MARKET PRICE DETERMINANTS OF LIVE CATTLE: THE CASE OF GARISSA LIVESTOCK MARKET

ABDULLAHIABDINOORABDOW

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DECLARATION

This research project is my original work and has not been submitted for a degree in any other university.

Abdullahi Abdinoor Abdow

X50/67935/2011

Signature ………………………………… Date ……………………………………….

This research paper has been submitted for award of the degree of Master of Arts in Economics with my approval as University Supervisor.

Dr. Odhiambo Sule

Signature ………………………………… Date ………………………………………..

DEDICATION

I dedicate this research paper to my wife Reyhan Mohamed and the entire family for their

endless support and understanding over the study period.

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To my fellow colleagues and friends, especially Mohamed Hilal, I would like to thank him for the moral support when things were getting tough.

ABSTRACT

Livestock in general and cattle in particular are indispensable components of rural livelihoods in Kenya. In the semi-arid and arid parts of the country, the pastoral communities depend mainly on their livestock for their livelihoods. This study examined the factors that influence the prices of live cattle in the major regional livestock market in Garissa, North Eastern Province. The main objectives of the paper are to examine market price determinants of live cattle, establish the relationship between the market prices and the factors that influence them, and further recommend policy measures to enhance the performance of the livestock sub-sector particularly on marketing and prices.

A hedonic pricing model was fitted to examine the determinants of observed live cattle prices. Transaction data from the records of Kenya Livestock Marketing Council on average monthly prices, age, sex, grade/body condition and season were used. The empirical results indicate that the significant variables in explaining the average market price of the cattle are: gender; both male and female, age of the cattle; both mature and young, the body condition of the cattle and the season in which the transaction happens.

From the results, it's evident that cattle possessing characteristics of males and mature positively shock the average market price while cattle possessing characteristics of female, young and thin negatively shock the average market price. The weather condition definitely has negative impact on the average prices. With the area under study often faced with long dry spells, this leads to a down side change in the market prices. This is in conformity with the reality.

Policy and institutional approaches to improve the livestock sub-sector on a number of fronts to ease the major constraints that tend to dampen the performance of livestock sub-sector in the Arid and Semi-Arid Lands, even in the face of favourable prices, are discussed in this paper.

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ABBREVIATIONS AND ACRONYMS

ADF   Augmented-Dickey Fuller (ADF)

ASALs   Arid and Semi-Arid Lands (ASAL)

AU/IBAR   Africa Union Inter-African Bureau for Animal Resources

COMESA   Common Market for Eastern and Southern Africa

GDP   Gross Domestic Product (GDP)

GOK   Government of Kenya

KIPPRA   Kenya Institute for Public Policy Research and Analysis

KLMC   Kenya Livestock Marketing Council

KMC   Kenya Meat Commission

LMD   Livestock Marketing Division

NEPDP   North Eastern Province Development Program

OLS   Ordinary Least Squares

RLO   Regulated Livestock Operations (RLO),

SNV   Netherlands Development Organization

VIF   Variance Inflation factor (VIF).

CHAPTER ONE: INTRODUCTION

1.1 Background of the Study

The livestock sub-sector in Kenya accounts for approximately 10% of the National Gross Domestic Product (GDP), and about 30% of the agricultural GDP in the country. The sub-sector also provides employment to Kenyans, with an estimated 50% of the national agricultural workforce and about 90% of the Arid and Semi-Arid Lands (ASAL) workforce getting their jobs in the livestock sub-sector (AU/IBAR & NEPDP, 2006). Moreover, livestock production in the Arid and Semi-Arid Lands (ASALs) accounts for nearly 90% of the livelihood base and nearly 95% of household income (Kenya Ministry of Agriculture, 2008).Livestock production is therefore a major component of the ASALs economy and indeed the Kenyan economy at large.

In Kenya where 80% of the country's landmass is arid and semi-arid land (ASAL), livestock enterprises, especially cattle production are often the most viable options in such areas. The livestock enterprises provide huge employment opportunities to the population in the ASALs areas hence prove to be crucial livelihoods (Otieno, 2008; Kenya Institute for Public Policy Research and Analysis [KIPPRA], 2009). According to the 2009 National Housing Census, there are about nine hundred and fifty thousand (950,000) of cattle in Kenya; 70% of which are kept by nomadic pastoralists and agro-pastoralists in the ASALs, while the rest are either in ranches or integrated in dairy farms (Kenya Ministry of Agriculture, 2008).

In pastoral communities, sales of livestock provide direct cash income which would be used to cover diverse household needs. In fact, livestock resources are seen to be the 'living bank' for

most of the nomadic pastoralists and have an important role in the agricultural intensification process through the provision of capital for investment.

The government of Kenya supports livestock marketing in the ASAL regions through the Livestock Marketing Division (LMD) that enables livestock farming communities to achieve competitive prices. However, the government discontinued its direct role in livestock marketing during the introduction of the Structural Adjustment Programmes that aimed to implement "free market" programmes and policies in the 1990s. This has led to the degradation of the once well-established markets hence leading to significant inefficiencies including ineffective market places, high transaction costs, unstable prices, and insecurity (Netherlands Development Organization SNV, 2012).

Cattle production is an integral component of Kenya's livestock sector. Cattle are the country's main source of red meat, supplying by value, 80 percent of the nation's ruminant off-take for slaughter (Behnke & Muthami, 2011). The Government of Kenya has invested Ksh. 840 million into the rehabilitation of the Kenya Meat Commission (KMC) and procurement of livestock from local producers in past recent years. The revival of the KMC in June 2006 and the operationalization of the Landhies Road Depot in Nairobi and the Kibarani Factory in Mombasa in 2007 have increased market outlets for many livestock producers.

Efforts have also been made to invest an additional Ksh 170 million for the construction of satellite abattoirs in Isiolo and Garissa and the rehabilitation of a slaughterhouse in Wajir.

Furthermore, Kenya has sought to expand livestock export markets by increasing beef cattle exports to the Middle East and Mauritius (Kenya Ministry of Agriculture, 2008).

1.2 Livestock Trade in the Arid and Semi-arid Regions of Kenya

Livestock marketing, understood as the process through which live animals change ownership, is increasingly perceived as critical for improving pastoral household income. However, there is relatively little analysis of the structure and performance of livestock marketing systems in Kenya, or of the various market actors involved. For example, the increasingly vibrant regional cross-border livestock trade between Somalia, Kenya and Ethiopia is poorly understood (Little, 2009).

Livestock trade is one of the main economic activities and a critical source of livelihood for the pastoral populations in Kenya (Mahmoud H, 2010). The primary reason for selling livestock in most African pastoralists is the generation of income to meet unforeseen expenses (Jabbar and Ayele, 2003). Pastoralists also, besides using livestock as sources of food and as a form of saving and wealth, sell animals at times of cash needs to purchase food and other necessities (Jabbar and Ayele, 2003). Moreover, beneficial income diversification is likely to be based on initial capital generated by livestock sales (Little et al., (2001). This implies that livestock markets and price levels have a very important impact on the welfare of livestock keepers.

Figure 1 below depicts the average cattle sale price for live cattle in Kenya over the period 2004 up to 2013. From Figure 1, we notice that in the last nearly one decade the prices of live cattle has been dramatically fluctuating. However, prices have been going up except for the period of 2011 and 2012 when the prices took a sharp decline due to the great famine that affected the

region, especially the ASAL regions which accounts for the vast majority of live cattle sales. After the drought, prices assumed the upward trajectory with a sharp rise noticed in 2013, most likely due to the good amount of rainfall experienced in those regions. Some of the other factors that account for price fluctuations could be inflations, and livestock diseases.

Figure 1: National average cattle sale prices, 2004-2013
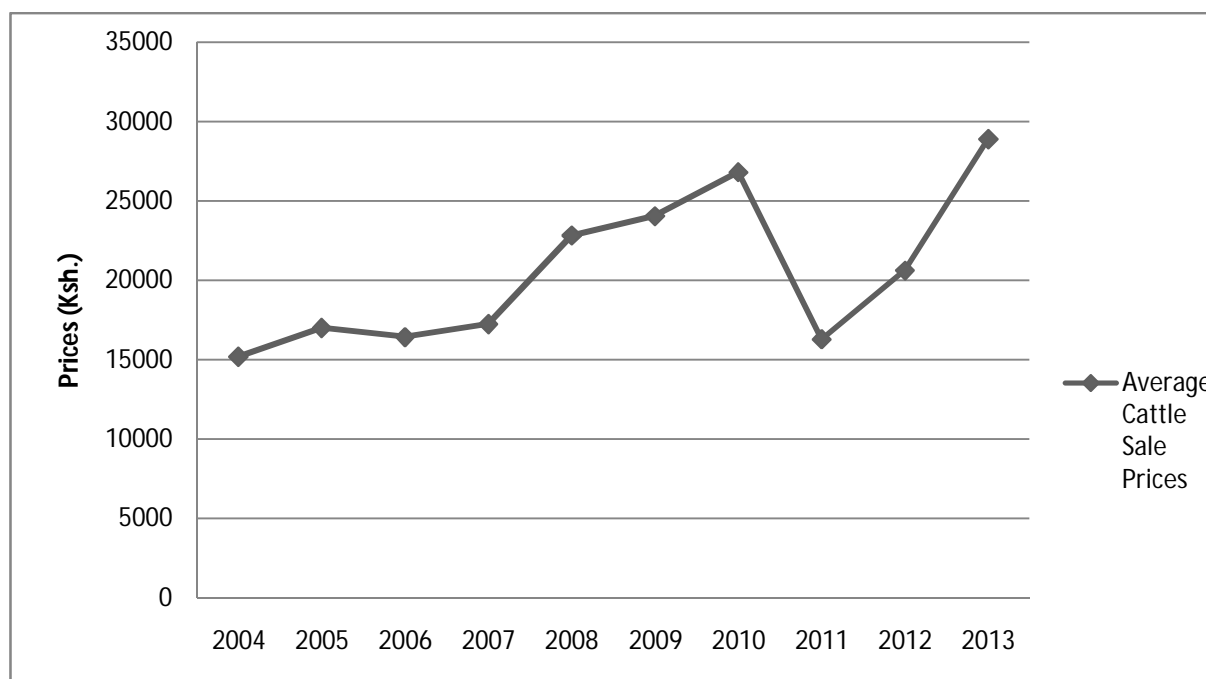
Source: National Livestock Information System, Ministry of Livestock Development

Note: Estimated average sale prices exclude dairy cows and immature animals. Producers directly sell their animals in primary, secondary and tertiary markets, and the estimates quoted here are an average of prices prevailing at all market levels.

1.3 Live Cattle Marketing in the ASALs

Pastoralists and agro-pastoralists are the main producers of livestock in the ASAL regions. Livestock keepers are often located in remote areas, at times in inaccessible terrain and far from town centres. Local independent agents collect livestock from producers in pastoralist

settlements, central water points and bush markets, and resell animals in primary markets or directly to traders (Legese et al., 2008; Bekele and Aklilu, 2008).

The livestock collectors often operate in marketplaces as brokers, acting as intermediaries between buyers and sellers. On the other hand, livestock traders operate at various levels of the trading chain. Large traders can usually count on high levels of capital, own their own trucks and have contracts with buyers, mostly with the Kenya Meat Commission (KMC) (Legese et al., 2008; Umar and Baulch, 2007).

Other participants in the livestock trading chain include trekkers hired by producers to move animals to market; feedlot operators, who fatten animals for sale in domestic or export markets; loaders, who operate at major market places and are in charge of loading animals onto trucks; lorry drivers, who are hired by traders to transport animals; and workers in market sales yards, who brand or mark animals after sale to prove new ownership (Legese et al., 2008; Umar and Baulch, 2007).

Producers often take their cattle to the primary markets or sell to itinerant stock traders who purchase animals from the "farm-gate", and take them to the primary markets. The primary markets are characterized by being patronized by producers and traders and are found within the production areas mainly within the village centres. Stock traders take the cattle they have purchased in the primary markets to the larger secondary markets found in larger urban areas such as the Garissa Livestock Market to earn profits.

At the secondary markets, the market players are medium to large stock traders and the volumes transacted are usually large. The large stock traders take the bought cattle to the terminal markets, mainly in Nairobi and Mombasa. The stock traders business is arbitrage, trying to earn profits by buying at low prices in areas and times of excess supply and selling at higher prices in places and times of excess demand.

There are a number of major stock routes in the ASALs that live cattle follow to the terminal markets as shown below:

North-Eastern Route: Mandera –Wajir – Isiolo – Nairobi. This route mainly deals with livestockoriginating from North Eastern province, Ethiopia and Somalia. The major markets in this route are Mandera, Wajir, Isiolo and Njiru (Nairobi).

Eastern Route: Garissa –Mwingi – Thika – Nairobi also Garissa – Tana River – Lamu – Mombasa. This route includes large number of cattle from Somalia. The major markets in this route are Garissa, Garsen and Mombasa.

Northern Route: Moyale-Marsabit-Isiolo-Nairobi. The major markets in this route are Moyale, Isiolo and Njiru (Nairobi).

North-Western Route: Turkana-West Pokot-Kitale-Nakuru-Nairobi. This route includes cattle from South Sudan and Ethiopia. The major markets in this route are Lodwar, Chepareria and Dagoretti.

Due to the growing domestic demand for red meat, Kenya supplements its requirement from neighbouring countries mainly from Somalia and Ethiopia. This provides an important opportunity for livestock producers in the country to target meeting domestic demand for meat. Besides this substantial domestic demand, there is the opportunity in external markets that can be accessed with adequate disease control standards and proper and relevant support from the government.

The major markets for live cattle from Kenya include the regional markets (Uganda and Tanzania), Common Market for Eastern and Southern Africa (COMESA) (Democratic republic of Congo, Mauritius, Madagascar, etc) and United Arab Emirates among other markets.

1.4 Garissa Livestock Market

Garissa Livestock Market is an important market that supplies Nairobi, Mombasa, Voi Range, Mpeketoni as well as adjoining areas in Kenya's Eastern Province. The market operates each Wednesday for cattle, but other livestock (sheep, goats, and camels) are traded throughout the week. Animals sold at the Garissa market are transported by Lorries to ranches or Nairobi markets.

Cattle sales data (2012-2013) from the Kenya Livestock Marketing Council (KLMC) indicates that about 37 percent of all cattle are sold between January and March; 35 percent in May–August, and about 28 percent in September–December. This is indicative that sales tend to correspond with or follow the wet season, when livestock body conditions are good and water and pasture are plentiful along the trekking routes.

In general, livestock volumes have been declining since 2003 (Figure 2), due to the fact that herd sizes for most pastoralists had not fully recovered from the cumulative effects of recurrent droughts especially between 2004 and 2006. Moreover, cattle sales experienced lowest in 2011 following the 2011/2012 famine that hugely affected northern Kenya and Southern Somalia. From Figure 2, it is also clear that cattle are by far the most traded livestock in Garissa Livestock Market which is a regional livestock market hub.

Figure2: Garissa market livestock sales (1997-2012)
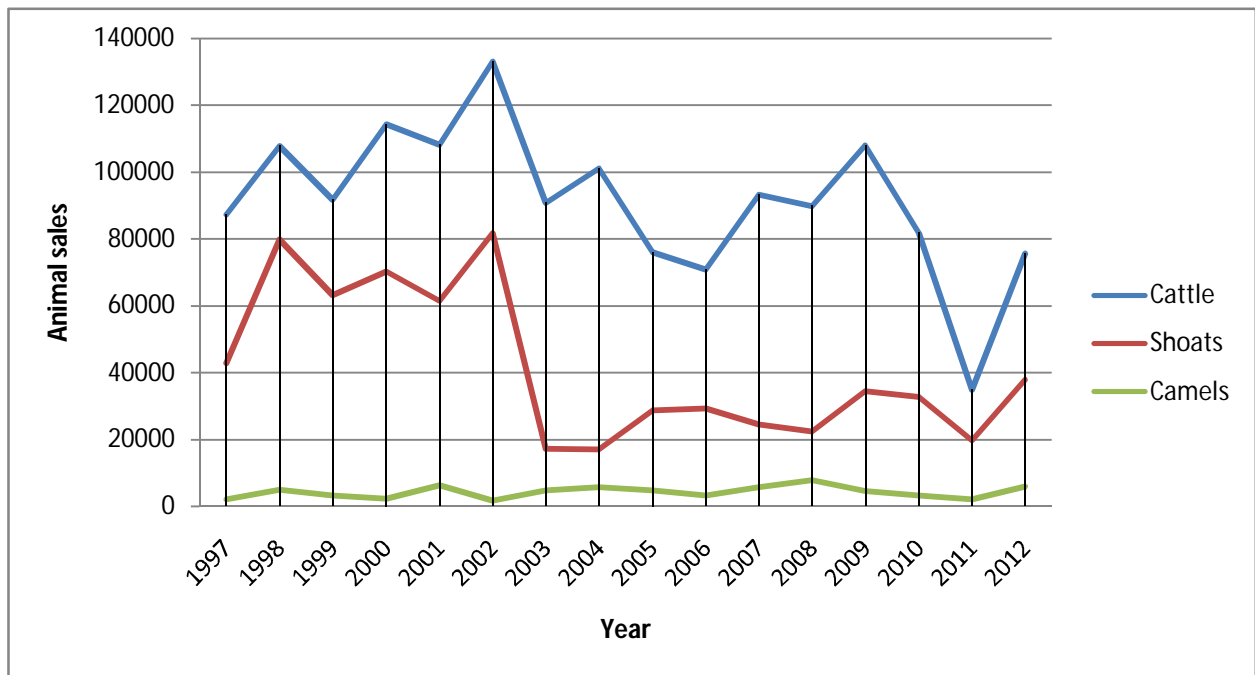
Source: Ministry of Livestock and Fisheries, Garissa

Garissa livestock market draws animals form a huge chunk of Kenya's ASAL region as well as Southern Somalia and Ethiopia. Below is a map that shows Garissa Livestock Market "catchment" in terms of the direction from which livestock flows into the market. The importance of the cross-border cattle trade among pastoral populations in Eastern Africa has

increased due to the high value of cattle and increasing demand for slaughtering and restocking in Kenya. Although there are no official statistics, anecdotal evidence suggests that the bulk of cattle sold in Garissa Market come from Somalia. The rest of the livestock come from Wajir, Mandera, and Ijara districts of Kenya, as well as from border areas of Southern Ethiopia via Wajir North and Moyale districts. Major cattle markets in southern Somalia include: Afgoi, Qorioley, Baidoa, Dinsor, Salagle, Bardhere, and Afmadow.

Somali and Kenyan traders buy cattle from these assembly markets and trek them overland to Garissa, where cattle trade is thought to be highly profitable. However, outbreaks of livestock diseases, perennial droughts, recurrent conflict, and insecurity along the border prompts frequent border closures between the two countries, significantly impact cross-border trade and, subsequently, pastoral livelihoods.

Figure 3: A map showing Garissa Livestock Market "Catchment"

Source: Famine Early Warning Systems Network (FEWSNET)

1.5 Statement of the Problem

Livestock production supports the livelihood of many households in the world, especially in Africa through the provision of diverse outputs, including food, and also acts as an important investment 'sink' that generates cash for socio-economic needs. In Kenya, the livestock subsector has overtime been a key player in the national economy and has particularly been the main economic mainstay of the occupants of a huge percentage of Kenya's lands mass, i.e the arid and semi-arid regions.

Despite the high economic and environmental potential of the ASAL areas, there are evidently high levels of poverty in those regions. Moreover, pastoralist communities have limited voice in relevant policy debates compared to the more settled agricultural groups and urban populations who at times get opportunities to voice their concerns and consequently contribute to policies. Pastoralists are therefore more likely to be marginalized (SNV, 2012).

The Government of Kenya through the Ministry of Livestock addresses support for the sub-sector. However, there still remain some issues that have not been adequately addressed, particularly market prices and related factors such as rangelands management, insecurity, and other relevant incentives and support.For example, the Kenya Livestock Marketing Council (KLMC) which is mandated to address marketing issues of livestock is weak and does not receive adequate budget for its operations, hence depending on donor funding for majority of its activities. Moreover, the Kenya Meat Commission (KMC) has been found to be operating below its potential due to lack of proper management and inadequate budgetary allocations.

Moreover, despite the significant importance of what determines the market values of livestock in the developing countries, most of the literature reviewed has been focusing on the developed world such as the United States and Canada. This is indicative of the low level of attention provided by African countries on livestock pricing sector. This study seeks to identify some of the key market price determinants of live cattle, and further provide informed policy advice to augment the performance of the sub-sector so that the lives of the pastoralist communities are significantly improved, while improving overall livestock production to enhance its contribution to the national Gross Domestic Product.

1.6 Research Questions
This research work will address the following pertinent questions:

a) What factors determine market prices of live cattle?

b) How do the age, grade, and sex of live cattle and the season they are sold influence their market price?

c) What policy measures need to be put in place to enable cattle sellers/owners fetch fair prices for their animals?

1.7 Objectives of the Study
The broad objective of this study is to determine the factors that determine market prices of live cattle. The specific objectives of the study are:-

1. To examine market price determinants of cattle with reference to Garissa Livestock Market.

2. To establish the relationship between the market prices of live cattle and the factors that determine them

3. To recommend policies to enhance the achievement of fair prices for live cattle so that pastoralists can improve their living standards.

1.8 Significance of the Study

Market price is a key issue in the livestock sub-sector as it plays a pivotal role in the income of many households especially in the rural areas, more specifically in the ASALs. Therefore, what determines these prices is equally a key player in the livelihoods of those who depend on livestock as their economic mainstay.

This research work will help us investigate the various parameters that determine the prices live cattle can fetch. It will also add to the existing knowledge on livestock pricing and pertinent issues that needs to be addressed in the sub-sector.

The findings of the study would also help government and relevant policy makers to undertake informed policies regarding thesub-sector which is remains crucial to the livelihoods of pastoralists, and the Kenyan economy in general. The policies for this study will consider some of the pertinent issues facing the livestock sub-sector. These issues include, insecurity such as the rampant cattle rustling, market access and pricing, rangelands management for better access to pastures etc.

1.9 Scope and Organization of the Study

The study covers the field of livestock price determinants specifically for Garissa Livestock Market. The research study is organized as follows; Chapter one covers introduction, and Chapter two reviews literature, both theoretical and empirical. The third chapter explains the methods, procedures and data that were used in the study to answer the research question. Chapter four focuses on the empirical analysis of the data employed in the study aimed to

examine the relationship between market prices of live cattle and the determinants of the prevailing prices. Chapter five contains the summary and conclusions of the findings of the study as well as the policy recommendation of the study.

CHAPTER TWO: LITERATURE REVIEW

2.0 Introduction

This section reviews the available literature relevant to the study. The theoretical literature will look at the theoretical underpinnings relating to price determinants and economic theories associated with pricing, while empirical literature will look at the empirical works/studies done by previous researchers regarding market price determinants of livestock especially live cattle. This is followed by an overview of the reviewed literature.

2.1 Theoretical Literature Review

The standard neo-classical model of price formation states that the forces of supply and demand determine market prices (Mankiw*et al* 2006; Parkin and Bade 2003). Key assumptions of this model include the following: many individual small buyers and sellers, homogenous products, information is perfect and there is no government intervention (Hirshleifer*et al* 2005).

Lines (2008), argues that price is formed through actual or implicit negotiations between market actors. He asserts that, it is an outcome of the complex interplay of economic interests and negotiating strengths i.e. relative market power of suppliers and buyers. In addition, factors mentioned by Coase (2000) that drive market participants to settle for a particular price need to be taken into consideration in this regard. He suggests that, in real-world markets, unobservable social relations and exogenous shocks help to determine market prices. He adds that, after all, buyers and sellers are far from passive market players, but astute activists set on withstanding the pressures of tough competition.

Institutional and socio-cultural factors also affect how prices are formed in decentralised livestock markets (Turner and Williams 2002), for example, although these might be invisible to

the casual observer of market transactions. Turner and Williams (2002) further suggest that the determinants of livestock prices in local markets include the typical livestock characteristics, but also factors embodied in the social characteristics of the sellers and/or buyers, institutional factors and external shocks.

A hedonic price model was fitted to determine the factors influencing live cattle prices in this study. A hedonic price function relates the price of a product to the various attributes embodied in the commodity. The underlying hypothesis is that products have utility-bearing attributes and the values of those attributes contribute to the price of the product. In the marketplace, utility-maximizing buyers and sellers interact to establish the market value for a given attribute. The observed price of a good is therefore a composite of the implicit values of the product's attributes. Characteristics that are likely to influence the price of live cattle include age, sex, grade as well as other related factors such as weather or seasons.

Rosen's hedonic pricing model is based on the hypothesis that goods are valued based on their attributes (Rosen S. 1974). Hedonic models have been widely used to evaluate the implicit prices of many agricultural commodities, especially livestock. The theoretical foundation of the hedonic price model is mainly made up of two parts: Lancaster preference theory and Rosen's characteristic supply-demand equilibrium model.

American scholar Lancaster (1966) first put forward a new consumer theory. The theory was expanded from the consumer theory of classical economics, also known as Lancaster preference theory. From the product heterogeneity, Lancaster (1966) analyzed basic "element" spaces that formed the product, and argued that the demand for the product was not based on the product itself,

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but on its characteristics. He noted that heterogeneous goods have a series of integrated characteristics, and the goods are sold as the gathering of inherent characteristics. And that households purchase these goods, use them as a kind of "investment", and turn them into utilities.

Therefore, he asserted that level of utilities depend on the quantity of different characteristics, hence it is difficult to analyze such goods market with the traditional economic model, because it cannot be considered by a single total price. It is against that backdrop that, Lancaster thought to adopt a series of prices (hedonic price) to express corresponding product characteristics. Therefore, the product price is made up of hedonic prices, with each product characteristic having its own implied price, and all hedonic prices form a price structure.

Later, American economist Rosen (1976) put forward the equilibrium model of market supply and demand based on product characteristics. Under the condition of perfect competitive market, with maximizing consumers' utility and producer's profit as the goal, Rosen (1976) analyzed theoretically the long term and short-term equilibrium of the heterogeneous product market. Rosen's work established the modelling foundation for the hedonic price theory, based on which, econometrics method can be used to estimate the hedonic price function, get implicit prices of product characteristics, and then analyze the demand of product characteristics.

On the supply of livestock to markets, Labys (1973) classified five general categories of factors that can influence the supply of cattle to markets. These factors are economic, ecological, technological, institutional and uncertainty. Economic determinants involve the process of acquiring inputs and the disposal of the product in the market (Labys, 1973). Furthermore, the

ecological determinants, such as rainfall and other climatic factors, have a positive impact on the availability of beef animals to be marketed (Carbera et al., 2007).

In addition, Makhura (2001) identified access to market information as an important determinant of market participation. The proximity to market information can influence production costs and, consequently, supply response (Mendelsohn, 2006). Mendelsohn (2006) also indicated that both ownership and off-farm income have a great influence on effective participation in the marketing system. Off-farm income is a good injection for livestock farming (Teweldemedhin and Kafidi, 2009) and greatly influences livestock disposals.

Access to other sources of income, such as from social grants and employment, may stop farmers from selling their cattle to meet their daily needs and production costs (Nthakheni, 2006). Remote locations with poor road conditions result in high costs of moving livestock to markets and hinder marketing efficiency (Mendelsohn, 2006). Moreover, the shortcomings of infrastructure seriously impede the physical flow of livestock to the market (Mendelsohn, 2006).

Economic researchers have also applied different economic valuation methods to understand the preference for and the value of animal traits in different contexts. Revealed preference and stated preference based models are some of the other commonly used approaches. Revealed preferences based valuation methods record and analyze actual payments on observable transactions for the commodities/services of interest while stated preference based valuation methods make use of data on hypothetical choices and implicit payments (Hensher et al. 2005).

Theoretically, the prices cattle sellers receive are reflections of the utility anticipated by the buyers and this utility is derived from the attributes of the product as cattle can be considered as quality (attribute) differentiated goods (Lancaster, 1966; Rosen, 1974).

This research focuses on the main phenotypic attributes that buyers inspect when buying an animal in addition to external factors such as seasonality. The external features farmers look at and attach value to, are age, color, body size, sex, and the place where the animals were brought from. As discussed above, experiences with some of these characteristics have shown that they significantly influence market prices of livestock.

2.2 Empirical Literature Review

Andargachew and Brokken's (1993) study of sheep pricing in highland Ethiopia and Jabbar's (1998) study of small ruminants in southern Nigeria made use of detailed, transactions-level data to disentangle the effects of various factors on livestock prices in Africa. The studies showed that attributes such as condition, breed, age, size, and castration affect the prices livestock fetch at market. These findings are consistent with findings from elsewhere in the East African ASAL that livestock prices and mortality rates are negatively correlated, implying that prices do not move to stabilize pastoralist incomes in the face of yield shocks, as is the prevailing wisdom with respect to cropping systems (Coppock 1994, Lybbert et al. 2000).

In such cases, market price instability compounds rather than ameliorates entitlements losses in the rangelands. So good rainfall years raise and stabilize livestock prices while drought years lead to low and unstable prices, thereby creating disincentives to reducing herds through sales in

times of stress. This helps explain the puzzle of low marketed off-take rates that contribute to pronounced livestock cycles in the ASAL areas (Fafchamps, 1998).

Bellemare *et al.*(2004), looked at household-level livestock marketing behaviour among Northern Kenyan and Southern Ethiopian Livestock keepers. The findings of the study showed that the northern livestock keepers are still far from autarky market conditions and the major driving factors that influence marketing of livestock in the area is adjustment to drought shocks. It further indicated that market participation widely varies from region to region and from season to season with an ultimate effect of trading routes for destined market traders.

Sharon*et al.* (2003) in a study conducted in northern Kenya and southern Ethiopia examined factors that limit livestock keepers marketed off- take response to conventional rise and fall in the livestock productivity and the possible remedies to foster more responsive pastoral livestock marketing in Kenya and Ethiopia regions. The study extensively explored the ASAL pastoralist livestock marketing behaviour and observed that: there is insufficient information for livestock keepers and traders to plan for incurring transaction costs especially in times of uncertainty such as drought period.

These sentiments were also shared by Mutuku *et al*., (2009). Additionally, the study further highlighted that undefined market system confines livestock keepers to be price takers in the market. These findings are similar to those highlighted by Perin (2002).

Conventionally, it is expected that the strong power of either market participants i.e. supply side

Verses the demand side, creates a barrier to entry thereby leading to an imperfect market competition. Analytic work by Dawe, (2002) demonstrated that apart from quantitative indicators, barriers of entry into a market through imperfect competition is depicted by high price elasticity, low expansion of market niches as well as restricted gain between the market players; which eventually results into slow growth of the overall industry.

Richards and Jeffrey (1996) employed a hedonic pricing model to establish indices of genetic worth of a dairy bull in Alberta, Canada. Their study indicated that the most important factors used by dairy farmers in valuing dairy bulls are milk volume, protein and fat content, general conformation, body capacity, and popularity of the bull.

Barret et al. (2003) used a structural-heteroscedasticity-in-mean estimation method to identify the determinants of livestock producer prices in the dry lands of northern Kenya. Their result showed the importance of animal characteristics, periodic events that shift local demand or supply, and rainfall in determining prices producers receive.

Williams et al. (2006) similarly used a hedonic model using weekly sales transactions to analyze cattle prices in West Africa and reported that location, season, and cattle attributes influence sheep prices.

In their study that aimed at investigating determinants of inter-annual price variation of small ruminants' price in the eastern highlands of Ethiopia, Gezahegn et al. (2006) employed hedonic

price modelling and reported significant differences in prices between seasons and markets, controlling for attributes of animals.

Kassie et al. (2011), similarly applied heteroscedasticity consistent hedonic price modelling to examine factors that influence cattle prices in the rural markets of central Ethiopia. The results of the study showed that season, market location, age, sex and body size are very important determinants of cattle price.

Chang et al. (2010) employed hedonic price modelling to study price differentials of retailed eggs and reported significant premiums attributed to production method, variation in geographic locations and egg colour. Similarly, Satimanon and Weatherspoon (2010) employed the same approach to determine price premiums of traits of fresh eggs using sustainable attribute data from retail markets in Terfa et al. the United States. Their study indicated that welfare-managed eggs have a significant price premium while the sustainable packaging attributes are insignificant.

Lansford, et al. (1998) used a semi-log hedonic pricing model to estimate the price of individual and ancestral characteristics of yearling Quarter Horses bred for racing. They noted that there has been little research pertaining to genetic and ancestral characteristics of Quarter Horses despite vast record keeping of ancestral information. The ancestral characteristics of the yearlings were described by racing performance of the yearling's sire and dam, as well as the racing performance of other offspring of the sire and dam. Racing performance was described as both number of races won and total race winnings. The authors concluded that several genetic and ancestral characteristics influence the price paid for race-bred yearling Quarter Horses.

Williamson et al. (1961) evaluated 9,481 lots of cattle sold in Virginia auction markets from 1951 to 1956. Utilizing least squared means estimation, the study estimated the effect of the following characteristics on the price of steers and heifers: sale size, lot size, breed(Hereford, Angus, Shorthorn, Hereford-Shorthorn and Hereford-Angus), and straight bred or crossbred, average weight, and grade (Medium, Good, and Fancy and Choice).The research found the price determinants for steers and heifers were notably different based on calf and market characteristics. The study further established that, as sale size increased, steers generally received higheraverage prices while heifer prices were unaffected.

The economists also found an optimal lot size between 21 to 30 head for steers. Price appeared to be unaffected by increasing lot size beyond the optimal range. However, the heifer regression model showed price was positively correlated with increasing lot size. Breed effect was the same regardless of sex, with Angus-influenced calves receiving the highest premiums. Hereford- and Shorthorn-bred calves followed, and straight bred animals brought substantially more than crossbreds. The regression results revealed an optimal weight range of 400 to 500 pounds (lbs.). Calves weighing a hundred pounds on either side of the optimal range received a slightly smaller price, and calves weighing more than 600 lbs. received the highest discounts. Buyers also rewarded cow-calf producers who marketed calves at higher qualitygrades.

Research by James and Farris (1971) used order buyer invoice data from 1966 to 1968 and United States Department of Agriculture (USDA) Market News Service monthly average prices from 1964 to 1968 to estimate price effects. The economists developed an OLS regression equation using cattle characteristics, such as weight, grade, and market class and breed type, with

other characteristics, including market location, lot size and seasonality. The study included new variables that made it notably different from previous work. A weight-squared variable captured the non-linear interaction between price and weight, and dummy variables were created to measure the effect of non-continuous cattle and market traits.

Research by Menzie et al. (1972) incorporated a similar approach using 1969 data from 47 Arizona auctions to determine how weight, sex, breed, lot size and current fat cattle prices influenced feeder cattle prices. The study included data on 2,941 sale lots with 28,501 cattle. Multiple regression analysis determined a hedonic pricing model similar to James and Farris (1971). The model used dummy variables to estimate price effects for pertinent genetic, management and market characteristic. The study used a weight-squared term to capture the non-linear weight-price interaction. The economists accounted for a variety of breed effects by including variables for Hereford, Angus, Hereford-Angus cross, Brahman crosses and other crosses.

Menzie et al. (1972) also explained the use of a weight-squared variable in feeder calf pricing models. They realized weight had a negative relationship on price that decreased in magnitude as weight increased. Including a weight-squared variable allowed for a non-constant weight-price relationship to be tested. The economists argued the non-linear relationship had important implications on returns. Since weight influences per head total returns, total returns for calves would not be linear.

The study also found a grade increase from low standard to high choice resulted in an $11 per hundredweight premium. Breed had a relatively small influence on price. However, Brahman-

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cross calves received the highest breed-related premiums generating $0.89per cwt. more than Herefords. Angus, Hereford-Angus cross and "Okie" cattle were also at a market advantage to Hereford.

Blank et al. (2006) evaluated 1997 to 2003 Western Video Market sales to determine the price differences in cattle based on region. The researchers used hedonic price modelling to test their hypothesis that California cattle receive lower prices than similar cattle in the Midwest. They believed that Western cattle were at a competitive disadvantage to cattle that were closer to the U.S. feedlot and packing industries in the Central Plains.

Additionally, Blank et al. (2006) explored the video auction price incentives for value-added management and marketing practices. The analysis was conducted on 1,979 lots of steer calves with an average weight range of 500 to 625 lbs., and only prices from steers with medium flesh score and frame scores of medium or medium-large were evaluated. The regression model estimated the effects of lot size, lot size squared, weight, weight squared, weight variability, region of origin, preconditioning, Quality Assurance Programs, natural market eligibility, Western Rancher's Beef cooperative participation, implants, bunk breaking, weaning time, forward contract period and breed on the price received for the cattle.

Hamed, Johnson and Miller (1999), examined transactions that occurred in Saline County, Missouri in the United States of America between January 1, 1996 and December 31, 1997 for possible large-scale livestock operation proximity effects. Using a linear measure of distance to the nearest Regulated Livestock Operations (RLO), the authors found that land parcels with

houses within 3 miles from an RLO suffered a loss in value. RLOs did not affect the value of vacant land.

Both revealed and stated preference techniques have also been employed to analyze the marketing or pricing of livestock in Africa. The revealed preference techniques mainly employ the hedonic pricing method. Previous studies that used this method are Andargachew and Brokken (1993), Fafchamps and Gavian (1997), Jabbar (1998), Barrett et al (2003) and Jabbar and Diedhiou (2003). These studies showed that, in general, weight, age, sex, body condition, body size, coat colour, reason of purchase, season, rainfall pattern, holidays, district location, breed type, market locations, and restrictions such as quarantines determine livestock prices observed in the market.

Kassie G.T et al (2012) used both revealed and stated preference approaches to determine the values attached to the different features of indigenous cattle in central Ethiopia. A hedonic model was employed to examine the determinants of cattle prices in the primary rural markets. Based on Akaike, Bayesian and log-likelihood criteria of model selection, the study concluded that market place; seasonal differences, sex and function-based classification of cattle, body size, and age were very important factors influencing the market prices cattle sellers receive. The study further revealed that the significance of the characteristics of animals in influencing prices paid for the animals reveals the importance of the preferences for traits in the decision-making process related to buying and selling of cattle.

Fafchamps and Gavian (1997) employed monthly price data of over 20 years in Niger to examine the determinants of prices, reported that season of selling, rainfall pattern, district location and seasonal holidays influence prices of livestock.

Based on a detailed transaction level data on cattle prices collected weekly for four years, Barrett et al. (2003) employed the concepts of structural heteroscedasticity and GARCH-M models to examine the determinants of prices and price variability in Northern Kenya. They conclude that season, rainfall pattern, holidays, market locations, restrictions such as quarantines and animal characteristics – body size and castration – are the main determinants of cattle prices in Kenya.

Chattopadhyay (1999) used a hedonic model to gauge the willingness of buyers to pay for reduced air pollution, found that residents in Chicago were willing to pay for a reduction in the pollution level of particulate matter (PM-10) and sulphur dioxide. As for the quality of water, Leggett and Bockstael (2000) reported that water quality, which was measured based on the concentration of faecal coli form bacteria, has a significant effect on property values, too.
Bayoh, Irwin and Roe (2004) studied transactions data from five townships within Mercer County, Ohio (United States of America). The data consisted of 3,476 residential property sales from 1999 to 2001.

Using a hedonic model, they found that proximity could have both a positive and negative effect. As distance from livestock increased, house values also increased, but *adjacent* livestock operations increased the value of a house. The authors speculated that the relative value-effect of

changes in the size and location of large-scale livestock operations depends on existing livestock levels. Residential parcels that are already proximate to a RLO may see their value increase with the increase in the local livestock concentrations. On the other hand, parcels initially isolated from livestock operations would find their property prices decline with the commencement of a nearby large-scale livestock operation.

Park, Seidl and Davies (2004) used a total of 3,345 residential transactions for a three-year period in Weld County, Colorado (United States of America). A large majority of the 184 livestock operations were cattle. Like previous studies, the researchers drew three rings around each housing unit to estimate the effect of distance. Size and location data were defined for each livestock type. As expected, irrespective of species, the effect of more operations or larger operations becomes weaker and less statistically significant as distance increases.

2.3 Overview of Literature Review
Various studies have been undertaken to determine factors that influence market prices of live livestock especially cattle. Previous research works used several variables as the basis of attributes used in hedonic pricing models. Characteristics used include sex, breed, lot size, frame size, muscling score, body condition, weight, time of sale, market location, among other factors. These have actually been determined through the use of hedonic pricing model.

However, majority of the literature reviewed did not take into account other external factors such as seasons of transaction, which this study seeks to examine besides the attributes. In addition, the few studies done in Kenya were not particularly carried out in the major markets strategically located in the hearts of the arid and semi-arid lands (ASALs) such as Garissa livestock market

which attracts huge traffic of live cattle sales. It is against this backdrop that the researcher would like to base his study on this crucial regional market.

While the body of literature examining cattle pricing factors is quite large, it is also a literature that has continually evolved over time. Given the volatility we are seeing in today's markets, taking a fresh look at factors affecting cattle prices, seems well warranted. Additionally, most work has seemed to focus on the developed world such as in the United States of America; much less work has focused on Africa, Kenya in particular. Surprisingly, little work has looked at seasonality aspect in price determination for livestock in many parts of Africa.

In conclusion, the above review of relevant literature has shown that there is an enormous body of knowledge on the relevance and application of hedonic price models. Although the focus of most of the studies reviewed was related to the inherent attributes of the cattle in the market e.g age, sex, grade, the importance of other related factors such as seasonality in determining prices observed in the market is a key lesson to learn. Interestingly though, there are hardly any publications done on cattle price determinants in the ASAL areas of Kenya using the hedonic price Model. This research employs the hedonic price modelling in a context where markets are yet to develop and cattle keeping have a more complex role than serving simply as sources of milk and meat, but rather as the main source of cash.

CHAPTER THREE: RESEARCH METHODOLOGY

3.0 Introduction

This chapter presents the methods adopted for the investigation in this study. Section 3.1 presents the theoretical framework used to analyze market price determinants of live cattle using hedonic price model. Section 3.2 presents the empirical model to be used in this study. In section 3.3, the definition of the variables of the study is explained. In section 3.4, the estimation procedure for the study is presented and finally section 3.5 presents the data type and source used in this study.

3.1 Theoretical Framework

For this analysis, a hedonic price model was fitted. The fundamental theory of the hedonic price model explains the price (P) of a commodity as a function of its characteristic (Rosen, 1974). The model's assumption is that a product is composed of a variety of specific attributes that consumers value independently.

Hedonic pricing approaches have been used to estimate the value of characteristics for a variety of agricultural products. The hedonic pricing approach is equally valid in investigating the derived demand for production inputs (e.g., Ladd and Martin 1976). The demand for live cattleis an example of a production input that may be valued using hedonic methods.

The general implicit form of the model can be presented as follows:-

$$P = f\left(X_1, X_2, X_3, \ldots\ldots\ldots, X_n\right) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(1)$$

Where P is the market price of live cattle and x_1, x_2,…,x_n are the various price determinants. The set of attribute variables such as grade, sex and age could not be the only determinants that explain the prices of live cattle as there are also external aspects such as seasonality that could also explain the differences in market prices.

Therefore, the price function specified in equation (1) can be formulated as follows:

$$P = f(X_1, X_2, X_3, .X_n .... Z) ....(2)$$

Where P is again the market price; x_1, x_2,…,x_n are attributes or characteristic variables and z accounts for the external factors/variables.

3.2 Empirical Model

The relationship between the market price of live cattle and factors that determine their prices can take several functional forms. Four functional forms i.e, linear, log-linear, linear-log, and log-log expressions are the most common ones. However, there is no strong theoretical basis for choosing the correct functional form of a hedonic regression, Halverson & Pollakowski (1981).

If linking price relationship with the variables is assumed to be linear (both the dependent and explanatory variables enter the regression in their linear form), the equation (2) therefore becomes:

$$P = \beta_1 X_1 + \beta_2 X_2 + ...+ \beta_n X_n + \beta_z Z + \varepsilon_t ....(3)$$

Where x_{1i}, x_{2i},…,x_{ni}, z_i are the price determining variables, parameters b_1, b_2, … , b_n, b_z represent the marginal implicit price of each variable and ε_l is the error term.

In the case of log-linear specification, the log of the dependent variable is regressed against linear explanatory variables:

$$LnP = \beta_1 X_1 + \beta_2 X_2 + ...+ \beta_n X_n + \beta_z Z + \varepsilon_t ....(4)$$

On the other hand, linear-log specification represents the relationship where a linear dependent variable is regressed against the log of the explanatory variables:

$$LnP = \beta_1 LnX_1 + \beta_2 LnX_2 + \ldots\ldots\ldots\ldots\ldots\ldots + \beta_n LnX_n + \beta_z LnZ + \varepsilon_t\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(5)$$

Log-log is the specification form where both the dependent and explanatory variables enter the regression in their log forms as follows:

$$LnP = \beta_1 LnX_1 + \beta_2 LnX_2 + \ldots\ldots\ldots\ldots\ldots\ldots + \beta_n LnX_n + \beta_z LnZ + \varepsilon_t\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(6)$$

For this study, we used the log-log functional form as suggested by Christensen, Jorgensen and Lau (1971).The model would allow us to measure the coefficients as elasticities. Also by converting the variables to logarithms, we can reduce multicollinearity and heteroscedasticity; hence reduce violation of the Ordinary Least Squares (OLS) assumptions.

Therefore, the empirical model to be estimated will be specified as:

$$LnP = \beta_0 + \beta_1 LnAge + \beta_2 LnSex + \beta_3 LnGrade + \beta_4 Season + \varepsilon_t\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(7)$$

Where, P= Market Price, A= age of animal (mature or not mature), SX= Sex; G= Grade or body condition rating, S= Season (rainy or dry season) and ε_t is the error term; b_1, b_2, b_3 and b_4 are the parameters to be estimated. Decomposing the model further we have:-

$$PRICE = \beta_0 + \beta_1 Lnmale + \beta_2 Lnfemale + \beta_3 Lnmature + \beta_4 Lnyoung + \beta_5 Lnfat + \beta_6 Lnthin +$$
$$\beta_7 Lnseason + \varepsilon_t\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(8)$$

3.3 Definition of the Variables
Market Price: The dependent variable of this study is the market price of live cattle. We used average monthly market prices of live cattle for a period of 48 months. Livestock market prices are normally assumed to be influenced by various factors. For the purpose of this study, age, sex, grade, and season are the factors that were considered.

Age: Age is an independent variable in the model. It measures whether a cattle sold in the market was mature or young. Prices are generally expected to be higher for matured cattle relative to the immature and young. This is associated with the live weight of animals which is the major criteria considered by live cattle buyers. In most cases, young and immature animals cannot attain the required live weight. For cattle, it is related to the feed conversion capacity of animals at this age. Thus, mature animals comparatively fetch higher prices.

Sex: This is an independent variable in the model, and it measures the sex of the cattle sold in the market. Sex indicates whether the cattle sold were female or male. The general trend in livestock markets in the ASAL areas is that female cows have relatively lower prices than their male counterparts. In most cases, the body weight is comparatively higher for the male cattle.

Grade/Body Condition: Grade is another independent variable which also measures the body condition of the cattle sold. It can either be fat or thin. In most cases the higher the grade, the higher the market price of the cattle for sale. The effect of dry season on prices due to its impact on supply and quality might indicate the potential to benefit from higher prices through temporal arbitrage using waiting grounds.

Season: Season is an independent variable in the model and it shows whether the cattle were sold at the market during a dry season or a wet/rainy season. Given the fact that most livestock in the ASAL regions depend on open rangelands for pasture, rainy seasons are the high seasons for availability of feeds, hence increase chances of animals getting fact, which is positively associated with higher market prices. Conversely, during the dry seasons, animals get weak due

to shortage of pasture, thus affecting their prices negatively. In the regression model, the wet season corresponds to the rainy season having relatively enough supply of feed to the livestock; the dry season to the contrary is the situation where there is shortage of feed and water and the time where producers are forced to take their livestock to the market.

3.4 Estimation Procedure

A multiple regression analysis was used to assess the significance of the parameter estimates. The study used *Eviews* statistical program to establish whether a statistically significant relationship exists between the determinants of prices of live cattle and the market prices cattle fetch at the Garissa Livestock Market.

Stationarity was tested for the data series by determining whether it contained a unit root. The Augmented-Dickey Fuller (ADF), Dickey & Fuller (1979) test was used for this determination. Co-integration of time series variables suggests that there is an equilibrium relationship between the variables. To estimate the long-run relationship, this paper used a Johansen vector error-correction framework (Johansen, 1991, 1992) which is normally good for models with more than two variables.

Multicollinearity exists when the independent variables of the hedonic model are correlated. It causes the estimates to have large variances and covariance, which causes the validity of the estimate to be questioned (Kmenta 1997; Kennedy 2003). Test for multicollinearity was done using Variance Inflation factor (VIF).

Autocorrelation is usually present in time-series data. It exists when there is correlation in a model's error terms. The existence of autocorrelation leads to a larger variance and standard

errors that are not efficient. Since the study seeks to use secondary data, test for autocorrelation of the residuals was done using Durbin-Watson Test.

3.5 Data Type and Source

The study used secondary monthly time series data for the period between January 2010 and December2013. The market price and together with other variables such as age, grade, sex and season data was obtained from the Kenya Livestock Marketing Council (KLMC), Garissa.

CHAPTER FOUR: EMPIRICAL ESTIMATION RESULTS

4.1 Introduction

The chapter covers data analysis and discussion of the results. It gives the descriptive statistics of the monthly prices of live cattle. In addition the chapter covers the regression results of estimated empirical model.

4.2 Empirical Results and Discussions

Table 1.0 descriptive statistics

	Price	male	Female	Mature	Young	Fat	Thin
Mean	9.7558	-0.4348	-1.0806	-0.6869	-0.3449	-0.8447	-1.2640
Median	9.7975	-0.4117	-1.0862	-0.6070	-0.3481	-0.7875	-1.2328
Maximum	10.2183	-0.2281	-0.6733	-0.2182	-0.1661	-0.2614	-0.7093
Minimum	8.9871	-0.7133	-1.5896	-1.4696	-0.5276	-1.6296	-1.8773
Std. Dev.	0.3673	0.1213	0.2264	0.3739	0.0828	0.4120	0.2224
Skewness	-0.5357	-0.4190	-0.1888	-0.6478	-0.0651	-0.3164	-0.3040
Kurtosis	2.0094	2.3615	2.3018	2.3524	2.5171	1.8918	3.3797
Jarque- Bera	4.2582	2.2201	1.2601	4.1963	0.5002	3.2569	1.0277
Probability	0.118941	0.3295	0.5325	0.1226	0.7787	0.1962	0.5982
Sum	468.278	-20.8745	-51.8714	-32.9721	-16.5568	-40.5453	-60.6737
Sum Sq. Dev.	6.3428	0.6918	2.4103	6.5735	0.3224	7.9763	2.3247
Observations	48	48	48	48	48	48	48

Table 1 gives the descriptive statistics for the dependent and independent variables. The natural logarithms of market price averaged at 9.76, with all other variables registering negative means for their natural logarithms. In terms of volatility, the number of fat cattle is more volatile as evidenced by its standard deviation of 0.4120 while the number of male sold as a proportion of all cattle has the least dispersion from the mean. All the variables are negatively skewed implying that they are left tailed. In terms of distribution the variables are non–normally distributed as shown by kurtosis values that depart from a value of 3.0. However, the number of thin cattle have a distribution close to normal since its kurtosis is 3.38 which is close to 3.0

4.3 Stationarity Test Results

Table 2.0 unit root test results

	AT LEVEL		AT FIRST DIFFERENCE	
Variables	With Intercept		With Intercept	
	Calculated Values	Critical Values	Calculated Values	Critical Values
price	-0.9512	-3.5812(at 1%) -2.9266 (at 5%)	-4.9223	-3.5812 (at 1%) -2.9266(at 5%)
male	-5.1727	-3.5812(at 1%) -2.9266 (at 5%)		
female	-5.4713	-3.5812(at 1%) -2.9266 (at 5%)		
Mature	-6.1242	-3.5812(at 1%) -2.9266 (at 5%)		
young	-6.4908	-3.5812(at 1%) -2.9266 (at 5%)		
fat	-1.5143	-3.5812(at 1%) -2.9266 (at 5%)	-7.3849	-3.5812 -2.9266
thin	-7.7159	-3.5812(at 1%) -2.9266 (at 5%)		

Table 2.0 presents the results for the unit root test that seeks to establish the order of integration of the variables. From the results, the total percentage of males, females, mature, young and this cattle sold are stationary at level thus implying that they are integrated of order zero; - I (0). Only the average market price and the percentage of fat cattle have one unit root hence turn out to be stationary upon the first difference implying that the average market price and the percentage of fat cattle sold are integrated of order one;- I (1).

4.4 Cointegration Test

Upon establishing the order of Cointegration for the variables, it's essential to test for Cointegration so as to determine the presence or absence of long run relationship among the variables. For this reason Johansen Cointegration test was applied. The results for the test were as follows:

Table 3.0 Johansen Cointegration test results.

Unrestricted Cointegration Rank Test (Trace)				
Hypothesized		Trace	0.05	
No. of CE(s)	Eigen value	Statistic	Critical Value	Prob.**
None *	0.720640	204.4032	159.5297	0.0000
At most 1 *	0.595316	145.7414	125.6154	0.0017
At most 2 *	0.520619	104.1276	95.75366	0.0117
At most 3 *	0.432823	70.30573	69.81889	0.0457
At most 4	0.343938	44.21992	47.85613	0.1054
At most 5	0.257101	24.83088	29.79707	0.1675
At most 6	0.190600	11.15993	15.49471	0.2019
Trace test indicates 4 cointegrating equations at the 0.05 level				
* denotes rejection of the hypothesis at the 0.05 level				
Unrestricted Cointegration Rank Test (Maximum Eigenvalue)				
Hypothesized		Max-Eigen	0.05	
No. of CE(s)				
None *	0.720640	58.66174	52.36261	0.0100
At most 1	0.595316	41.61380	46.23142	0.1439
At most 2	0.520619	33.82190	40.07757	0.2136
At most 3	0.432823	26.08582	33.87687	0.3155
At most 4	0.343938	19.38903	27.58434	0.3850
At most 5	0.257101	13.67096	21.13162	0.3926
At most 6	0.190600	9.727254	14.26460	0.2305
Max-eigen value test indicates 1 cointegrating equations at the 0.05 level				

From table 3.0 we conclude that there exists a long run relationship among the variables. This is evidenced by the trace and Max–Eigen statistics that indicate the presence of four and one cointegrating equations respectively. The implication here is that the variables move in a similar direction in the long run. Therefore our OLS estimation results give the long run relationship among the variables. This long run relationship therefore is the unrestricted regression. Since the variables are cointegrated then it calls for the Error Correction Model to correct for the short run disequilibrium.

4.5 OLS Regression Results

Upon carrying out the diagnostic tests on Stationarity and Cointegration, we regressed independent variables on the dependent variable. The results for estimation are presented in table 4.0 as follows:

Table 4.0 : OLS regression results

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNMALE	5.496530	1.361079	4.038361	0.0002
LNFEMALE	-2.988004	0.714953	-4.179298	0.0001
LNMATURE	4.494303	1.692220	2.655862	0.0112
LNYOUNG	-1.634378	0.612985	-2.666262	0.0109
LNFAT	0.077969	0.373390	0.208815	0.8356
LNTHIN	-0.656115	0.334476	-1.961622	0.0566
LNSEASON	-0.075919	0.156487	-0.485144	0.0302
R-squared	0.550227			
Durbin-Watson stat	1.984664			

Since the independent variables are like dummy variables as they take two states: - for gender we have male and female, for age of the cattle we have mature and young, for body condition we have fat and thin while for season we have wet and dry conditions, we therefore ignore the constant in our regression to avoid the problem of perfect collinearity.

From the regression results, the significant variables in explaining the average market price of the cattle are: gender; - both male and female, age of the cattle; - both mature and young, the thin body condition of the cattle and the season, given that their probability values are less than 5 percent significance level with the thin body condition at 10 percent significance level. Male, mature and fat variables positively influence the average market prices. For males, a one percent increase in the number of male cattle in the market as a proportion of the total number of cattle

offered for sale in the market increases the average market price for the cattle by 5.49 percent holding other factors constant.

For mature cattle, one percent increase in the number of mature cattle in the market as a proportion of the total number of cattle offered for sale in the market increases the average market price for the cattle by 4.49 percent holding other factors constant. Female characteristic, young, thin and season all shock the average market price negatively with the female characteristic posting the highest elasticity. The fat characteristic of the cattle positively influence the average market prices.

From the results, it's evident that cattle possessing characteristics of males and mature positively shock the average market price, while cattle possessing characteristics of female, young and thin negatively shock the average market price. The weather conditions definitely have negative impact on the average prices. With the area under study being faced with long dry spells, this leads to down side change in the market prices. This is in conformity with the reality.

Form the results, the independent variables account for 55.02 percent changes in the average market price as evidenced by the value for R^2. The Durbin Watson of 1.98 which is close to 2.0 negates the presence of autocorrelation.

Regression with a combination of characteristics

To ensure robustness of the results we combine some characteristics of two attributes of the cattle and establish their effects on the average market prices. In the case we combine gender

with the age, gender and body condition, age and the body condition. The regression results are summarised as follows:

Table 5.0 Results for gender and age characteristics combined

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNMALE	10.39406	7.899735	1.315748	0.1964
LNFEMALE	-3.483995	1.927333	-1.807677	0.0788
LNMATURE	13.13722	13.21825	0.993870	0.3267
LNYOUNG	-11.85953	3.869120	-3.065175	0.0040
LNFAT	0.298983	0.304222	0.982780	0.3321
LNTHIN	-0.423620	0.275332	-1.538580	0.0240
LNSEASON	-0.015484	0.137402	-0.112694	0.9109
LNFEMALEMATURE	8.842180	6.612961	1.337098	0.1894
LNMALEMATURE	11.99921	19.73888	0.607897	0.0470
LNMALEYOUNG	-12.13383	3.537238	-3.430312	0.0015
LNFEMALEYOUNG	-5.542934	2.475731	-2.238908	0.0313

R-squared	0.641474
Adjusted R-squared	0.544575
Durbin-Watson stat	1.799021

The results show that mature male cattle positively significantly influences average market price with the elasticity of 11.99. However, male young cattle negatively affect the price. Similarly are the young female cattle. The results are consistent with the OLS regression where female and young characteristics of the cattle have a negative effect on the average market price.

Table 6.0 Results for gender, age and body condition characteristics combined

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNMALE	23.87421	7.273501	3.282354	0.0023
LNFEMALE	-0.286112	0.955682	-0.299380	0.7664
LNMATURE	11.89763	5.002877	2.378158	0.0230
LNYOUNG	-4.036403	1.298364	-3.108838	0.0037
LNFAT	0.136475	1.915647	0.071242	0.9436

LNTHIN	-0.438734	1.863311	-0.235459	0.8152
LNSEASON	-0.107506	0.135804	-0.791627	0.4339
LNMALEMATURE	29.40925	12.83984	-2.290468	0.0281
LNMALEYOUNG	-10.94964	3.981342	-2.750239	0.0094
LNMALEFAT	0.517331	2.809934	0.184108	0.8550
LNMALETHIN	0.322662	2.777288	0.116179	0.9082
LNMATUREFAT	0.807117	4.078371	0.197902	0.8443
LNMATURETHIN	-0.326779	4.128200	-0.079158	0.9374

R-squared	0.594171
Adjusted R-squared	0.455030
Durbin-Watson stat	1.931400

From the results, both the male fat and the male thin cattle positively affect the average market price though insignificantly. Similarly are the mature fat cattle. However, mature thin cattle negatively impact on the average market prices though insignificantly too. The positive significant effects of male –mature and the male – young cattle are consistent with the previous findings.

4.6 The Error Correction Model

Since the variables have a long run relationship as evidenced by presence of Cointegration test, we run the error correction model to account for the short term disequilibrium. The results for the error correction model are summarised in table 7.0

Table 7.0 Results for Error Correction Model

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNFAT)	0.085234	0.111268	0.766020	0.4483
LNTHIN	0.036325	0.041793	0.869165	0.3901
LNMALE	-0.407077	0.444034	-0.916771	0.3649
LNFEMALE	-0.071334	0.235917	-0.302369	0.7640
LNSEASON	0.068710	0.062553	1.098435	0.2787
LNMATURE	0.212194	0.558524	0.379920	0.7061
LNYOUNG	0.121611	0.202446	0.600709	0.5515
E (-1)	-0.004459	0.058893	-0.075722	0.0400

R-squared	0.211950
Adjusted R-squared	0.070505
Durbin-Watson stat	1.515990

From the results, the error correcting coefficient fulfils the requirement of it being negative and less than one. This implies that the rate at which the short term disequilibrium are correcting towards the long run stable equilibrium is 0.44 percent monthly.

CHAPTER FIVE: SUMMARY, CONCLUSIONS AND POLICY RECOMMENDATIONS

5.1 Introduction

This chapter provides the summary and conclusion of the study, policy recommendations, and limitations of the study and areas of further research.

5.2 Summary

The research paper examined the market price determinants of live cattle as observed in Garissa Livestock Market from January 2010 through December 2013, and establishes the relationship between observed market price and the factors that determine them. A hedonic pricing model was fitted to examine the determinants of observed prices for live cattle. The dependent variable was the average monthly market prices of live cattle, while the independent variables included; age, sex, grade/body condition and season in which the observed month fell on.

The study used pre-estimation tests and also examined time series properties of the underlying data using the Augmented Dickey Fuller test to check whether the data contained a unit root. The Augmented Dickey Fuller test showed that the total percentage of males, females, mature, young are stationary at level thus implying that they are integrated of order zero. Only the average market price and the percentage of fat cattle have one unit root hence turn out to be stationary upon the first difference implying that the average market price and the percentage of fat cattle sold are integrated at order one.

The test for co-integration showed that there exists a long run relationship among the variables. This is evidenced by the trace and Max–Eigen statistics that indicate the presence of four and one

cointegrating equations respectively. The implication here is that the variables move in a similar direction in the long run.

5.3 Conclusion

The livestock sub-sector in Kenya plays a significant role in the economy with many rural Kenyans deriving a range of financial benefits from livestock keeping. Livestock owners often 'cash in' their animals for particular purposes at a time of need and choice. This flexibility gives livestock owners access to money without the need to borrow, and confers an additional financial benefit beyond the sale, slaughter or transfer value of their livestock. In addition, the sub-sector provides a source of meat in the local markets and beyond as it contributes to Kenya's export especially in beef export which is a source of foreign exchange earnings for the country.

Since pastoralists hold most of their wealth in the form of livestock, markets for their livestock exert considerable influence over their livelihoods, both by establishing the value of their assets and by affecting their livestock management decisions. Given the critical role livestock plays in the lives of the pastoralist communities, there still exists a myriad of constraints that can be averted by the government through relevant policies. These challenges include poor market access and price volatility, insecurity, poor rangelands management, poor market information, lack of relevant infrastructure etc.

Given these challenges, the study sought to carry out an empirical examination to establish the relationship between market price of livestock and some of the price determining factors such as body condition, sex, age and season/weather.

From the data analysis the following conclusions are deduced. First is that male cattle positively and significantly impact on the average market prices of cattle. However, both genders are critical determinants of the average market price for the cattle. The results imply that the male cattle are more valuable compared to the female cattle as far as Garissa cattle market is concerned. Therefore, the more the number of male cattle as a proportion of the total cattle in the market, the higher the upward surge in the average prices.

Secondly, season is a critical determinant of the average market price in Garissa with it having a negative effect on the price. For the body condition, thin cattle fetch low market prices hence negatively impact on the average price in the market. With regard to the cattle age, the market prices are positively driven by mature cattle as opposed to the young cattle. This is perhaps due to mature cattle having more products upon processing as opposed to the young ones.

5.4 Policy Recommendations

Kenya's livestock sub-sector earns the country a substantial foreign exchange through export of live animals, beef, hides and skins, and dairy products. It also employs about a huge chunk of the country's agricultural sector labour force. Furthermore, the sub-sector contributes significant earnings to households especially in the ASAL areas through sale of livestock and livestock products; and provides raw material for some agro-industries in the country.

Marketing of livestock and livestock products is a major economic enterprise that engages many businessmen in the country. In Kenya, livestock marketing is largely in the hands of the private sector, with the government only offering regulatory and facilitation services. The key marketing agents include the private live animal traders, butchers, and middlemen. In the past, the

international markets for livestock and livestock products for Kenya have mainly been in the Middle East and European countries, a situation that has changed during the last few years. This is mainly because Kenya has not been able to meet the necessary Sanitary and Phytosanitary Standards set under the relevant World Trade Organization statute.

The determinants of price formation in livestock markets have been revealed by theory and empirical evidence. This implies that policy recommendations can be suggested. This section therefore provides some policy options that can be pursued to realize the full potential of the livestock sub-sector to benefit pastoral communities as well as the general economy in Kenya. The following are some of the policy recommendations suggested to curb bottlenecks that impede the livestock sub-sector and hence promote the realisation of its full potential:-

Early warning systems and proper mitigation interventions should be set up in the livestock subsector. Droughts occur in the region regularly, particularly in the arid and semi arid areas which often results to loss of livestock, collapse of local livestock markets and sometimes leading to famine. There is, therefore, need to put in place measures that will minimize losses occasioned by such droughts. This can be achieved by establishing early warning systems as a policy to control potential hazards, and also consider restocking measures for mitigation against the damages caused by drought. Furthermore, the government of Kenya should consider putting in place mechanisms for emergency livestock off- take.

Developing and the rehabilitation of livestock marketing infrastructure is a key aspect in enhancing the performance of the livestock subsector. The Ministry of Agriculture and Livestock

Development should in collaboration with county governments allocate funds for the development of livestock marketing infrastructure in order to improve local livestock market. Specific attention should be offered to the protection of the existing holding grounds from acquisition by private developers or any other entity and the setting up of quarantine stations at Mombasa port, which up to now does not exist at all. Developing good infrastructure directly facilitates efficient market and trade performance, and, by extension, affects producer prices. At the moment Kenya's infrastructure such as roads, holding grounds, stock routes for livestock, etc is in poor state, and hence not conducive to efficient livestock marketing.

Livestock marketing information system should also be strengthened by facilitating disseminations to both the producers and consumers. Given the importance of prices in determining livestock production and the farmers' earnings, the government should establish mechanisms for strengthening the market information systems and institutionalize linkages with other international markets to overcome such distortions and their effects. An efficient market information system is an essential element for enhancing market competitiveness. In a system where market information flow is efficient, the ability of producers, traders and consumers to make the right choices is vastly enhanced. On the other hand, inefficient market information system creates market distortions that eventually tend to make business expensive to both the producers and consumers.

Promote peace building initiatives and the establishment conflict early warning systems in an effort to combat community conflicts. Insecurity limits livestock transportation to various markets and, therefore, reduces performance of livestock trade. For example, trekking animals to

the markets has been found to be cheaper than truck transport, but trekking is currently unsafe due to the banditry menace and cattle rustling especially in the ASAL areas. Therefore, by collaborating with local ASAL communities, the issue of insecurity can be addressed well by embarking on serious peace building and awareness initiatives.

Enforcement of the Sanitary and Phytosanitary Standards (SPS) as per the World Trade Organization Agreements of which Kenya is a signatory should be undertaken. The government should develop and enforce a code of practice that will be acceptable to national and international standards at all stages of production and marketing. The high standards set by importing countries on livestock and livestock products hinder the country's ability to exploit the high potential in the international markets.

Deliberate efforts to facilitate the development of skills and adoption of appropriate value addition technologies in the livestock subsector should be undertaken by the government and other relevant stakeholders. Lack of skilled manpower continues to affect new technology development and uptake, especially in value addition investment ventures. This will create opportunities to ensure diversification of livestock products hence improving the production level of the subsector.

The government should support local manufacturing and processing industries and put in place mechanisms that promote the use of livestock by-products such as the support to hides and skins management for growth of the leather industry. Most livestock by-products go to waste mainly because of limited processing capacity in the country. Therefore, that stock of by-products which

presents immense potential and opportunity for improved earnings and welfare of the livestock farmers, traders and processors, can be positively tapped to increase productivity.

Promotion of rangelands management aimed at addressing resource management in pasturelands and communal grazing areas is very necessary. One of the major challenges faced by livestock keepers especially in the ASAL areas of Kenya is the poor rangelands management that tend to result in overgrazing, deforestation, burning of pasture fields etc. All these problems leads to risks such as loss of pasture for the livestock which eventually leads to loss of livestock hence loss of livelihoods for the poor communities who tend to rely solely on livestock keeping. Therefore, by putting in place policies to manage existing rangelands, such risks would be mitigated.

Finally, the government of Kenya needs to recognize the central contribution of the informal cross border livestock trade to the national economy. With Kenya being a net livestock importer, dependent on the cross-border trade especially from Somalia and Ethiopia to provide the bulk of the red meat available in Nairobi, it neither officially sanctions the entire cross-border trade, nor does it attempt to accurately monitor it. Therefore, to support regional trade, it is recommended that Kenyan policy makers document the scale of the trade and its benefits to our economy so as to chart a way forward on how to raise revenue from the cross-border livestock trade that would in turn be used to plough back into the subsector.

5.5 Limitations of the Study

The study used monthly secondary time series data which was marked by cases of missing values especially with the volume of sales in terms of sex. Approximate values were used in such instances and this may have compromised the accuracy and quality of the data.

5.6 Areas of Further Research

This study has focused on determinants of price over a short period of time (48 months). Future research should investigate these determinants over a longer time in order to begin to explore how other factors such as colour, breed type; supply responses etc. affect market prices of livestock. Further studies should also be undertaken to find out factors that can enhance livestock exports so as to recommend informed policies that would promote the sub-sector's performance and contribution to the national GDP.

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APPENDIX

Null Hypothesis: LNP has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.951214	0.7626
Test critical values:	1% level	-3.581152	
	5% level	-2.926622	
	10% level	-2.601424	

Trend and intercept

Null Hypothesis: LNP has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 1 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.656519	0.7543
Test critical values:	1% level	-4.170583	
	5% level	-3.510740	
	10% level	-3.185512	

Null Hypothesis: D(LNP) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.922341	0.0002
Test critical values:	1% level	-3.581152	
	5% level	-2.926622	
	10% level	-2.601424	

Null Hypothesis: D(LNP) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.976031	0.0011
Test critical values:	1% level	-4.170583	
	5% level	-3.510740	
	10% level	-3.185512	

Male

Null Hypothesis: LNMALE has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.172665	0.0001
Test critical values:	1% level	-3.577723	
	5% level	-2.925169	
	10% level	-2.600658	

Female

Null Hypothesis: LNFEMALE has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.471335	0.0000
Test critical values:	1% level	-3.577723	
	5% level	-2.925169	
	10% level	-2.600658	

Mature

Null Hypothesis: LNMATURE has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-6.124251	0.0000
Test critical values:	1% level	-3.581152	
	5% level	-2.926622	
	10% level	-2.601424	

Young

Null Hypothesis: LNYOUNG has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=9)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-6.490806	0.0000

Test critical values:	1% level	-3.577723
	5% level	-2.925169
	10% level	-2.600658

Constant - fat

Null Hypothesis: LNFAT has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=9)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-1.514331	0.5177
Test critical values: 1% level	-3.577723	
5% level	-2.925169	
10% level	-2.600658	

Constant and trend – fat

Null Hypothesis: LNFAT has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=9)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-1.721534	0.7259
Test critical values: 1% level	-4.165756	
5% level	-3.508508	
10% level	-3.184230	

Fist diff. – constant

Null Hypothesis: D(LNFAT) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=9)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-7.384878	0.0000
Test critical values: 1% level	-3.581152	
5% level	-2.926622	
10% level	-2.601424	

First diff – trend and constant

Null Hypothesis: D(LNFAT) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=9)

60

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-7.367898	0.0000
Test critical values: 1% level	-4.170583	
5% level	-3.510740	
10% level	-3.185512	

Thin – constant

Null Hypothesis: D(LNTHIN) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=9)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-7.715974	0.0000
Test critical values: 1% level	-3.581152	
5% level	-2.926622	
10% level	-2.601424	

Cointegration Test

Date: 09/08/14   Time: 16:20
Sample (adjusted): 3 48
Included observations: 46 after adjustments
Trend assumption: Linear deterministic trend
Series: LNP LNMALE LNFEMALE LNFAT LNMATURE LNSEASON
LNTHIN LNYOUNG
Lags interval (in first differences): 1 to 1

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.720640	204.4032	159.5297	0.0000
At most 1 *	0.595316	145.7414	125.6154	0.0017
At most 2 *	0.520619	104.1276	95.75366	0.0117
At most 3 *	0.432823	70.30573	69.81889	0.0457
At most 4	0.343938	44.21992	47.85613	0.1054
At most 5	0.257101	24.83088	29.79707	0.1675
At most 6	0.190600	11.15993	15.49471	0.2019
At most 7	0.030665	1.432673	3.841466	0.2313

Trace test indicates 4 cointegratingeqn(s) at the 0.05 level
 * denotes rejection of the hypothesis at the 0.05 level
 **MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.720640	58.66174	52.36261	0.0100
At most 1	0.595316	41.61380	46.23142	0.1439
At most 2	0.520619	33.82190	40.07757	0.2136
At most 3	0.432823	26.08582	33.87687	0.3155
At most 4	0.343938	19.38903	27.58434	0.3850
At most 5	0.257101	13.67096	21.13162	0.3926
At most 6	0.190600	9.727254	14.26460	0.2305
At most 7	0.030665	1.432673	3.841466	0.2313

Max-eigenvalue test indicates 1 cointegratingeqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Descriptive statistics

	LNP	LNMALE	LNFEMALE	LNFAT	LNMATURE	LNTHIN	LNYOUNG
Mean	9.755799	-0.434887	-1.080654	-0.686918	-0.344933	-0.844696	-1.264036
Median	9.797571	-0.411737	-1.086200	-0.607012	-0.348141	-0.787518	-1.232729
Maximum	10.21830	-0.228156	-0.673345	-0.218156	-0.166055	-0.261365	-0.709277
Minimum	8.987197	-0.713350	-1.589635	-1.469676	-0.527633	-1.629641	-1.877317
Std. Dev.	0.367360	0.121326	0.226455	0.373983	0.082832	0.411957	0.222398
Skewness	-0.535711	-0.419059	-0.188866	-0.647848	-0.065076	-0.316388	-0.304011
Kurtosis	2.009452	2.361558	2.301853	2.352430	2.517108	1.891831	3.379679
Jarque-Bera	4.258259	2.220101	1.260182	4.196355	0.500248	3.256884	1.027692
Probability	0.118941	0.329542	0.532543	0.122680	0.778704	0.196235	0.598190
Sum	468.2783	-20.87459	-51.87140	-32.97206	-16.55680	-40.54539	-60.67372
Sum Sq. Dev.	6.342812	0.691842	2.410255	6.573558	0.322471	7.976314	2.324655
Observations	48	48	48	48	48	48	48

Dependent Variable: LNP
Method: Least Squares
Date: 09/08/14   Time: 16:45
Sample: 1 48
Included observations: 48

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNMALE	5.496530	1.361079	4.038361	0.0002
LNFEMALE	-2.988004	0.714953	-4.179298	0.0001
LNMATURE	4.494303	1.692220	2.655862	0.0112
LNYOUNG	-1.634378	0.612985	-2.666262	0.0109
LNFAT	0.077969	0.373390	0.208815	0.8356
LNTHIN	-0.656115	0.334476	-1.961622	0.0566

LNSEASON	-0.075919	0.156487	-0.485144	0.0302

R-squared	0.550227	Mean dependent var	9.755799
Adjusted R-squared	0.255138	S.D. dependent var	0.367360
S.E. of regression	0.317052	Akaike info criterion	0.674533
Sum squared resid	4.121391	Schwarz criterion	0.947417
Log likelihood	-9.188802	Hannan-Quinn criter.	0.777656
Durbin-Watson stat	1.784664		

Dependent Variable: LNP
Method: Least Squares
Date: 09/08/14   Time: 16:56
Sample: 1 48
Included observations: 48

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNMALE	10.39406	7.899735	1.315748	0.1964
LNFEMALE	-3.483995	1.927333	-1.807677	0.0788
LNMATURE	13.13722	13.21825	0.993870	0.3267
LNYOUNG	-11.85953	3.869120	-3.065175	0.0040
LNFAT	0.298983	0.304222	0.982780	0.3321
LNTHIN	-0.423620	0.275332	-1.538580	0.0240
LNSEASON	-0.015484	0.137402	-0.112694	0.0302
LNFEMALEMATURE	8.842180	6.612961	1.337098	0.1894
LNMALEMATURE	11.99921	19.73888	0.607897	0.5470
LNMALEYOUNG	-12.13383	3.537238	-3.430312	0.0015
LNFEMALEYOUNG	-5.542934	2.475731	-2.238908	0.0313

R-squared	0.641474	Mean dependent var	9.755799
Adjusted R-squared	0.544575	S.D. dependent var	0.367360
S.E. of regression	0.247914	Akaike info criterion	0.246578
Sum squared resid	2.274065	Schwarz criterion	0.675395
Log likelihood	5.082119	Hannan-Quinn criter.	0.408629
Durbin-Watson stat	1.599021		

Dependent Variable: LNP
Method: Least Squares
Date: 09/08/14   Time: 16:44
Sample: 1 48
Included observations: 48

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNMALE	23.87421	7.273501	3.282354	0.0023
LNFEMALE	-0.286112	0.955682	-0.299380	0.7664
LNMATURE	11.89763	5.002877	-2.378158	0.0230
LNYOUNG	-4.036403	1.298364	-3.108838	0.0037
LNFAT	0.136475	1.915647	0.071242	0.9436

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNTHIN	-0.438734	1.863311	-0.235459	0.8152
LNSEASON	0.107506	0.135804	0.791627	0.4339
LNMALEMATURE	29.40925	12.83984	-2.290468	0.0281
LNMALEYOUNG	-10.94964	3.981342	-2.750239	0.0094
LNMALEFAT	0.517331	2.809934	0.184108	0.8550
LNMALETHIN	0.322662	2.777288	0.116179	0.9082
LNMATUREFAT	-0.807117	4.078371	-0.197902	0.8443
LNMATURETHIN	-0.326779	4.128200	-0.079158	0.9374

R-squared	0.594171	Mean dependent var		9.755799
Adjusted R-squared	0.455030	S.D. dependent var		0.367360
S.E. of regression	0.271193	Akaike info criterion		0.453841
Sum squared resid	2.574096	Schwarz criterion		0.960625
Log likelihood	2.107809	Hannan-Quinn criter.		0.645356
Durbin-Watson stat	1.931400			

Dependent Variable: LNP
Method: Least Squares
Date: 09/08/14   Time: 16:58
Sample: 1 48
Included observations: 48

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNMALE	7.080301	3.467440	-2.041939	0.0483
LNFEMALE	-5.595838	1.527562	-3.663247	0.0008
LNMATURE	0.945998	1.633016	-0.579295	0.5659
LNYOUNG	-0.246996	0.601924	-0.410344	0.6839
LNFAT	6.294172	3.994123	-1.575858	0.1236
LNTHIN	-7.259610	3.248100	-2.235033	0.0315
LNSEASON	0.096229	0.133609	0.720226	0.4759
LNMALEFAT	5.259869	2.940278	-1.788902	0.0818
LNMALETHIN	-5.679242	4.447020	-1.277089	0.2095
LNFEMALEFAT	-4.102631	2.858294	-1.435343	0.1596
LNFEMALETHIN	-4.154852	1.683439	-2.468074	0.0183

R-squared	0.582478	Mean dependent var		9.755799
Adjusted R-squared	0.469634	S.D. dependent var		0.367360
S.E. of regression	0.267534	Akaike info criterion		0.398913
Sum squared resid	2.648262	Schwarz criterion		0.827730
Log likelihood	1.426087	Hannan-Quinn criter.		0.560964
Durbin-Watson stat	0.491776			

Dependent Variable: LNP
Method: Least Squares
Date: 09/08/14   Time: 17:03
Sample: 1 48
Included observations: 48

Variable	Coefficient	Std. Error	t-Statistic	Prob.

LNMALE	0.486761	1.804846	0.269697	0.7889
LNFEMALE	-0.259862	0.961498	0.270268	0.7885
LNMATURE	11.12787	4.498026	-2.473944	0.0181
LNYOUNG	-4.964042	1.184460	-4.190974	0.0002
LNFAT	8.996418	3.049805	-2.949834	0.0055
LNTHIN	-3.958408	3.688122	-1.073286	0.2901
LNSEASON	0.091461	0.130818	0.699145	0.4888
LNMATUREFAT	10.30551	3.750596	-2.747699	0.0092
LNMATURETHIN	-3.585373	5.793706	-0.618839	0.5398
LNYOUNGTHIN	-1.846348	1.662120	-1.110839	0.2738
LNYOUNGFAT	-4.539661	1.630026	-2.785023	0.0084

R-squared	0.602041	Mean dependent var	9.755799
Adjusted R-squared	0.494484	S.D. dependent var	0.367360
S.E. of regression	0.261192	Akaike info criterion	0.350926
Sum squared resid	2.524182	Schwarz criterion	0.779743
Log likelihood	2.577765	Hannan-Quinn criter.	0.512977
Durbin-Watson stat	0.527959		

Dependent Variable: D(LNP)
Method: Least Squares
Date: 09/09/14   Time: 14:43
Sample (adjusted): 2 48
Included observations: 47 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNFAT)	0.085234	0.111268	0.766020	0.4483
LNTHIN	0.036325	0.041793	0.869165	0.3901
LNMALE	-0.407077	0.444034	-0.916771	0.3649
LNFEMALE	-0.071334	0.235917	-0.302369	0.7640
LNSEASON	0.068710	0.062553	1.098435	0.2787
LNMATURE	0.212194	0.558524	0.379920	0.7061
LNYOUNG	0.121611	0.202446	0.600709	0.5515
E1	-0.004459	0.058893	-0.075722	0.0400

R-squared	0.211950	Mean dependent var	0.011957
Adjusted R-squared	0.070505	S.D. dependent var	0.108610
S.E. of regression	0.104711	Akaike info criterion	-1.521383
Sum squared resid	0.427613	Schwarz criterion	-1.206464
Log likelihood	43.75249	Hannan-Quinn criter.	-1.402877
Durbin-Watson stat	1.515990		