary to economic theories of perfect and monopolistic competition, most market structures are characterized by a few large firms that are engaged in strategic interaction in their marketing decisions and their numbers are endogenous (Etro, 2013). This may explain the fact that despite the finding that the markets under study are integrated, the speed of price adjustment was low which is an indication of inefficient market structures. The finding of APT between market pairs further confirms that the identified

constraints have led to some level of uncompetitive market behaviours among the traders.

4.8.6 Marketing Margins

Market performance is the end result, which firms in any market arrive by pursuing the line of conduct they have deemed best for themselves. It measures the impact of structure and conduct terms of variables such as prices, costs, and volume of sales. A low margin indicates a high level of pricing efficiency and vice versa. Based on the data on concerning the selling and buying prices, and total marketing costs one can calculate the marketing margin. A margin of 5 percent is acceptable for storable goods in the African context (Goossens, 1995).

The costs that could be clearly identified are transport of the product, storage, market fees, loading and offloading. The most important marketing cost incurred by the traders was transport of the commodities. Based on the purchase price, sales price and total marketing costs for the commodities, marketing margins and return to sales for the wholesalers and retailers are presented in Table 4.15.

Table 4.15 Marketing Margins for Maize and Beans

Trader type	Retailers		Wholesalers	
	Maize	Beans	Maize	Beans
Commodity				
Trader revenue (Kshs/kg)	36.32	62.05	38.00	65.68
Cost of purchase (Kshs/kg)	32.22	57.68	34.36	59.7
Transport (Kshs/kg)	0.9	0.93	1.47	1.29
Market fees (Kshs/kg)	0.44	0.44	0.44	0.44
Loading/offloading (Kshs/kg)	0.22	0.22	0.22	0.22
Storage (Kshs/kg)	0.34	0.34	0.14	0.14
Total variable costs	1.9	1.93	2.27	2.09
Marketing margin (Kshs/kg)	2.2	2.44	1.37	3.89
Marketing margin as a share of selling price (%)	6.05	3.9	3.6	5.9

Source: Author's survey (2009)

The retailer marketing costs contributed 5.23 percent and 3.11 percent for maize and beans selling price respectively while wholesale costs contributed 5.97 percent and 3.18 percent per kg for maize and beans selling price respectively. The marketing margin analysis indicated that the proportion of the buyers' money accounted for by profits that the traders get was within acceptable limits for beans retailing and maize wholesaling. The traders' low share of the selling price can be attributed to some level of competition in the trade that squeezed profits. However, the marketing margin was above the threshold for maize retailers and beans wholesalers

showing that the traders were making very high profits. This means that there were some factors that inhibited attainment of perfect market efficiency.

4.9 Chapter Summary

This chapter presents the analysis of price movements and trader activities to determine the efficiency of maize and beans markets in the highlands of central Kenya. A structure and conduct analysis showed that markets tend towards a competitive structure. However, a number of barriers that may hinder attainment of perfectly competitive markets were reported.

Bivariate correlation of price series showed high correlation coefficients (significant at 0.01 level) for both maize and beans, with markets closer to one another recording higher coefficients. Granger causality tests showed that causality was mostly bidirectional. However, Siakago and Ishiara were identified as important price formation markets both of which are located in low production areas. Cointegration analysis indicated that the markets in the highlands of central Kenya were integrated, however short run price adjustments were very low. Tests for non-linearity in price transmission showed asymmetries in price transmissions, which was higher for markets that were farther apart.

CHAPTER 5

Summary of Findings, Conclusions and Recommendations

5.1 Introduction

The main challenge facing the policy makers and other agricultural stakeholders in Kenya is to ensure that markets facilitate efficient movements of food from production to consumption areas as well as provide an incentive structure for increased production. This study examines the efficiency of maize and beans markets in the eastern central highlands of central Kenya using a combination of approaches that included; correlation analysis, cointegration analysis, VECM and SCP.

5.2 Summary of Findings and Conclusions

Time series analysis of price data was used to establish comovement of prices between markets. The results showed market efficiency measured through market integration. Maize and beans price series were non-stationary which a common problem with time series data is. When the series were differenced once, they became stationary which is a requirement for subsequent cointegration tests. Johansen's cointegration tests showed cointegration between markets in the highlands of central Kenya. All the trace statistics and maximum eigen value tests indicated at least one cointegrating equation confirming the existence of a long-run price relationship between the markets.

The evidence presented in the study, supported the asymmetric price responses hypothesis. The results also show that differences between upward and downward

speed of price response between market pairs is much higher for markets that are far apart more than those that are closer to each other. The results confirm the hypothesis of sticky prices in food markets in the sense that they show greater response to rising prices than to falling prices between them. This means that some structural characteristics of the markets enabled the traders to derive benefits of price changes at the expense of buyers thus lowering market efficiency.

Structure and performance analysis of wholesalers and retailers revealed that generally trader characteristics and activities tended towards a competitive market structure, an indication of market efficiency. Size distribution showed a tendency towards many smaller traders than few big ones. Concentration was higher among wholesaler than retailers showing that competition was high among the retailers. The estimated HHI was 0.01 and 0.02 for maize and beans retailing respectively while wholesalers had a HHI of 0.17 and 0.15 for maize and beans respectively. The medium concentration of wholesalers means that they are less efficient than the retailers. Although prices are generally determined by the prevailing market conditions, wholesalers often colluded in setting prices which confirms lack of pure competition among them. However, since small rural markets were considered, the volumes traded in each market day may not be sufficiently high to attract many wholesalers leading to less competition.

Contrary to the expectation of a competitive market structure, a number of barriers that hinder attainment of a perfectly efficient market structure were reported.

A variety of taxes are levied for movement of cereals and for use of market facilities. These included import duties, local government cess and market levies; as well as paying bribes to police and local government staff. The problem is made worse by lack of credit facilities available for the traders for operations and business expansion. There was lack of an organized market information system to assist in making market decisions. Marketing margins and marketing costs which were used to indicate traders' performance show that for retailers, they were mostly within acceptable range for beans but higher for maize. This means that there are factors hindering pure competition in the markets which can be corrected by proper policy interventions.

Granger causality test was used for determining the direction of causality relationship between the price series. According to the results, most markets exhibited bidirectional causality meaning that both demand and supply conditions influence price movements. However, Siakago and Ishiara markets were found to be unidirectionally causing all the other maize and beans markets respectively. Thus the markets were considered to be the central markets therefore important in price formation. The methodology and results of this study can be applied to identify central markets in any other county in the country. Devolved governments may use the markets in low production areas to effect a desired policy change especially price stabilization in a region. In times of food shortages the county and central governments and food aid agencies should target the low production areas to stabilize food prices.

5.3 Policy Implications and Recommendations

One of the most important findings of this study was to identify central markets for maize and beans in the study area. Central markets are important for policy targeting during times of famine and price volatility to send price signals to other markets. This therefore means that the devolved governments may use the markets in low production areas to effect desired policy changes especially price stabilization in the region. In times of food shortages the county and central governments and food aid agencies should target the low production areas to stabilize food prices.

The models however, revealed low speeds of price adjustment between the integrated markets. Low speeds of adjustment between the markets mean that some level of intervention is required in order to facilitate production and enhance movement of products between the markets. This is important for policymakers, both in the central and county governments, when prioritizing investment to facilitate the flow of food commodities from surplus to deficit areas. Organised and efficient market infrastructural facilities especially transport and communication services increase market integration and bring about the transmission of right price signals.

Asymmetric price transmission between market pairs that was observed in the study suggests that there is the possibility of sub-optimal market structures. This finding that markets are not perfectly competitive mainly occurs if sellers have to develop the market institutions themselves. In addition, some of the market actors are not able to respond quickly to profitable opportunities. These results do not make a

compelling case for government to get involved in marketing. Nonetheless, focus should shift to interventions in the institutional environment.

Although the traders size distribution signal a competitive market structure, they face a number of constraints: inadequate capital, inadequate entrepreneurial skills, high cost of doing business and lack of a reliable market information system. This finding implies that enabling environment to traders may enhance their ability to carry out market activities more efficiently. Policies aimed at building institutions to facilitate traders to access credit and information will play an important role in increasing competition as well as facilitate spatial distribution of commodities from production to demand zones. Training market participants in entrepreneurial skills will further improve market efficiency.

The SAPs require that the government does not intervene in the food markets. However, results from this study show that the markets are yet to convert themselves into well functioning and efficient structures by nongovernment intervention. Even with reduced involvement in markets, the government has the responsibility of providing adequate infrastructure to support market activities and reduce transaction costs e.g. transport and communication infrastructure, storage and market facilities, weights and measures equipment. Although the government has embarked on upgrading physical market facilities under the economic stimulus programme in the study area, more needs to be done in order to enhance trade between the markets. A

good transport network will enable producers and traders to explore new markets thereby increasing production and exchange volumes.

Partnerships between county governments and private organizations can further contribute to favorable trading environment by offering facilities for information access, weighing, analysis of grain moisture content and storage. The private sector can also participate in the introduction of standard weights and measures units and if there is an established mechanism to ensure compliance. Since market information is considered a public good, the county governments should give private sector more incentive to provide a simple market information system utilizing modern communication technology which can disseminate information for both local and regional markets.

Given the importance of maize and beans in the livelihoods of communities in the rural areas, it is important for the traders to form associations that will assist them to participate in various levels of the marketing chain and benefit from economies of scale. The associations can provide an opportunity for the traders to get credit facilities, training and collective marketing. The strategic plan for agriculture should focus primarily on improving efficiency through the whole value chain so that it can become a competitive consumer driven sector.

5.4 Contribution to Knowledge

This study sought to analyze the efficiency of maize and beans markets in the eastern central highlands of Kenya. By examining the trader size distribution, it made

it possible to understand the market power situation. Size distribution is an indicator of market competitiveness. While monopolistic markets are considered exploitative, competitive markets are considered more efficient and offer incentives for market growth and development. By examining the activities and behavior of traders, the study identified various constraints that they face. This information offers a guide on the solutions to the constraints which is important for the development of efficient rural food markets.

A fundamental issue when analyzing reforms in the agricultural markets is the extent to which agricultural commodity markets respond to changes in prices. This study sought to analyze efficiency by considering long term price movements between markets in the study area. Price transmission between markets is central in understanding the extent of integrating economic agents into the marketing process. Cointegration procedure was used to show the degree of price integration and its direction between markets. Application of an error correction model provided an analytical tool that can focus beyond market integration to testing for asymmetry in the relationship between prices.

The primary interest in agricultural market analysis is to assess the impact of marketing inefficiencies on producer and consumer prices. One of the most important hypotheses generated by marketing economists is that as the market structure moves away from perfect competition, output and allocative efficiency will decrease and prices will rise. Thus, in order to understand sources of apparent inefficiencies, this

study complemented time series econometric methods of spatial price analysis and an analysis of activities of market participants in order to produce relevant policy recommendations. This is a departure from most studies which apply only a single approach to analyze market efficiencies. This empirical exercise allows the testing of economic theory and also provides important insights as to how changes in one market are transmitted to another as well as the extent to which markets function. This combination of data sources and analytical techniques is an innovative approach not common in agricultural research.

5.5 Suggestions for Further Research

Market efficiency depends not only on the nature of relationships among one group of actors within the marketing system. Further research should incorporate the other participants (producers, transporters, millers, etc) in the maize and beans market chain. Profits made by the trader can be as a result of them being more efficient than competitors rather than participating in collusive activities. Thus the markets also need to be tested against the efficiency structure hypothesis which suggests that increased profits accrue to traders with greater efficiency.

Price transmission has been applied to test economic theory and has featured prominently in agricultural partial equilibrium models. In these models, price transmission parameter values play an important role in determining direction, magnitude and distribution of welfare effects on trade policy scenarios. Thus future

research may focus on the use of the model to analyze the distribution of costs and benefits across the population groups.

REFERENCES

- Abdulai, A. (2000). Spatial price transmission and asymmetry in the Ghanaian maize market. *Journal of Development Economics*, 63, 327-349.
- Ahmadi-Esfahani, F. Z. (2006). Testing the law of one price in the Chinese wholesale food markets. *Agribusiness*, 22(4), 569-589.
- Aleksandrova, A. & Lubys, J. (2004). Application of the Structure-Conduct-Performance Paradigm in a Transition Economy: Explaining Reported Profitability of the Largest Latvian Firms. *SSE Riga Working Papers*, 8(63)
- Alexander, C. & Wyeth, J. (1994). Cointegration and Market Integration: An Application to the Indonesian Rice Market. *Journal of Development Studies*, 30 (4), 303-328
- Alila, P. O. & Atieno, R. (2006). Agricultural Policy in Kenya: Issues and Processes. A paper for the future agricultures consortium workshop, Institute of Development Studies, 20-22 March 2006. Nairobi, Kenya
- Asche, F., Gjølborg, O. and Guttormsen, A.G. (2012). Testing the central market hypothesis: a multivariate analysis of Tanzanian sorghum markets. *Agricultural Economics*, 43, 115-123.
- Asche, F., Gordon, D. V. & Hannesson, R. (2004). Tests for market integration and the law of one price: The market for whitefish in France. *Marine Resources Economics*, 19, 195-210.

- Badiane, O. (2000). The effects of liberalization of food markets in Africa. In: van Tilburg, A., Moll, H.A.J. & Kuyvenhoven, A. (Eds.), *Agricultural Markets Beyond Liberalization*. (pp135-158). Boston: Kluwer Academic Publishers.
- Bain J.S. (1951). Relation of profit rate to industry concentration of American manufacturing, 1936-1940. *Quarterly Journal of Economics*, 65. New York: John Wiley and Sons.
- Bakucs, Z., Bojnec, Š. and Fertó, I. (2014). Spatial product market integration between two small, open neighbouring economies. *Agribusiness*, 00 (0), 1–17
- Barett, C. B. (2001). Measuring integration and efficiency in international agricultural markets. *Review of Agricultural Economics*, 23, 19-32.
- Barett, C.B. (1996). Market analysis methods: are our enriched toolkits well suited to enlivened makets? *American Journal of Agricultural Economics*, 78(3), 825-829.
- Basu, J. P. (2006). Cointegration and market integration: An application to the potato markets in rural west Bengal, India. Paper prepared for the presentation at the IAAE conference, Gold Coast, Australia, August 12-18, 2006.
- Baulch, B. (1997). Testing for food market integration revisited. *Journal of Development Studies*, 33, 512-134.
- Bressler, R. G., & Kings, R. A. (1970). *Markets, prices and interregional trade*. New York: John Wiley and Sons.

- Bugueiro, M., Brümmer, B. and Diaz, J. (2010). Market integration and price leadership in selected sugar markets. The case of Colombia, Brazil and the world. *Economía Agraria*, 14, 23-32.
- COMESA ACTESA (2010). Smallholder Marketing Behaviour and Urban Consumption Patterns in Eastern and Southern Africa. Policy Synthesis #3, March 2010. Available on <http://www.aec.msu.edu/fs2/gisama/index.html>
- Cramer, G. L. & Jensen, W. (1982). *Agricultural Economics and Agribusiness* (2nd Edition). USA: McGraw-Hill Book Company.
- Delgado, C. (1986). A variance component approach to food market integration in northern Nigeria. *American Journal of Agricultural Economics*, 68, 970-979
- Ellis, F. (2005). *Rural livelihoods and diversity in developing countries*. Oxford University Press, Oxford
- Engle, R. F., & Granger, C.W.J. (1987). Co-integration and error correction: representation, estimation, and testing. *Econometrics*, 55(2), 251-276.
- Engle, R. F., & Granger, C.W.J. (1991). *Long-run economic relationships: readings in cointegration*. New York: Oxford University Press Inc.
- Etro, F. (2013). The theory of endogenous market structures. *Journal of Economic Surveys*, 0, 1-27

- Fama, E. (1970). Efficient capital markets: a review of theory and empirical work. *Journal of Finance*, 383-417
- Goodwin, B.K. and Schroeder, T.C. (1991). Cointegration tests and spatial price linkages in regional cattle markets. *American Journal of Agricultural Economics*, 73(2):453-464.
- García-Enríquez, J., Hualde, J., Arteche, J. and Murillas-Maza, A. (2013). Spatial integration in the Spanish mackerel market. *Journal of Agricultural Economics*. The Agricultural Economics Society.
- GoK (2010). *Economic Review of Agriculture 2010*. Nairobi: Ministry of Agriculture.
- Goletti, F. & Babu, S. (1994). Market Liberalization and Integration of Maize Markets in Malawi. *Agricultural Economics*, 11, 311-324
- Goletti, F. & Christina-Tsigas, E. (1995). Analyzing market integration. In Scott, G. J (Ed.), *Prices, Products, and People. Analyzing Agricultural Markets in Developing Countries*. Colorado, USA: Lynne Rienner Publishers, Inc.
- Gonzalez-Rivera, G. and Helfand, S. (2001). The extent, pattern and degree of market integration: A multivariate approach for the Brazilian rice market. *American Journal of Agricultural Economics*, 83(3), 576-592.
- Goodwin, B. K. & Piggott, N. E. (1999). Spatial market integration in the presence of threshold effects. Paper Presented at the AAEA Meetings in Nashville May 13,1999.

- Goossens, F. (1995). Agricultural Marketing and Marketing Analysis. Working paper 1995/23. Faculty of Agricultural and Applied Biological Sciences, Katholieke Universiteit Leuven.
- Granger, C.W.J. & Newbold P. (1974). Spurious regressions in econometric. *Journal of Econometrics*, 37 (July), 45-66.
- Gujarati, D. N. & Sangeetha (2007). *Basic Econometrics*, (4th ed.). New York: McGraw-Hill Inc.
- Handerson, J. M., & Quandt, R.E. (1971). *Microeconomic theory: a mathematical approach* (2nd Ed.). New York: McGraw-Hill Book Company.
- Harriss, B. (1979). There is method in my madness: Or is it vice versa? Measuring agricultural performance. *Food Research Institute Studies*, 17: 197-218.
- Harris-White, B. (1995). Efficiency and complexity: distributive margins and the profits of market enterprises. In Scott, G. J (Ed.), *Prices, Products, and People. Analyzing Agricultural Markets in Developing Countries*. Colorado, USA: Lynne Rienner Publishers, Inc.
- Hau, A. M & von Oppen, M. (2004). The efficiency of the vegetable market in northern thailand. Conference on International Agricultural Research for Development. Berlin, October 5-7, 2004.
- Hendry, D. F & Juselius, K. (1999). *Explaining cointegration analysis part 1*. Nuffield College, Oxford and European University Institute, Florence.

- Houck, J. P. (1977). An approach to specifying and estimating nonreversible functions. *American Journal of Agricultural Economics*, 59, 570-572.
- Ihle, R., & Amikuzuno, J. (2009). The integration of tomato markets in Ghana with and without direct trade flows. Contributed Paper prepared for presentation at the IAAE Conference, Beijing, China, August 16-22, 2009.
- Iregui, A. M. & Otero, J. (2013). A spatiotemporal analysis of agricultural prices: An application to Colombian data. *Agribusiness*, 29(4), 497-508.
- Jaetzold, R., Schmidt, H., Hornet, Z. B. & Shisanya, C. A. (2007). *Farm Management Handbook of Kenya. Natural Conditions and Farm Information*. 2nd Edition. Vol.11/ C. Eastern Province. Ministry of Agriculture/GTZ, Nairobi, Kenya
- Jayne, T.S., Chapoto, A., & Govereh, J. (2007). Grain marketing policy at the crossroads: Challenges for eastern and southern Africa. Paper prepared for FAO workshop on “staple food trade and market policy option for promoting development in eastern
- Jayne, T., Govereh, J., Mwanamo, A., Nyoro, J. and. Chapoto A. (2002). False promise or false premise? The experience of food and input market reform in Eastern and Southern Africa. *World Development* 30(11), 1967-1985.
- Jayne, T.S., & Stephen, J. (1997). Food marketing and pricing policy in eastern and southern Africa”. FAO, Rome, Italy, march 1-2, 2007
- Jones, W. O. (1972). *Marketing Staple Food Crops in Tropical Africa*. Ithaca, NY: Cornell University Press.

- Karanja, A. (2002). *Liberalisation and smallholder agricultural development: a case study of coffee farms in Central Kenya*. MSc Dissertation, Wageningen University.
- Katungi, E., Farrow A., Mutuoki, T., Gebeyehu, S., & Karanja, D. (2010). *Improving Common Bean Productivity: An Analysis of Socio-Economic Factors in Ethiopia and Eastern Kenya*. Cali, Colombia:CIAT.
- Kimenyi, M. S. (2002). *Agriculture, Economic Growth and Poverty Reduction*. KIPPRA Occasional Paper No. 3. June 2002.
- Kinnucan, H. W. and Forker, O. D. (1987). Assymetry in farm-retail price transmission for major dairy products. *American Agricultural Economics Association*.
- Kherallah, M., Gelgado, C., Gabre-Madhin, E., Minot, N., & Johnson, M. (2000). *The road half travelled: agricultural market reform in sub-saharan Africa*. *Food Policy Report*. Washington, D.C: IFPRI.
- Koch (1980). *Industrial Organization and Prices*. Prentice-Hall International
- Kohl, R. L. & Uhl, J. N. (1985). *Marketing of Agricultural Products* (5th Edition). Collier Macmillan, USA.
- Lele, U. (1972). *Food Marketing in India: Private Performance and Public Policy*. Ithaca NY: Cornell University Press.

- Lutz, C., Van Tilburg, A. & Van Der Kamp, B. (1995). The process of short- and long-term price integration in the Benin maize market. *European Review of Agricultural Economics*, 22, 191-211.
- MacKinnon, J. G. (1991). Critical Values for Cointegration Tests. In R. Engel and C. Granger (eds.). *Long- run Economic Relationships: Readings in Cointegration*, Oxford University Press.
- Madalla, G. S. (2005). *Introduction to Econometrics* (3rd ed.). Singapore: John Wiley and Sons (Asia) Pte. Ltd.
- Mauyo, L.W., Kosgei, D.K., Okalebo, J. R., Kirkby, R. A., Kimani, P.M., Ugen, M., & Maritim, H. K. (2003). Structure and conduct of cross-border bean (*Phaseolus vulgaris*) marketing in east Africa: the case of western Kenya and eastern Uganda. *African Crop Science Conference Proceedings*, 6, 642-648. African Crop Science Society.
- Mauyo, L. W., Okalebo, J. R., Kirkby, R. A., Buruchara, R., Ugen, M., Mengist, C. T., Anjichi, V. E. & Musebe, R.O. (2007). Technical efficiency and regional market integration of cross-border bean marketing in western Kenya and eastern Uganda. *African Journal of Business Management*, 77-84.
- McNew, K. & Fackler, P. L. (1997). Testing market equilibrium: Is cointegration informative? *Journal of agricultural resource economics*, 22: 191-207.

- Mendoza, G. (1995). A primer on marketing channels and margins. In Scott, G. J (Ed.). *Prices, Products, and People. Analyzing Agricultural Markets in Developing Countries*. Colorado, USA: Lynne Rienner Publishers, Inc.
- Mendoza, M. S., & Rosegrant, M. W., (1995). Pricing conduct of spatially differentiated markets, In Scott, G. J (Ed.). *Prices, Products, and People. Analyzing Agricultural Markets in Developing Countries*. Colorado, USA: Lynne Rienner Publishers, Inc.
- Meyer, J., & Cramon-Taubadel, S., (2002). Assymetric price transmission: a survey. Department of Agricultural Economics, Göttingen, Germany.
- Mukumbu, M. (1994). Consumer and Milling Industry Responses to Maize Market Reform in Kenya. *Proceedings on the Conference on Market Reforms, Agricultural Production and Food Security*. Egerton University/Policy Analysis Marix, June 1994, Nairobi
- Muturi, S. N. (Ed.), Kilungo, J. K., Muendo, K. M., Mairura, Z., & Kariuki, J.G., (2001). Marketing of Smallholder Produce; A synthesis of Case Studies in the Highlands of Central Kenya. *RELMA technical report series 26*. Nairobi, Kenya: RELMA, SIDA.
- Myers, R. J. (1994). Time series econometrics and commodity price analysis: A review. *Review of marketing and agricultural economics* 62: 167-181.

- Ngugi, D.M.G. (1997). *The Implications of Agricultural Market Liberalization for Market Efficiency and Agricultural Policy in Kenya: The Case of Maize*. Unpublished MSc thesis, Bunda College of Agriculture, Malawi.
- Nyoro, J. K., Kiiru, M. W., & Jayne, T.S. (1999). *Evolution of Kenya's Maize Marketing Systems in the Post-liberalization Era*. Nairobi, Kenya: Tegemeo Agricultural Monitoring and Policy Analysis (TAMPA).
- Nzuma, J. M. (2007). *An Economic Analysis of The Impacts of Trade Liberalization on Kenya's Maize Sector*. Unpublished Ph.D thesis, University of Guelph.
- Olila, P.O & Atieno, R. (2006). Agricultural policy in Kenya: issues and processes. *Future Agricultures Consortium workshop, 20-22 march 2006*. Nairobi, Kenya: Institute of Development studies..
- Omamo, S. W., & Mose, L.O. (2001). Fertilizer trade under market liberalization: preliminary evidence from Kenya. *Food policy*, 26(1), 1-10.
- Ongutade, A. E., & Folayan, J.A. (2006). Assessment of efficiency of price information transmission between the central market and source market for cocoa in south-western Nigeria: a cointegration analysis. *Agricultural Journal*, 1(4), 198-201.
- Onyuma, S. O., Icart, E., & Owuor, G. (2006). Testing market integration for fresh pineapples in kenya. Poster paper prepared for presentation at the IAAE Conference, Gold Coast, Australia, August 12-18, 2006.

- Pesaran, B. and Pesaran, M. H. (2009). *Time Series Econometrics Using Microfit 5.0*. New York: Oxford University Press.
- Pesaran, M. H. and Shin, Y. (1996). Cointegration and speed of convergence to equilibrium. *Journal of Econometrics*, 71, 117-143
- Rashid, S. (2002). Liberalization, access to information, and spatial integration of Ugandan maize markets: A dynamic multivariate analysis. Paper prepared for the third annual workshop of the project, Policies for Improved Land Management in Uganda. April 17-18, 2002
- Ravallion, M. (1986). Testing market integration. *American Journal of Agricultural Economics*, 68, (1)102 – 109.
- Scott, G. (1995). Agricultural transformation in Zambia: past experience and future prospects. *Agricultural transformation workshop*, Abidjan East Lansing: Michigan State University.
- Scherer, F. M., & Ross, D. (1990). *Industrial market structure and economic performance* (3rd ed.). Boston: Houghton Mifflin.
- Stephens, E. C., Mabaya, E., Cramon-Taubadel, S. and Barrett, C. B. (2012). Spatial price adjustment with and without trade. *Oxford Bulletin of Economics and Statistics*, 74, 3, 453-468.

- Tamimi, T. (1999). *Investigating production opportunities, marketing efficiency and option of trade for fruits and vegetables in Palestine*. Stuttgart, Germany: Verlag Ulrich E. Grauer.
- Tekgüç, H. (2013). Oligopoly and Price Transmission in Turkey's fluid milk market. *Agribusiness*, 29(3), 293-305.
- Tweeten, L.G. & Quance, C.L. (1969). Positivistic measures of aggregate supply elasticities: some new approaches. *American Journal of Agricultural Economics*, 51, 342-352.
- Van Campenhout, B. (2007). Modeling trends in food market integration: Method and an application to Tanzanian maize markets. *Food Policy*, 32, 112-127.
- Van Wijn, M. S. & Makokha, S. N. (2000). Macro-economic policy reforms and the economic environment of farmers in Kenya. In *EPIDODE working paper E-WP05*: Kenya Agricultural Research Institute, Wageningen University, Development Economics group.
- Von Cramon-Taubadel, S., & Loy, J.P. (1996). Price asymmetry in the international wheat market: comment. *Canadian Journal of Agricultural Economics*, 44, 311-317.
- Wambugu, S. K., Karugia, J.T and Oluoch-Kosura, W. (2011). Conditions for achieving sustainable Agricultural Intensification in Africa: Evidence from Kenya. In: Djurfeldt, G., Aryeetey, E., & Isinika, A. (eds.) *African*

smallholders: Food crops, markets and policy. CAB International: Wallingford
Oxfordshire, UK

Wambugu, S.K. (2005). *An analysis of the Nature and Extent of Integration of Maize Markets in Kenya*. Unpublished Ph.D Thesis, Kenyatta University.

Warrack, A. A. (2008). A conceptual framework for analysis of market efficiency. *Canadian Journal of Agricultural Economics*, 20(3), 9-22

World Bank. (2008). *World Development Report. Agriculture for Development*. Washington, D.C: The World Bank.

Wyeth, J. (1992). The measurement of market integration and applications to food security policies. In *Discussion Paper No. 34*: Institute of Development Studies.

Yu, T. E., Bessler, D. A., & Fuller, S. (2006). Cointegration and Causality Analysis of World Vegetable Oil and Crude Oil Prices. *AAEA Annual Meeting*, Long Beach, California July 23-26, 2006.

Appendix 3.1: Trader Questionnaire

Enumerator's Name _____

Date of interview ____/____/____

Name of Respondent _____

Core var. no	Variable label	Variable values	Skip-rules, information etc.
	1. Trader Demographic and Socio-Economic Characteristics		
1.	District _____		
2.	Division _____		
3.	Location _____		
4.	Sub-Location _____		
5.	Name of the market _____		
6.	Trader type	<i>Retailer=1, Wholesaler=2, Broker=3, Millers=4, NCPB=5</i>	
7.	Gender of Trader	<i>1=Male, 2= female</i>	
8.	Age of Trader ___ years		
9.	Number of years trader has been in the business		
10.	Educational level of Trader?	<i>1=None, 2=Primary, 3=Secondary, 4=College/University</i>	
	2. Marketing		
11.	What are the existing sources of the cereals and grain legumes?	<i>1= At farm gate, 2= In the village market, 3= Brokers, 4= Wholesalers, 5= National Cereals and Produce Board, 6= Farmers' groups</i>	<i>Response can be more than one</i>

12.	What are your most suitable marketing options for your produce?	1= Consumers, 2= In the village market,3= In market outside the village,4= schools, 5= National Cereals and Produce Board, 6= NGO or donor project, 7= Farmers' groups or organization, 8= Hospitals	Response can be more than one
13.	Do you have access to market information?	1=yes, 2=no	
14.	How often	1 = Daily, 2 = Every other day, 3 = weekly, 4 = other	
15.	What are your markets of operation? 1 _____ 2 _____ 3 _____ 4 _____		
16.	Are you involved in collective marketing as traders or trader groups?	1=yes, 2=no	
17.	If not, Why?	1 = Lack of organized marketing body 2 = Presence of brokers 3 = Lack of reliability 4=Others (specify)	
18.	How much food crops do you sell in a month? Maize _____ Kgs_____		List figures if possible
19.	Sorghum _____ Kgs_____		
20.	Beans _____ Kgs_____		
21.	Cow Peas _____ Kgs_____		
22.	Millet _____ Kgs_____		
23.	Green grams? _____ Kgs_____		

24.	In what units do you buy your cereals?	<i>1 = per 1Kg 3 = per 90 kg</i> <i>2 = per 2kg 4 = debe</i>	
25.	In what quantities do you sell your cereals?	<i>1 = per 1Kg 3 = per 90 kg</i> <i>2 = per 2kg 4 = debe</i>	
26.	What mode of payment do you use for your products?	<i>1 = Cash 3 = Cheque</i> <i>2 = Credit 4 = Others (specify)</i>	
27.	Are you involved in collective sourcing with other traders?	<i>1 = Yes, 2 = No</i>	
28.	If Not, why?	<i>1 = Lack of organized marketing body</i> <i>2 = Presence of brokers 3 = Others (specify)</i>	
29.	Do traders engage in value addition activities for their products?	<i>1 = Yes, 2 = No</i>	
30.	Does a market information system exist?	<i>1 = Yes, 2 = No</i>	
31.	Are there policies on collective marketing?	<i>1 = Yes, 2 = No</i>	
32.	What is the level of involvement of women in trading of the agricultural products	<i>None =1, Average =,2 High =3</i>	
33.	Do women traders keep the income they get from the sale of agricultural products?	<i>1 = Yes, 2 = No</i>	
34.	Does the quantity of produce traded change with seasons?	<i>1 = Yes, 2 = No</i>	
35.	Do prices of agricultural commodities change with seasons?	<i>1 = Yes, 2 = No</i>	
36.	Do prices of the commodities changes on a monthly basis?	<i>1 = Yes, 2 = No</i>	

37.	Who does the purchasing of the commodities you are selling for you?	1 = self, 2 = Family member/relative, 3 = Agent/Middlemen, = Others (please specify)	<i>Response can be more than one</i>
38.	From whom do you normally buy these commodities?	1 = wholesalers (open air), 2 = Wholesalers (store/stall), 3= Retailers (open air), 4 = Retailers (store/stall), 5= Lorry traders, 6 = Posho millers, 7= Large scale millers, 8 = NCPB depots, 9 = Farmers.	<i>Response can be more than one</i>
39.	Who buys the commodities you are selling?	1= wholesalers (open air), 2 = Wholesalers (store/stall), 3 = Retailers (open air), 4 = Retailers (store/stall), 5 = Farmers, 6 = Lorry traders, 7 = Posho millers, 8 = Large scale millers, 9 = NCPB depots.	<i>Response can be more than one</i>
40.	To whom do you sell most of your commodities?	1= wholesalers (open air), 2 = Wholesalers (store/stall), 3 = Retailers (open air), 4 = Retailers (store/stall), 5 = Farmers, 6 = Lorry traders, 7 = Posho millers, 8 = Large scale millers, 9 = NCPB depots.	
41.	Have you received any training in commodity trading and processing?	1 = Yes, 2 = No	
42.	Do you import any of the commodities you are selling - if yes, indicate from which country _____	1 = Yes, 2 = No	
43.	Do you export any of the commodities – if Yes, indicate to which country _____	1 = Yes, 2 = No	
	3. COMMODITIES SELLING AND TRANSACTION COSTS		

44.	<p>What was the average buying price of the commodities last season?</p> <p>Maize Kshs. _____</p> <p>Sorghum Kshs. _____</p> <p>Beans Kshs. _____</p> <p>Cowpeas Kshs. _____</p> <p>Millet Kshs. _____</p> <p>Green grams Kshs. _____</p>		<p><i>Specify the unit eg Millet Kshs. 150 per 2kg</i></p>
45.	<p>What means of transport do you use to transport your commodities?</p>	<p>1 = Own lorry/tractor, 2 = hired lorry/tractor, 3 = Matatu/Pick-up, 4 = Oxcart, 5=wheelbarrow, 6 = head load, 7 = Others (please specify)</p>	<p><i>Response can be more than one</i></p>
46.	<p>What is the average distance from where you buy the commodities to the market? _____ Km</p>		

47.	<p>What was the average transport cost per 90 Kg bag of the following commodities last season?</p> <p>Maize (1) _____ (2) _____</p> <p>Sorghum (1) _____ (2) _____</p> <p>Beans (1) _____ (2) _____</p> <p>Cowpeas (1). _____ (2) _____</p> <p>Millet (1) _____ (2) _____</p> <p>Green grams (1) _____ (2) _____</p>		<p>1 = on all weather road Ksh-----,</p> <p>2 = On dry weather road Ksh.-----</p>
48.	<p>How much money do you pay to get a trading license? Kshs.</p> <p>_____</p>		
49.	<p>For how long is the trading license valid?</p> <p>_____</p>		<p><i>Specify whether 1 day, month, year etc</i></p>
50.	<p>How much money do you pay for storage?</p> <p>Kshs _____ per 90 Kg bag/month</p>		
51.	<p>State the other marketing costs that you incur</p>	<p>1 = boarding and lodging, 2 = Bribes to police, 3 = Bribes to licensing officers, 4 = Loading and unloading costs, 5 = Other miscellaneous costs</p>	<p><i>Response can be more than 1 (Please specify them and their costs)</i></p>
	<p>5. INFRASTRUCTURE COMPONENTS</p>		

52.	What type of roads do you normally use to transport the commodities?	1= All weather, 2= Dry weather,	
53.	How many trips do you make from where you buy to the market in a month? _____		
54.	<p>How many bags of the following commodities do you transport per month?</p> <p>Maize _____</p> <p>Sorghum _____</p> <p>Beans _____</p> <p>Cowpeas _____</p> <p>Millet _____</p> <p>Green grams _____</p>		
55.	In your own view is the road network well developed to enable easy transportation of the commodities?	1=Yes, 2 = No	
56.	<p>What problems do you encounter in transportation of the commodities that you sell?</p> <p>1) _____</p> <p>2) _____</p> <p>3) _____</p> <p>—</p> <p>4) _____</p> <p>—</p>		<i>List all the problems</i>

57.	What should be done to alleviate these transport problems? 1) _____ - 2) _____ - 3) _____ 4) _____ -		
	5. STORAGE		
58.	Do you store the commodities you trade in?	1=Yes, 2= No	
59.	If yes, how long do you store? _____		
60.	Where do you store it?	1= Stalls in the market place, 2= in my granary/godown, 3 = In hired granary/godown, 4 = In my own house/store, 5= In hired NCPB depots, 6= Others (please specify).	
61.	How many bags of the commodities do you normally store per month? _____		
62.	Why do you store the commodities?	1 =to assemble larger quantities (bulk building), 2 = To disassemble into smaller quantities (bulk breaking), 3= to overcome periods of low prices, 4 = Lack of transport, 5 = Other reasons (please specify)	<i>Response can be more than one</i>
63.	What limits your capacity to store more commodities?	1= Lack of capital/credit, 2= high storage costs, 3 = Problem of pest infestation, 4 = Little price increases, 5 = Erratic price changes, 6 = Availability of NCPB depots in the neighborhood, 7 = Others (please specify)	<i>Response can be more than one</i>

64.	In your own view what should be done to increase your capacity to store more the commodities?		
65.	What maize storage problems do you face? 1) _____ 2) _____ 3) _____ 4) _____		
66.	What should be done to address these storage problems? 1) _____ 2) _____ - 3) _____ 4) _____		
6. MARKET CENTRES AND MARKETING FACILITIES			
67.	Where do you sell most of your commodities?	1=Nearest market centre/town, 2 = To middlemen/agents, 3 = To NCPB stores, 4 = to lorry traders, 5 = to institutions, 6 = Other (please specify)	
68.	What is the average distance from your home to the market centre? Kms. _____		
69.	How many market centres are there in your location? _____		
70.	In your own opinion are these market centres available and accessible? _____	1=Yes 2=No	
71.	Do these market centres have the necessary facilities for maize marketing?	1=Yes 2=No	

72.	<p>What improvements in your view are required on these market facilities?</p> <p>1) _____</p> <p>2) _____</p> <p>—</p> <p>3) _____</p> <p>—</p> <p>4) _____</p> <p>—</p>		
7. AVAILABILITY OF MARKET INFORMATION AND CREDIT			
73.	<p>How do you get information on prices and availability of the commodities?</p>	<p>1= by visiting market places, 2 = From friends and relatives, 3 = From government officials, 4 = from NCPB officials, 5 = from agricultural extension officers, 6= from the print media, 7 = from the electronic media, 8 = others (please specify)</p>	
74.	<p>Is the market information that you get adequate for your decision making?</p>	<p>1=Yes, 2= No</p>	
75.	<p>Is the market information that you get available when you need it?</p>	<p>1=Yes, 2= No</p>	
76.	<p>In your own opinion is the flow of market information okay?</p>	<p>1=Yes, 2= No</p>	
77.	<p>If yes or no please briefly explain.</p>		

78.	<p>In your own opinion what should be done to improve flow of market information?</p> <p>1) _____ —</p> <p>2) _____ —</p> <p>3) _____ —</p> <p>4) _____ —</p>		
79.	<p>How did you get the initial capital of enter into trade?</p>	<p>1= Used capital from other business, 2= used borrowed money from friends and relatives, 3 = used capital from agricultural activities, 4 = used loan/credit, 5 = other sources (please specify)</p>	
80.	<p>If you got credit/loan what was the source</p>	<p>1= Commercial Banks, 2= Cooperative societies, 3 = Relative/friends, 4 = Fellow maize traders, 5 = informal money lenders, 6 = Others (please specify)</p>	
81.	<p>Do you provide credit to others?</p>	<p>1= Yes, 2 = No</p>	
82.	<p>If yes, to whom do you give?</p>	<p>1= Maize farmers, 2= other maize traders, 3 = Others (please specify)</p>	
83.	<p>If you get credit, do you think it is adequate?</p>	<p>1= Yes, 2=No</p>	
84.	<p>What do traders need as collateral (security) in accessing credit?</p>	<p>1=No collateral required, 2= Land title deeds, 3=Self help group/CBO guarantors, 4= livestock, 5= savings and shares, 6=household assets</p>	<p><i>Response can be more than one</i></p>
85.	<p>In your opinion is the availability of credit better or worse now compared to the preliberalization era (1993)?</p>	<p>1=Better 2=worse</p>	

86.	What problems do you encounter in acquiring credit? 1) _____ 2) _____ 3) _____ 4) _____ —		
87.	Please state what should be done to solve these problems 1) _____ — 2) _____ — 3) _____ 4) _____ —		
8. GOVERNMENT POLICY			
88.	Do you require a trading license to engage in the trade?	1= Yes, 2= No.	
89.	Do you know the role of the National Cereals and Produce Board (NCPB) in marketing of the commodities you trade in?	1= Yes, 2= No.	
90.	If yes, are the roles of NCPB in marketing?	1= its role as buyer and seller of last resort (B & SLR), 2 = Its role in maintaining strategic maize reserves, 3= Others (please specify).	<i>Response can be more than one</i>
91.	Do you find the NCPB as an impediment to your investment in trade?	1=Yes, 2= No.	

92.	If yes, in what ways? 1) _____ 2) _____ 3) _____ 4) _____		
93.	How does the distribution of famine relief food affect your maize trade? 1) _____ 2) _____ 3) _____ 4) _____ -		
94.	Are you aware that the market of the commodities has been fully liberalized?	1= Yes, 2= No	
95.	Is the liberalization policy good or bad? Give reasons. 1) _____ 2) _____ 3) _____ 4) _____ —	1=good, 2=bad	
96.	Do you believe that the government is committed to these liberalization policies?	1= Yes, 2= No	
97.	What problems have you been facing since liberalization of trade?	1= Low prices, 2= lack of capital, 3= unstable prices, 4=uncertain government policy, 5 = Fluctuating maize supply and demand, 6 = lack of transport, 7= Lack of credit, 8 = Interference by NCPB, 9= Lack of storage, 10= Lack of market information, 11 = Other problems (specify)	

98.	In your opinion what should be done to alleviate these problems? 1) _____ — 2) _____ — 3) _____ — 4) _____ —		
99.	Are you aware that you do not need a movement permit to move the commodities in any quantity from one district to another?	1=Yes, 2=No.	
100.	Are you aware that you can import the commodities into the country subject to payment of a variable duty?	1=Yes, 2=No.	
101.	Are you aware that you can sell the commodities wherever you want and not necessarily to the NCPB.	1= Yes, 2= No	
102.	Which, in your view, of the following categories of traders have increased or decrease since the liberalization? <u>Increased</u> <u>Decreased</u> 1) _____ 1) _____ 2) _____ 2) _____ 3) _____ 3) _____ 4) _____ 4) _____	1=wholesaler (open air), 2=wholesaler (store/stall), 3=Retailer (open air), 4=retailers(store/stall), 5= lorry trader, 6 = Posho miller, 7= large scale miller, 8=NCPB, 9=Transporters.	<i>Rank them in the order of largest increase or decrease</i>
103.	Overall, are you satisfied with the performance of the marketing system in Kenya?	1= very satisfied, 2 = not satisfied, 3 = Satisfied, 4 = no opinion	<i>Tick only one</i>

Appendix 4.1: Maize and Beans Price Trends

Figure 4.1a: Trend in Maize Price Series for Mbeere

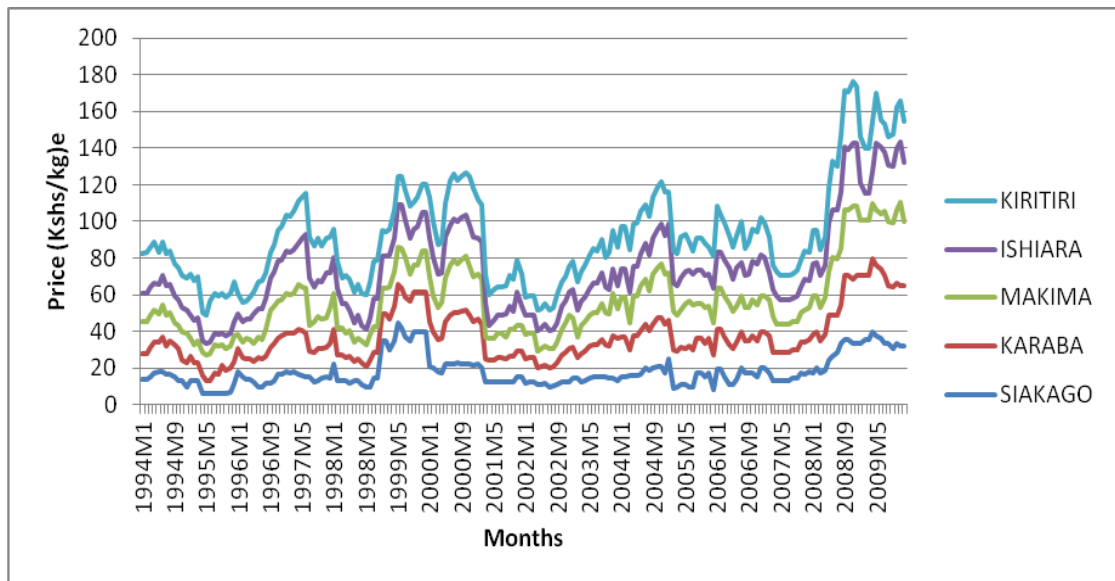


Figure 4.1b: Trend in Maize Price Series for Meru South

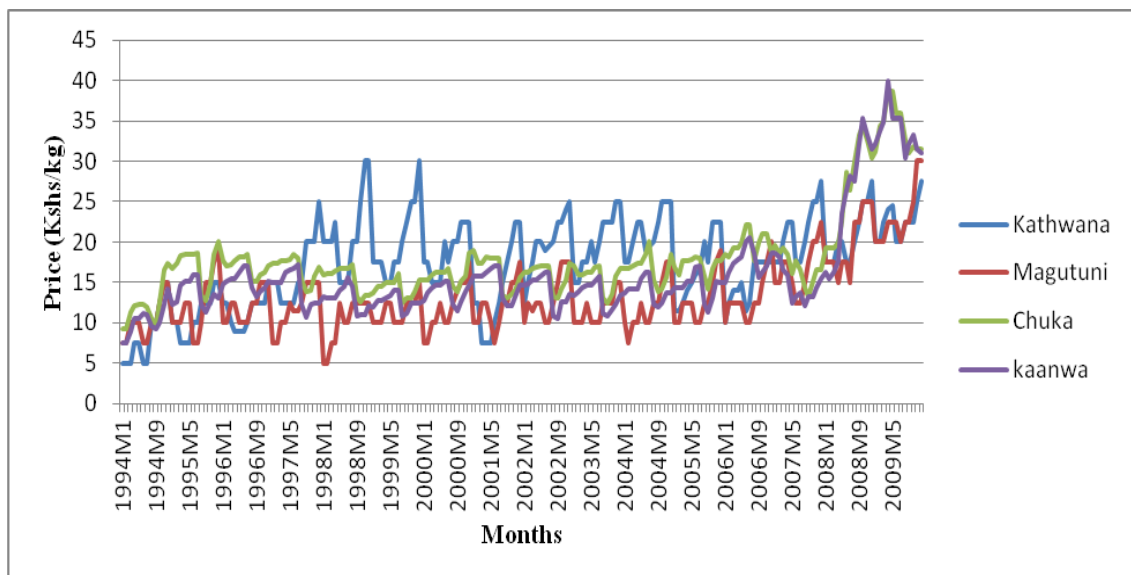


Figure 4.1c: Trend in Beans Price Series for Mbeere

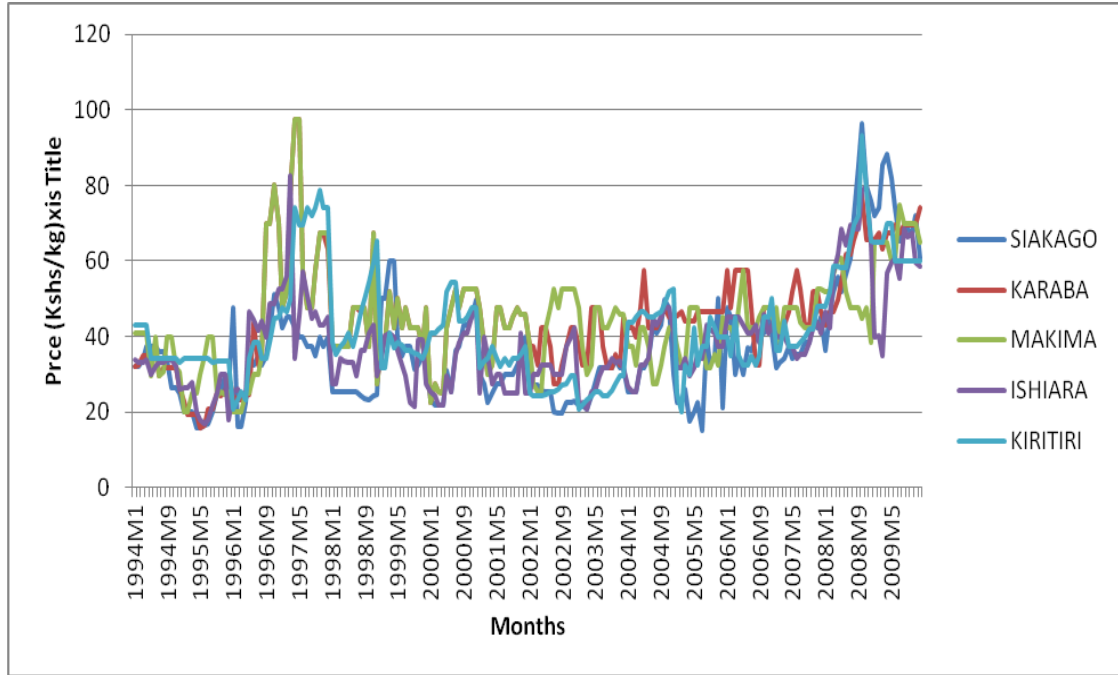
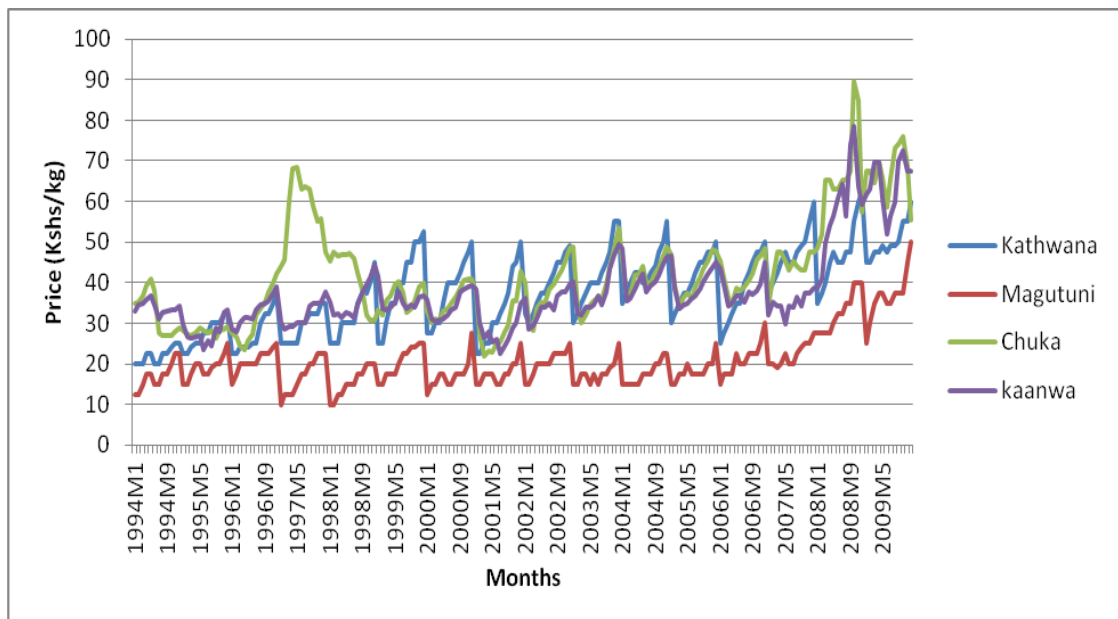


Figure 4.1d: Trend in Beans Price Series for Meru South



Appendix 4.2 Descriptive Statistics for Prices (1994-2009)

Table 4.2a Descriptive Statistics for Maize Price Series

Market	N	Range	Minimum	Maximum	Mean	CV
SIKAGO	192	39	6	45	18.13	2.13
KARABA	192	33.4	6.5	39.9	19.13	2.82
MAKIMA	192	37	8	45	19.18	2.80
ISHIARA	192	30	6.5	36.5	17.55	2.77
KIRITIRI	192	23.3	9.9	33.2	18.47	4.16
KATHWANA	192	25	5	30	17.37	3.16
MAGUTUNI	192	25	5	30	13.39	3.01
CHUKA	192	29.5	9.2	38.7	17.93	3.24
KAANWA	192	32.4	7.5	39.9	15.94	2.63

Table 4.2b Descriptive Statistics for Beans Price Series

Market	N	Range	Minimum	Maximum	Mean	CV
SIKAGO	192	81.4	15	96.4	36.69	2.34
KARABA	192	81.5	16	97.5	45.16	3.10
MAKIMA	192	77.5	20	97.5	44.39	3.28
ISHIARA	192	65.5	17	82.5	38.15	3.04
KIRITIRI	192	73.1	20	93.1	42.11	3.02
KATHWANA	192	42.5	20	62.5	37.32	3.71
MAGUTUNI	192	40	10	50	20.73	3.09
CHUKA	192	67.7	22	89.7	42.01	3.26
KAANWA	192	55.9	22.7	78.6	38.03	3.62

Appendix 3.2: Questions for Key Focus Group Discussion

April 2009

1. Food security:
 - a. What is the food security status at various months of the year?
 - b. What are the common types of food consumed at different times/?
 - c. What is the number of meal times at different times?
 - d. How many people are net buyers/net sellers of food and for how long?
 - e. What is the common source of cash to buy food?
 - f. Do farmers store excess food after harvest? If yes, what are the post harvest technologies practiced by the farmers?
 - g. Are their value addition activities?
 - h. What are the common crop pests and diseases?
 - i. How do farmers control pests and diseases? What common agro-chemicals do the farmers buy?
 - j. Is contract farming a common practice? If yes, for what crops?
2. Labour issues,
 - a. What are the major sources household incomes?
 - b. How much household labour is available for agricultural activities?
 - c. What are the factors that affect labour?
 - d. What is the impact of HIV/AIDS in agricultural activities and to what extent?
 - e. How does off-farm employment impact on household income?
 - f. Do they hire or rent out labour?
 - g. Do they hire or rent out land? What is the extent of hiring labour?
 - h. Has labour availability affected crop production?
3. Capital availability:
 - a. How accessible are the farmers to credit and savings facilities?
 - b. How many micro-credit institutions can farmers easily access? Which are these institutions?
 - c. What do farmers use as collateral in accessing credit?
 - d. Are farmers in groups? If yes, what is their common interest in such formations? (e.g. resource mobilization, labour pooling for agricultural activities, wealth creation, etc.)
 - e. What is the nature of group membership?
 - f. Which are the common activities farmers pool labour?
 - g. Sources of information, different sources of information to farmers on SWM, their effectiveness/extension network
4. Marketing:
 - a. What are the existing marketing opportunities for the cereals and grain legumes?

- b. What are the most suitable marketing options?
- c. Identify marketing chains for agricultural produce?
- d. Do farmers have access to market information? If yes, How often and from where?
- e. Do farmers engage in collective marketing? Reasons why and why not?
- f. On what commodities do they engage in collective marketing and at which/what selling points?
- g. How is collective marketing conducted/committees?
- h. Do farmers and traders engage in value addition activities for their products?
- i. Does a market information system exist?
- j. What constraints do farmers/traders face in their marketing activities?
- k. Are there policies on small holder collective marketing?