SPATIAL MARKET INTEGRATION AND PRICE TRANSMISSION OF SELECTED GROUNDNUTS MARKETS IN ZAMBIA

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A Thesis submitted to the Graduate School in partial fulfilment of the requirements for the Award of the Master of Science Degree in Agricultural and Applied Economics

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DECLARATION AND RECOMMENDATION

Declaration

This research thesis is my original work and has not been presented in this or any other university for the award of a degree and that all the sources that I used have been acknowledged.

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Recommendation

This research thesis has been submitted to the Graduate School of Egerton University with our recommendation as the University supervisors.

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DEDICATION

I dedicate this thesis to my parents, Francis Ignasio Chola Lupiya and Maidah M'gwadi Lupiya, my siblings and friends.

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ABSTRACT

With increasing population in the main consumption regions of Zambia, there is a persistent shortage in the supply of groundnuts especially in Lusaka and the Copperbelt regions. This is despite the major producing areas of Eastern and Northern regions having significant surpluses. This is a clear indication of market failure to stimulate groundnut production and distribution in addition to excessive price volatility, information asymmetry, and lack of organized and consistent markets. Knowing about the extent of market integration and price transmission in groundnut markets is important for agricultural policy decisions. The general objective of the study is to investigate the degree of integration and price transmission among geographically separated groundnut markets in Zambia in order to enhance the flow of market information among groundnut market participants. The specific objectives of the study are to characterize the spatial price differentials of groundnuts between deficit and surplus areas, to determine the extent of market integration between the deficit and surplus areas and lastly, determine the speed of adjustment in the retail prices between the surplus and deficit areas. The study analyzed monthly average retail price data covering the period from January 2001 to March 2017. Descriptive statistics revealed that consumption regions had the highest nominal mean prices with Lusaka and Kitwe recording K12.32 and K8.82 per Kg respectively while the producing regions recorded the lowest mean groundnuts prices. The Augmented Dickey-Fuller (ADF) and Kwiatkowski Philips Schmidt Shin (KPSS) tests were both used to test for stationarity, Johansen Co-integration test was used to test for long-run relationships among the variables while the Vector Error Correction Model was used to ascertain the speed of adjustment between the deficit and surplus areas. Both the ADF and KPSS showed that Chipata, Chadiza, Petauke and Kasama markets were non-stationary at level, meaning that the prices in these markets had a unit root process, but Lusaka and Kitwe prices were stationary at their original levels. However, after the first difference, all the markets were stationary and significant at 1 percent level. After establishing that there was Stationarity among the variables, Johansen Co-integration test showed the existence of co-integration at 5 percent level of significance. Furthermore, granger causality showed bi-directional causality between Kitwe and Chadiza markets. The VECM showed that after exogenous shocks, most of the corrections were made by the urban markets which are the deficits markets. The study recommends that policy makers or private and public development practitioners should consider development and constant use of market infrastructures in order to enhance efficiency in the groundnut markets.

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ACRONYMS AND ABBREVIATIONS

ADF	Augmented Dickey-Fuller
CPI	Consumer Price Index
CSO	Central Statistics Office
COMACO	Community for Conservation Markets
ECM	Error Correction Model
FAO	Food and Agriculture Organization
GDP	Gross Domestic Product
GRZ	Government Republic of Zambia
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
KPSS	Kwiatkowski-Philips-Schmidt-Shin
MDGs	Millennium Development Goals
MAL	Ministry of Agriculture and Livestock
MOA	Ministry Of Agriculture
NAMBOARD	National Agricultural Marketing Board
NASFAM	National Smallholder Farmers' Association of Malawi
PBM	Parity Bound Model
SDGs	Sustainable Development Goals
SPSS	Statistical Package for the Social Sciences
TAR	Threshold Autoregressive Model
TVECM	Threshold Vector Error Correction Model
UNDP	United Nations Development Programme
VAR	Vector Autoregressive Model
VECM	Vector Error Correction Model
ZDA	Zambia Development Agency

CHAPTER ONE

INTRODUCTION

1.1 Background to the study

Agriculture continues to be one of the key priority sectors in Zambia as it contributes to the country's export base and general growth of the economy. The agricultural sector contributes 20 percent towards the country's Gross Domestic Product (GRZ, 2013). In 2015, the agriculture sector contributed 8.5 percent towards the Gross Domestic Product and 9.6 percent of the national export earnings (Chapoto and Chisanga, 2016). The sector is dominated by smallholder farmers growing a variety of crops for their livelihood and income generation as it acts as a source of employment. With around 58% of the Zambian population living in absolute poverty, the sector has remained the prime blueprint to the achievement of the New Sustainable Development Goals (SDGs) designed to alleviate poverty and hunger in all its forms (UNDP, 2013).

As a result, agriculture has continued to receive priority attention by the government of Zambia through increased budget allocation. This is in an effort to increase agricultural productivity that will, in turn, increase food security, employment rates and reduce poverty (ZDA, 2011). Despite the importance of the agricultural sector as a whole, the government has given much priority to maize production which takes up more than 60% of the share of arable land (CSO/MAL, 2011). Other vital crops like groundnuts among others are given less consideration.

Groundnut is the fifth most widely grown crop in the Sub Saharan Africa after maize, sorghum, millet and cassava (FAO, 2010). However, it is the second most widely grown crop after maize by smallholder farmers and constitutes 8% of arable land in Zambia (Mukuka *et al*., 2013; Chapoto and Chisenga, 2016). The crop thrives well on a vast range of conditions with the majority of smallholder farmers in Zambia and SSA growing exclusively for both consumption and as a cash crop (FAO, 2008). The major groundnut-producing areas in Zambia are Eastern and Northern Provinces in agro-ecological zones I and II, which are suited for its cultivation (MAL, 2012). In Eastern province, smallholder farmers produce 30 percent of national production (CSO, 2011).

Groundnuts are not only rich in proteins, but also a source of income for rural households. The crop also serves as an important raw material in the manufacturing of products such as peanut butter, oil and animal feeds. Also, as a legume crop, it provides nitrogen fixation thereby enhancing soil fertility (Setimela *et al*., 2004). In the years between 2000 and 2011, land under groundnut production was expanded by 22% with over 18% of the farmers in the country joining groundnut production. This led to significant increases in groundnut yields in the country (Zulu *et al.*, 2014). As an incentive, farmers need stable and competitive prices for their groundnuts.

Agricultural markets and market information are cardinal for effective participation of smallholder farmers in agricultural markets (Mawazo *et al*., 2014). Smallholder farmers, particularly groundnuts producers, have challenges to access market information such as the price of a commodity in the local markets (Ross and De Klerk, 2012). This, in turn, affects the producers' capacity to participate in informed and profitable trade as well as taking advantage of seasonal and spatial arbitrage. Due to the lack of market price information, smallholder farmers will only negotiate for the price that the buyers provide, hence jeopardizing their marketing decisions.

The defunct National Agricultural Marketing Board (NAMBOARD) had traditionally been responsible for the buying and selling of agricultural commodities. This conditioned private traders to obtain licenses for every agricultural product they wanted to engage in. Furthermore, obtaining licenses was not an easy task, as such entry into the market was highly restricted. This made the government through respective agencies to be responsible for determining prices of agricultural commodities. It was, later on, discovered that government involvement in pricing commodities prevented competition among traders leading to farmer exploitation that affected farmers' morale. As an incentive, the Zambian government saw it befitting to liberalize markets in 1992 to improve market sufficiency (MOA, 2004).

Several strategies and policies have been put in place to enhance market access, market information and market participation by smallholder farmers. The National Development Plan is committed to the aspirations and determination of the country to foster a prosperous middle-income status through the two main economic pillars of Vision 2030 and the New Sustainable Development Goals (GRZ, 2013). This can best be achieved by creating a favourable environment for the growth of the agricultural sector by taking the interest of the smallholder farmers who are the majority. To successfully implement this, a study on agricultural crop market performance and its associated price dynamics will be a vital contribution to an effective marketing system of agricultural products.

Despite the government embarking on these policies, groundnut marketing in Zambia has remained inefficient with farmers experiencing excessive price volatility, information asymmetry and lack of organized and consistent markets (Ross and Klerk, 2012). These inefficiencies in the market have led to the acute demand of groundnuts in the scarcity areas despite the surpluses in the main groundnut producing areas (Ross and Klerk, 2012; Mofya-Mukuka and Shipekesa, 2013). Hence, there is the need to establish an efficient and well-coordinated market system capable of effectively transmitting price signals among markets in spatial locations and distribute groundnut from surplus regions to regions of demand. This will assist in regulating and monitoring groundnut prices in different markets.

The study explored the network of buyers, sellers and other actors that converge to trade in a particular product (groundnuts), thereby determining the pricing efficiency in the market. This would help to ascertain the extent to which spatial markets are integrated. To do so, the study focused on certain markets in Eastern and Northern Provinces which are the major producing areas. Additionally, the study also focused on Lusaka and Copperbelt Provinces that have traditionally been regarded as the main consumption areas (Chiwele *et al*., 1998). There is need to identify areas that are plunged with chronic groundnut deficit to devise an appropriate mechanism for ensuring that the area has enough food all the time. However, regulating and monitoring of prices cannot be done in each area or village of Zambia. This can be done through selecting few markets and establishing if these markets are integrated or not.

Economic theory suggests that optimum distribution of resources can be attained if markets and marketing channels are functioning properly. Spatial market integration approach is used to test relationships between markets. Market integration exists when there are co-movements in prices of similar commodities in different markets and if trade occurs across spatial markets. According to Goletti *et al*. (1995), the study defined spatial integration as a smooth price transmission of both information and price signals through across markets. A well-integrated market is cardinal for a well-functioning market economy. Ahmad and Gjolberg (2015) argue that spatial price relationships have often been used to indicate overall market performance. Also, an understanding of spatial market integration enables policy makers to formulate good economic policies.

When markets are integrated, food commodities flow from surplus to deficit areas. Deficit areas are usually associated with high prices, thereby creating an incentive for traders to bring food from surplus areas to deficit areas. Rational traders will join the market and capitalize on these arbitrage opportunities increasing the demand for the commodity in the surplus area while increasing supply of the commodity in the deficit areas. This tendency continues until the prices in both markets reach an equilibrium level. Thus, trade at this point is unprofitable (Semira, 2014).

The price differences that cannot be explained by transportation and transaction costs show inefficient arbitrage and most likely the presence of market power. When markets are not integrated, it reflects the existence of imperfect competition, poor infrastructure and missing institution that disturb the efficient flow of commodities (Ahmed and Gjolberg, 2015).

1.2 Statement of the Problem

Groundnuts consumption at the national and local level in Zambia is very high. With increasing population in the main consumption regions, there is a persistent shortage in the supply of groundnuts especially in Lusaka and the Copperbelt regions. This is despite the major producing areas of Eastern and Northern regions having significant surpluses. This is a clear indication of market failure to stimulate groundnut production and distribution in addition to excessive price volatility, information asymmetry and lack of organized and consistent markets. These market inefficiencies not only make it hard for producers to plan their production and forecast profits, but it also interferes with end-users consumptions patterns. Despite the Zambian government liberalizing the groundnut markets, scanty studies have been done on spatial integration of groundnut markets. It is from the foregoing that this study aimed at filling these gaps by evaluating the degree of spatial integration and price transmission among geographically separated groundnut markets in Zambia.

1.3 Objectives

1.3.1 General Objective

To investigate the degree of integration and price transmission among geographically separated groundnut markets in Zambia in order to enhance the flow of market information among groundnut market participants.

1.3.2 Specific Objectives

i. To characterize the spatial price differentials of groundnuts between deficit and surplus areas.
ii. To determine the extent of market integration between the deficit and surplus areas.
iii. To determine the speed of adjustment in the retail prices between the deficit and surplus areas.

1.4 Research Questions

i. What are the spatially induced differences in groundnut prices between deficit and surplus markets?
ii. To what extent are the deficit and surplus groundnut markets integrated?
iii. What is the speed of adjustment in the retail prices between the deficit and surplus area?

1.5 Justification of the Study

Despite the importance and benefits of market integration to the economy, no study related to the subject matter had been conducted in Zambia to assess the extent of groundnuts integration between markets. Therefore, providing knowledge on groundnut information does not just end at the point of groundnut production and consumption, but goes beyond to inform policy and fulfil Vision 2030 through the National Development Plan’s five-year medium term. Most studies in Zambia have shifted concentration to crops like maize, coffee, tobacco, cotton, cassava, sugar cane and recently horticultural while neglecting vital food crops like groundnuts yet it was the second most important crop grown nationally (Muyatwa, 2000; Chisanga *et al*., 2015; Sunga, 2017).

The knowledge of market integration would enable the government and stakeholders to come up with sound policies such as price stabilization policies that would protect farmers from price risks. This would, in turn, enhance self-sufficiency among smallholder farmers. Alderman (1993) argued that there was a positive relationship between the ease to implement stabilization policies and the extent to which markets were integrated. In addition, Fackler and Goodwin (2001) rightly argued that the extent of market integration was important for designing stabilization policies. Therefore, this study would play a critical role in implementing appropriate policies. Also, Kabbiri *et al*. (2016) observed that studies on market integration had concentrated a lot on countries like China, Ethiopia, Ghana, India, Malawi, Russia and United States of America (USA). Therefore, this study would make literature available for future references in countries that have not been covered particularly Zambia.

1.6 Scope and Limitation of the study

This study only focused on a few selected groundnuts markets in Zambia. Smallholder farmers nearly in all the provinces of Zambia mainly grow groundnuts. The study selected major producing markets in both Eastern and Northern Province as they had a long tradition of growing groundnuts before and after liberalization. The selected consumption regions are Lusaka and Copperbelt Provinces because these provinces are experiencing rapid urbanization.

Furthermore, the data collected was from January 2001 to March 2017. This period factors in the period of liberalization of groundnuts markets in Zambia. The study used monthly average prices to show seasonal price fluctuations, although these averages could not adequately show groundnuts shortage in various regions. Katete market was dropped from the dataset and replaced by Petauke markets due to excessive missing values in most of the years. Petauke market was chosen because it is near Katete market. As noted by Tomek and Robinson (1990) under the spatial arbitrage theory, prices of similar commodity in adjacent markets moved in unison and that they did not divert much from one another.

1.7 Operational definition of terms

Agriculture: The growing of crops and rearing of animals for domestic consumption and/or sale in order to reduce hunger and poverty.

Causality: The relationship between two or more variables and it depicts the direction of the relationship between those variables.

Liberalization: agriculture production and marketing is free from state control and market forces are determined by the demand and supply factors.

Market: a place where buyers and sellers of a particular good or services meet in order to facilitate an exchange, in this case groundnut market.

Market Integration: Is when prices for similar commodities do not behave independently. In other words, when there are co-movements in prices among different locations**.** In this study, market integration refers to smooth price transmission of signals and information among spatially separated markets.

Market Margin: The difference between what the consumer pays for the good and the price received by the producer of that same product.

Price transmission: Is the process by which prices in one-market affects prices in another market.

Transaction cost: These are costs incurred when facilitating an economic exchange, these include searching for market information, negotiating, monitoring and enforcing contracts.

CHAPTER TWO
LITERATURE REVIEW

2.1. Overview of world Groundnuts production and trade

Groundnut (*Arachis hypogeas*) is a leguminous crop rich in protein and its products play a crucial role among millions of smallholders across the world. The crop originated from South America and spread eastward to Africa four centuries ago (Smith, 1950). Groundnut crop thrives well in hot temperatures and does not tolerate soil that is acidic (Webster and Wilson, 1998). Groundnuts are mostly distributed in tropical, subtropical and temperate regions (Hammons, 1994). In terms of production, China is the leading producer of groundnuts accounting for 35 percent of world production, followed by India that produces 7, 156, 448 metric tons of groundnuts contributing 37 percent of the total world export (Sawe, 2017). Other important producers in developing countries are Nigeria producing 30 % of Africa's total, seconded by Senegal and Sudan with each producing about 8%, and Ghana and Chad with approximately about 5 % each (FAO, 2010).`

The production of groundnuts in Africa has seen severe fluctuations and has trended downwards. Groundnut yields are still low of about 800kg/ha, which is less than one-third of the potential yield of about 3000kg/ha. The large gap between the actual and potential yields is attributed to several factors such as lack of improved varieties, soil infertility, poor crop management practices, low inputs use especially in groundnuts cultivation and pests and diseases (AICC, 2016).

The share of groundnut trade on the world market ranges between 4-6% of total world population with the remaining higher share of world groundnut production, serving the domestic market (Ntare *et al*., 2004). This entails that the national demand for groundnuts in meeting the domestic subsistence needs is high and still increasing. There are three traditional types of groundnuts, and these include Virginia, the largest variety, runner which is the medium-sized and Spanish or Valencia the smallest and rich in oil content. Unshelled groundnuts trade accounts for the majority of transactions both locally and internationally while both unshelled and shelled groundnuts comprise the most basic form of groundnut trade. There has been an upsurge in the consumption of groundnuts for all uses and a steady deviation from its usage for oil and meal towards confectionery groundnuts. This is due to the increase in world imports of confectionery groundnuts by 83 percent during 1979-81 to 1994-96 (Freeman *et al*., 1999).

2.2. Overview of the Groundnut sector in Zambia

Groundnuts play a critical role in human diet because they contain up to 38 percent of proteins and have other nutrients and antioxidants (Abbiw, 1990). Approximately 8.8 % of total land cultivated in Zambia is planted to groundnut (Mukaka *et al*., 2013). The crop is mainly produced for domestic consumption in Zambia. It can be eaten raw, fresh, boiled, pounded into powder and added to relish (*visashi*) and also used to make peanut butter (*cimponde*). There are different varieties of groundnuts grown across the country, and these include Chalimbana, Makulu red, MGV-2, MGV-4, MGV-5, Champion, Chipego, Luena, Natal Common, Chishango, Katete and Comet (Ross and de Klerk, 2012). The development of these new varieties was mostly centred on the five attributes which include seed size, maturity days, yield, disease resistance and oil content (Mukuka *et al*., 2013). However, of all the varieties, Chalimbana also referred to as Malawi Chalimbana is the most cultivated variety among smallholder farmers.

Groundnuts are largely cultivated by smallholder farmers and are suitably grown in agro-ecological regions 1 and 2 (MAL, 2012). In general, there are three major agro-ecological zones which are characterized based on rainfall patterns, soil type, and climate. Region 1 is semi-arid with rainfall ranging between 600 to 800 mm and its growing season is relatively short (80-120 days). Agro-ecological zone 2 is associated with fertile soils with rainfall pattern between 800-1000mm. Its growing season ranges from 100-140 days. And region 3 has rainfall more than 1000 mm with a growing season ranging from 120-150 days. This zone is associated with extreme soil acidity (Chikowo, 2010). The crop is mostly grown in Eastern province where over 69 percent of the small-scale farmers produce 30 percent of total national production (CSO, 2011). The figure 1 below shows the metric tons of groundnuts produced per province in 2009/10 season. It depicts that Eastern and Northern provinces generate 30 and 21 percent respectively of the nation’s production while Lusaka and Copperbelt are among the lowest implying that there was huge consumption in these regions.

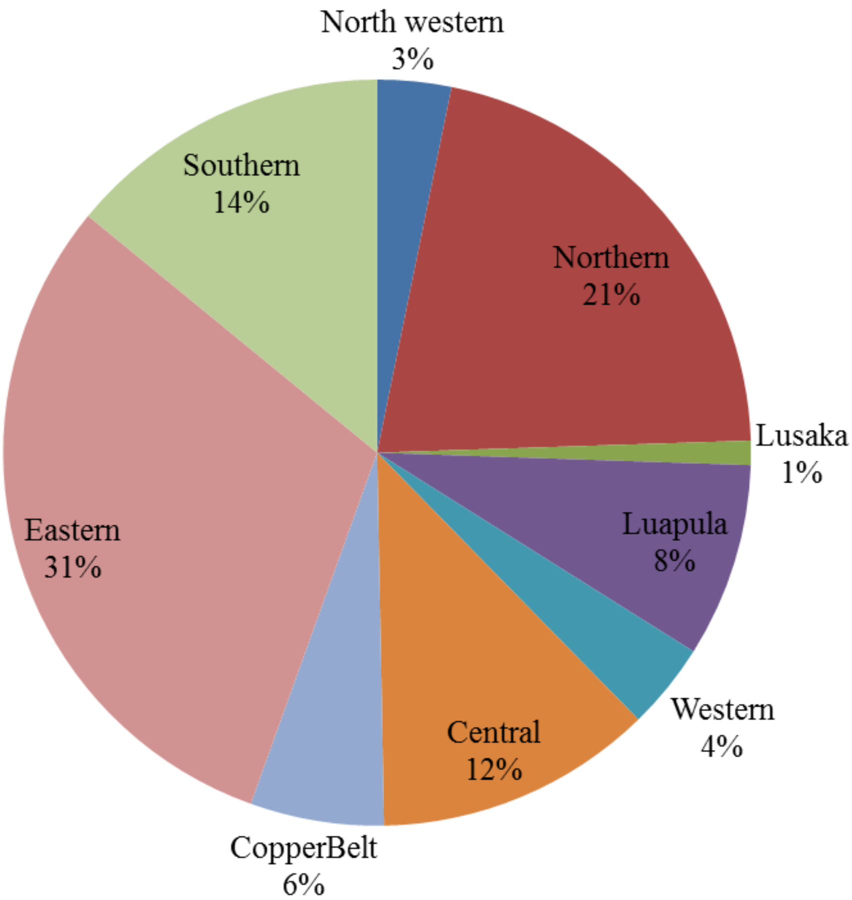

Figure 1: Groundnut production regions

Table 1 explicitly shows that groundnut production over the years has been fluctuating. It recorded the highest production of 164,602 metric tonnes in 2009/10 season. After which, groundnuts has seen declining levels. In general, the area planted under groundnuts has been increasing though the yields have been below one metric tonne less than the global average of 1.7MT/Ha (Chapoto and Chisanga, 2016; FAO, 2011). This was attributed to the unpredictability of groundnut markets and recycling of groundnut seeds, thus failure of farmers to adopt improved seed varieties (Mukuka *et al*., 2013).

Table 1: Groundnut production, acreage and yield in Zambia

Year	Production(MT)	Yield(MT/Ha)
2009/10	164,602	0.61
2010/11	139,388	0.66
2011/12	113,026	0.61
2012/13	106,792	0.52
2013/14	143,591	0.58
2014/15	111,429	0.46
2015/16	131,562	0.59

Source: Crop Forecast Survey

2.3. Structural organization of groundnut market in Zambia

As stated earlier, Groundnuts are the second most grown crop behind maize and the most important legume crop produced in Zambia. The crop is grown for consumption and as a means of cash by smallholder household (Kannaiyan and Haciwa, 1990). Groundnuts are grown nearly in all the provinces and are largely traded across the country. In essence, this means that access to market information and transport plays a critical role in the market. Therefore, bridging the information gap between farmers and market actors would ensure proper linkages between production and markets (Mtumbuka *et al*., 2015). More so, since transport is also an important component in the flow of groundnuts from surplus to consumption regions, a good road network is needed. However, like many other African countries, Zambia suffers from a poorly developed transport and infrastructural development system (Muyatwa, 2000; Sunga, 2017). Poor market infrastructural system affects the participation of market agents and thus reduces the chances of spatial market perfection (Loveridge, 1991; Muyatwa, 2000; Kabbiri *et al*., 2016; Sunga, 2017).

The marketing channel of groundnuts includes producers, middlemen or agents, traders, processors, and exporters. Traders are generally categorized into small-scale and large-scale traders. Small-scale traders normally buy groundnuts in small amounts but mostly from village markets. These traders are independent, operating with their own funds and supplying to a market of their choice. Such traders generally handle several tonnes of groundnuts. Large-scale traders on the other hand often have enough money to buy large quantities of groundnut produce. This group uses a variety of buying techniques encompassing shop-front buying, funding of buying agents in the field, pre-purchase of farmers' crops whilst still in the field, buying through in-house agricultural extension agents and signature of purchase agreements. These traders are able to clean and repackage the nuts. The processors producing peanut butter and purchasing groundnuts through large-scale traders, buying agents or directly from contracted farmers through in-house extension agents. The small-scale and large-scale traders purchase groundnuts for retail and wholesale purposes in domestic markets. Groundnuts are later sold to the processors and exporters. Groundnut processors include Community Markets for Conservation (COMACO) and Rabs (Rabs are processors based in Malawi). Since the processing plant for Rabs is based in Malawi this means that groundnut from Zambia crosses the Zambia-Malawi border twice, thereby attracting double taxation (Mukuka *et al*., 2013).

Groundnuts like other crops have seasonal price variations. Groundnut domestic prices are low when the new marketing season begins in May due to the high supply of the nuts and skyrocket at the time of planting in end November or early December since the supply is relatively limited and the demand is high. Due to lack of market information, low and unpredictable groundnut prices and inconsistent demand of groundnuts has led to farmers yielding low returns from the crop and causing them to switch to the production of other crops, especially maize, that continues to receive government subsidies.

In terms of export volumes, records on raw groundnuts have consistently been less than 200 MT per year from 1990 to 2010 (FAOSTAT various years). The groundnuts figures from 1990 to 2000 were very low in comparison to the exports by other countries in the region with similar climatic conditions for groundnut production. Nevertheless, these groundnut export values did not reflect the actual quantities of exports as a result of high levels of informal cross-border trade. However, unlike Zambia, other countries in the region have experienced significant growth in their groundnut exports. Malawi's exports increased from about 4,000 MT in 2008 to around 18, 000MT in 2009. In the year 2015, Malawi was accounted for about 9, 531 MT of groundnut exports against the global demand of 1,940,210 MT, thus, contributing 0.49% towards the global demand (AICC, 2016). Similarly, Mozambique's export doubled between the years 2009 to 2010. Malawi therefore provides an important case study for Zambia, as it seeks to improve the export capacity of its groundnuts and, by lowering aflatoxin levels, improve the health of Zambian consumers (Mukaka *et al*., 2013). A study by Chapoto and Chisanga (2016) observed that the import-export value ratio was greater than one for groundnuts. In essence, this implies the Zambia imports more groundnuts and other groundnut products than it exports. Thus the local demand for groundnuts is high and still increasing than its supply. Therefore, it is evident that the production of groundnuts has never matched local and export markets demand for groundnuts.

Groundnuts prices across the country are determined by several factors, these include, timing of sales. As noted earlier, groundnuts like most agricultural commodities experience seasonal supply and demand fluctuations leading to seasonal price movements. Secondly, prices of groundnuts differ according to whether the groundnuts are shelled or unshelled. Shelling is a form of value addition that can be performed on-farm, and can lead to a price increase. More than 80 percent of the groundnuts sold are shelled and this task is mostly done by women and children. Lastly, remoteness also determines the selling price of groundnuts. There are also significant differences in prices between areas nearer to the main cities or roads and those that are in more remote areas. For instance, farmers found in districts along the Great East road have higher groundnut prices compared to those further off the main road (Mukuka *et al*., 2013).

2.4 Review of literature on market integration

This section provides a review of literature related to similar studies that have investigated the spatial market integration and price transmission in certain agricultural commodity markets. This guides the selection of appropriate variables and methodologies to use in the analysis. Researchers have used various approaches in analyzing the spatial integration and price transmission in agricultural commodity markets. Negassa (1997) applied causality tests to study the vertical and spatial integration of Grain Market in Ethiopia. Weekly price data were collected from August 1996 to July 1997 and deflated by CPI (1995=100). The study found that grain markets in Ethiopia show a high degree of vertical and spatial market integration.

Alemu and Biacuana (2006) used a threshold vector error correction approach to measure market integration in the major surplus and deficit maize markets in Mozambique. The study focused on seven markets, namely, Chimoio-Maputo, Chimoio-Beira, Ribaue-Nampula and Mocuba-Nampula. The results showed that threshold values that are estimates of transaction costs were correlated positively with the distance between the markets and inversely related to the conditions of roads connecting the markets. From the four surplus and deficit market combinations studied, only two market pairs were integrated. However, the strongest degree of integration was found between Chimoio-Maputo market pair. The study further concluded that results from the impulse response showed that it took relatively lesser time for shocks introduced in markets that were integrated to be eliminated than markets not integrated (that is Chimoio-Beira and Ribaue-Nampula markets).

Fackler and Tastan (2008) proposed new measures for market integration and also applied the indirect inference methodology to estimate the level of integration of soybean markets for the US-Rotterdam and Brazil-Rotterdam market pairs. The indirect inference methodology overcomes the estimation shortcomings inherent with the application of vector auto-regression methods as well as the use of cointegration or Granger-causality in the study of market integration. The first measure was the expected degree to which price in a given market location responded to shocks arising from another market location. The second measure was the frequency with which the markets in different locations were part of the same trading network. The two measures estimated the degree of market integration. The third measure was the measure of the whole market integration. Results from an indirect inference estimation showed that the US-Rotterdam market linkage was highly integrated as a result of constant use of the linkage. The study also found high market integration for the Brazil-Rotterdam link which was nearly in constant use. However, Fackler and Tastan (2008) interpreted the results with caution since it was not directly possible to separately identify markets that exhibited single trade patterns.

Using Indices of Market Concentration specification, Oladapo and Momoh (2008) measured the price relationships as a proxy for the degree of market integration of cassava, yam, white maize and yellow maize markets in Oyo state in Nigeria. Results from the Indices of Market Concentration estimation revealed that market pairs of the four commodities within Oyo state had a high degree of integration in the short-run. However, compared to yellow maize, white maize market pairs had the highest degree of market integration which the study associated with high demand for white maize. The study also found that changes in the urban market prices for the agricultural commodities caused changes in rural market prices. The high degree of integration between urban and rural markets was largely explained by the short distances between the market pairs as well as the nature of the distribution channels.

In investigating the relevance of data frequency in price transmission analysis, Amikuzuno (2010) used both the standard and threshold vector error model to estimate the adjustment parameters for semi-weekly and monthly data. The results revealed that the adjustment parameters for monthly data were higher in all cases than the estimates of semi-weekly data.

This suggested that the use of monthly price data would lead to an overestimation of price adjustment parameters. Furthermore, a study by Bakucs and Ferto (2007) attempted to map the spatial integration on the Hungarian milk market using both the Vector Error Correction (VECM) and Threshold Vector Error Correction (TVECM). The study found that use of aggregated data led to interpretation problems and that one could not draw inference about the country level market integration using aggregated data on region level.

Trade liberalization has resulted in the integration of spatial markets across national borders. To establish this relationship, Sanogo and Amadou (2010) applied the Engle-Granger methodology and a threshold autoregressive model in analysing the extent of rice market integration between two central markets in Nepal and India. The study established an asymmetric cointegration between central markets in Nepal and India, with both negative and positive price adjustments prevailing. Adjustment in negative price deviations from the long-run equilibrium was faster than the positive price deviation adjustments which implied that traders in the central rice market in Nepal quickly adjusted prices upwards to reach the long-run equilibrium than with positive price deviations. Furthermore, the study established a significant relationship in price transmission between central markets in India and Nepal. The speed of price adjustment was negative and statistically significant, indicating that the flow of rice across the borders caused price deviations from the long-run equilibrium due to transaction costs and infrastructural conditions.

Akwasi *et al*. (2011) conducted a study on the efficiency of the plantain marketing system in Ghana. The study used monthly wholesale price in GHS/10 kg and applied Johansen multivariate co-integration analysis and error correction model. The selected markets were Accra market regarded as consuming market; Kumasi, Sunyani and Koforidua markets were assembling markets; Goaso, Begoro and Obogo markets as producing markets. Selection of these markets was mainly based on the volume of production and trade. The results showed that arbitrage in the plantain market system was still working since there was both short and long-run relationship between central consumption market and the three assembling and producing markets. The results also depicted that price transmission speed between the consuming market and other markets was relatively weak at 27.7 percent compared to perfect adjustment of 100 percent threshold.

Acquah (2012) used a threshold cointegration and consistent threshold cointegration techniques to analyse the long-run equilibrium relationship between Ghanaian retail and wholesale maize markets. The study also performed the order of integration test for asymmetry of price adjustment. Null hypothesis test of no cointegration upon the estimation of threshold autoregressive model was highly significant, indicating cointegration of retail and wholesale maize markets. Additionally, test for the null hypothesis for symmetry of price transmission was significant which indicated asymmetric adjustment of retail and wholesale prices to the achievement of long-run equilibrium. Similar to Sanogo and Amadou (2010), Acquah (2012) found that the elimination of negative price deviation from the long-run equilibrium between the retail and wholesale markets was faster than positive deviations. However, the consistency of the results produced by the threshold cointegration and consistent threshold cointegration models was low which the author attributed to the restrictions or assumptions made with respect to the threshold parameters.

Sekhar (2012) used Gonzalo-Granger and persistence profile approach in conducting a systematic assessment of the extent and degree of integration of agricultural markets in India. The study focused on groundnut oil, mustard oil, gram and rice markets. Sekhar (2012) found that whereas rice markets were integrated within states and regions, the extent of integration was not high at the national level. The author attributed this to inter-regional movement restrictions on rice which limited rice market efficiency. Contrastingly, the other crop markets were well integrated domestically within states, regions and at the national level. Results from the persistence profile approach for assessing the degree of integration revealed that the speed of adjustment in rice markets was relatively longer while much shorter for gram, groundnut oil and mustard oil markets. However, the study did not include transaction costs which are important determinants of the level of market integration. Thus, this study attempted to provide an understanding of the market integration effects of transaction costs.

In Niger, a study by Zakari *et al*. (2014) investigated price transmission from internal and regional markets to Niger's domestic grain markets using monthly wholesale prices. To analyze the degree of price transmission, co-integration and VECM were employed. The study found out that grain markets in Niger responded to negative and positive shocks in regional and internal markets differently. Maize and rice markets had the high speed of adjustment to world prices compared to millet and sorghum markets. In a study almost similar to this one, Mahamodou (2012) in Senegal analyzed the asymmetry of price transmission from the global groundnuts market to the Dakar groundnuts market. To analyze price transmission, his study focused on the Threshold co-integration approach. The first step was to investigate the dynamic properties of the price series in order to understand if price pairs were integrated in the same order. For this, the study used the Augmented Dickey-Fuller (ADF) test. It was concluded that the central groundnut market was not integrated into the international market.

In Nigeria, Edet *et al*. (2014) investigated the dynamics of price transmission and market integration of paw-paw and leafy fluted pumpkin in the rural and urban markets of Akwa Ibom State. Monthly market prices of paw-paw and leafy fluted pumpkin in the rural and urban markets were used in the analysis of the data covering the period from January 2005 to September 2013. The study applied trend analysis, bi-variate correlation analysis and Granger causality tests to establish the association between rural and urban prices of paw-paw and leafy fluted pumpkin. According to Edet *et al*. (2014), the exponential growth rate equation was used in this study to investigate the growth in monthly prices of pawpaw and leafy Telfairia (fluted pumpkin) because literature has supported continuously inflated prices of agricultural commodities for some years in Nigeria. Findings from this study revealed that prices of pawpaw and leafy fluted pumpkin in the rural and urban markets had a positive relationship with time and exponential growth rates that were less than unity in pawpaw, but greater than unity in the rural price of leafy fluted pumpkin. The Pearson correlation coefficient matrix showed that the rural price of pawpaw and leafy fluted pumpkin had linear symmetric relationships with their corresponding urban prices in the study area. Lastly, the Granger causality test revealed a bi-directional relationship between the rural and urban price of pawpaw and leafy fluted pumpkin in the study area.

Mtumbuka *et al.* (2014) conducted a study on spatial price integration of bean markets in nine selected markets in Malawi. The study used both the standard autoregressive and Threshold Autoregressive (TAR) Methods whose aim was to compare the results from both models to ascertain whether transaction costs have a significant impact on market integration. The findings were that prices of beans in selected markets moved in the same direction in the long run and that bean price spread happened between markets in Malawi. The study further showed that some markets are not copiously integrated with one another and that markets exhibited inadequate information flow.

Baquedano and Liefert (2014), using single equation error correction model, examined cointegration of local markets and international agricultural commodity markets among sixty developing countries. Specifically, Baquedano and Liefert (2014) focused on the response of domestic market prices for wheat, maize, rice and sorghum in developing countries to changes in the world market prices. The study established a long-run cointegration relationship between the aggregate consumer food prices for the agricultural commodities and world market prices. Additionally, similar to Sekhar (2012), Baquedano and Liefert (2014) found that the transmission of the changes in world prices to the domestic markets for the four commodities was not high. The study noted that price transmission was highest for wheat market pairs and lowest for sorghum market pairs. Furthermore, the movement to the new equilibrium prices in the domestic markets was slow, indicating slow adjustment process in response to price shocks in the world markets. In general, wheat adjusted sluggishly to world price shocks which the study attributed to wheat being the most heavily imported commodity in developing nations.

McLaren (2015) used FAO panel data of export and producer prices to establish the producer prices transmission effect of international agricultural price variations for 117 countries over 35 years. Using two-stage least squares (2SLS) in a three meteorological instrumental variable approach, the study found asymmetric long-run price transmission of prices from international markets to domestic markets albeit slightly small. The study established that market power was an important determinant of price transmission since the power of intermediaries between geographically dispersed farmers and economies lead to an asymmetric price transmission. Notably, the asymmetry in price transmission was more prevalent with prices fall among market pairs.

Wondemu (2015) tested asymmetric price adjustment of Ethiopian grain markets using point-space model and found that teff crops' prices adjusted quickly to market shocks caused by an increase in prices as compared to when prices reduced. These findings were further affirmed by Ganneval (2016) who used Threshold Vector Error Correction Model to analyse price transmission among spatial rapeseed, feed barley, corn and protein pea in French markets. Ganneval (2016) found that market pairs responded faster to high deviations from long-run equilibrium but slower to price equilibration after experiencing shocks. The findings by Wondemu (2015) and Ganneval (2016) underlined the spatial integration of agricultural commodity markets which then explain the degree of price transmission in agricultural commodity markets. Furthermore, the results are indicative of market inefficiencies that may, to some extent, explain how market prices respond to shocks in the agricultural markets across geographical space.

Despite theoretical studies on market integration taking two approaches in their last two decades which is the use of parity bound models (PBM) and threshold autoregressive models (TAR). The PBM and TAR model also have shortcomings. The major criticisms surrounding parity bound models are that their results are sensitive to underlying distributional assumptions and also assumes that the model is static in nature. Shortcomings attributed to the TAR model is the assumption that transaction cost is constant over the study period and issues concerning inference on the threshold parameters rendering it impossible to obtain standard errors and confidence intervals (Campenhout, 2007). Also, TAR models are said to impose non-theoretical restrictions and are associated with calculation challenges. In addition, the TAR model also checks for the existence of non-linear transaction cost and the presence of price bands (Habte, 2017).

However, Von Cramon-Taubadel and Meyer (2002) posited that no uniform method exits in the evaluation of market integration. Kilima (2006) further argued that the degree of price transmission had no single explicit test as a result of market dynamic relationships arising from trade breaks and non linearities due to distortions in arbitrage. Therefore, in this regard, the study adopted co-integration and VECM model to study spatial market integration and price transmission in the selected groundnuts markets in Zambia. This was because scanty studies have been done on spatial integration of commodity markets generally, and groundnut markets specifically. And also, most studies on marketing in Zambia have concentrated on the staple maize crop (Mason and Myers, 2013).

2.5 Theoretical Framework

The study was underpinned on the theory of the Law of One price (LOP) which exists because of arbitrage opportunities. Market integration for agriculture commodities has received massive attention from policy analysts and policy makers as it gives insights on how well agriculture commodity markets function. Studies on market integration enable appropriate policy interventions in both the short and long-run and help to diagnose problems in agricultural commodity markets. For instance, if the transportation cost of a commodity from one market to the other is less than the market margins, this entails lack of market information, trade barriers or credit constraints. On the other hand, if transportation costs between market pairs are higher than other market pairs, this may indicate that road quality, imperfect competition and excessive checkpoints are a major issue (Rashid *et al*., 2010).

Market integration definition relates to tradability or contestability. This entails that if two markets are integrated, the supply and demand conditions in one market influence or affect the price or transactions volume in the other market (Barrett and Li, 2002). Actions of spatial arbitrageurs ensure that prices of similar products between markets in different locations vary by the cost of transferring the good from the lower price region to the region with the higher price (Kibiego *et al.*, 2006).

According to the law of one price (LOP), price transmission tends to be complete once equilibrium prices of the product being marketed across different markets differ only by the transaction cost. However, if there are shifts in demand and supply in a single market, it affects trade and prices in the other market so as to reinstate equilibrium through spatial arbitrage. Lack of market integration and/or complete price transmission changes between markets has implications on economic welfare. Incomplete price transmissions emanating from either excessive transaction costs such as transportation costs, negotiation costs, and incomplete information, or border policies such as import quotas, tariff, non-tariff barriers and export subsidies hinder the benefits of arbitrage thus distorting the marketing decisions of groundnuts producers and traders. Under such conditions, the law of one price does not hold (Ghafoor and Aslam, 2012).

Assume the prices of groundnuts in two spatially separated markets are P_{it} and P_{jt} respectively, where P_{tc} are transfer costs. The formal mathematical presentation will be of the Law of one Price as:

$$P_{jt} = P_{it} + P_{tc} \quad (1)$$

If the above relationship holds, the markets question are then integrated, and equilibrium exists between the two markets. This indicates that there would be product movement from the i^{th} to the j^{th} market, since prices in latter tend to be higher than the price in the former. This therefore, makes the price difference between these markets to be larger than the transportation cost from the i^{th} to the j^{th} market. The increased commodity supply in the j^{th} market will cause its price, that is, P_{jt} to drop until prices in both markets tend to reach equilibrium. This will eventually stop the benefits and flow of trade.

2.6 Conceptual Framework

Whether markets are integrated or not depends on several factors. These factors are at the core in terms of finding better prescription in order to improve markets efficiency. Factors determining whether markets are integrated or segmented include; transaction costs, market information, public goods such as infrastructure, government policies, imperfect competition and institutions. Factors such as agricultural production, seasonality and climate change have an influence in the surplus regions and also the deficit areas are affected by population growth and income. Assuming there are two markets, market integration can be illustrated as shown in Figure 2 below.

When two markets are not integrated due to transaction costs such as poor transportation as well as communication infrastructure it entails that groundnuts price information will not be adequate for market participants, thereby leading to decisions that contribute to inefficient outcomes or inefficient markets. Improving transaction costs may increase participation among market agents and enhance the flow of groundnuts from the surplus area to the deficit area. If markets are now integrated, there will be feedback information from the deficit area to the surplus areas as illustrated by the dotted line in the diagram below. This will eventually lead to sound economic policies such as trade policies, rural and development polices macro policies, market institution development, and innovative panaceas. This will, thus, increase food and income security in the deficit areas and among the market participants respectively.

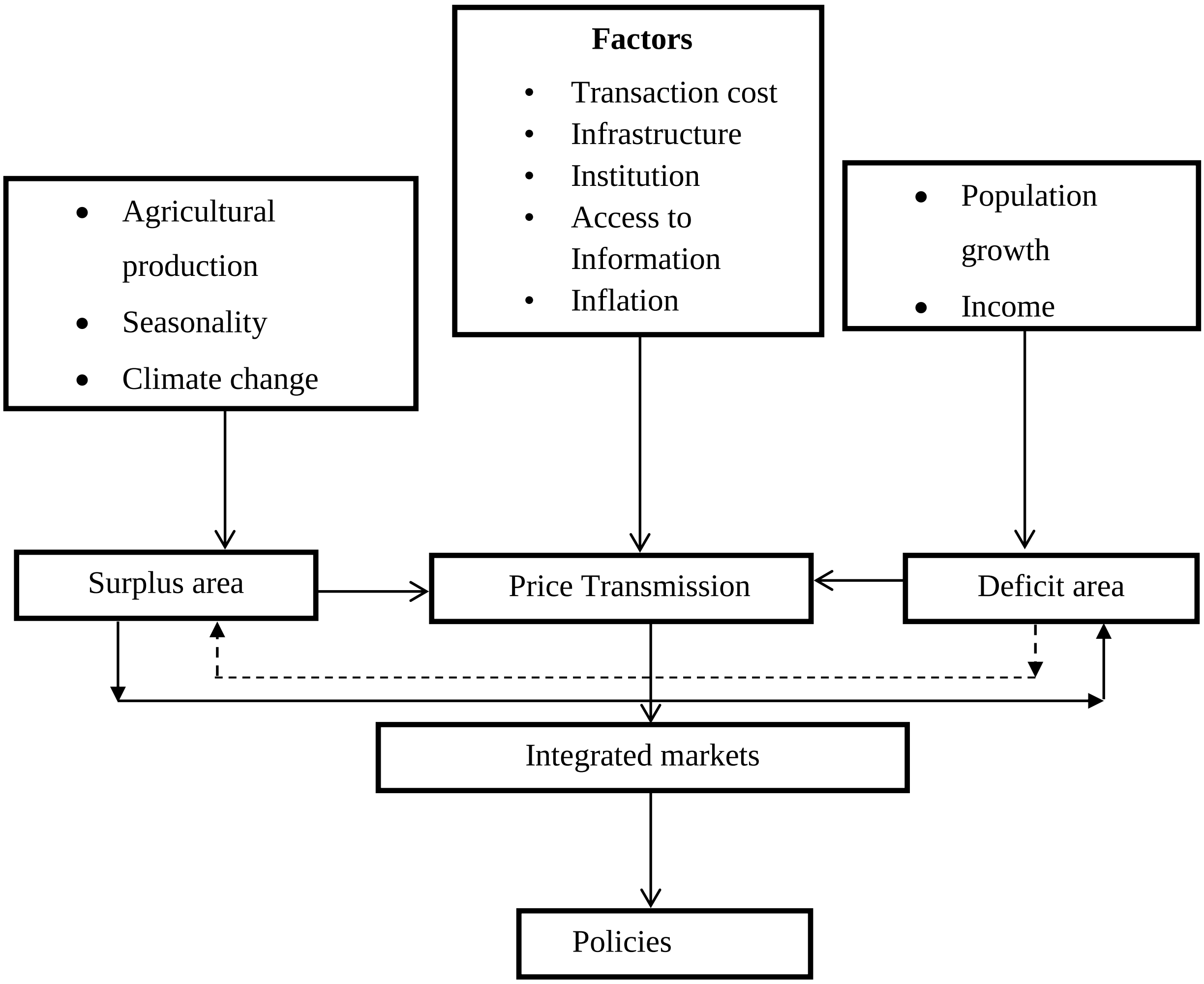

Figure 2: Conceptual framework

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Study area

The study focused on four provinces namely Copperbelt (13.0570°S 27.5496°E), Eastern (13.8056°S 31.9928°E), Lusaka (15.3657°S 29.2321°E) and Northern (9.7670°S 30.8958°E) provinces in Zambia (Latitude Longitude Organization, 2017). The four provinces are among the ten provinces of Zambia, Lusaka province being the capital city and the Copperbelt province being the mineral-rich province. The two provinces are perceived to be the consumption areas while Eastern and Northern provinces are the major production areas of groundnuts. Eastern province is the largest producer of groundnuts seconded by Northern Province in the country (CSO, 2011).

Markets that were studied in eastern province are Chadiza, Chipata and Petauke; while in the Northern Province Kasama market was studied. These markets are the surplus markets and markets in deficit areas that were studied included Kitwe market in Copperbelt and Lusaka market. Markets in surplus areas were selected based on production and trade volumes.

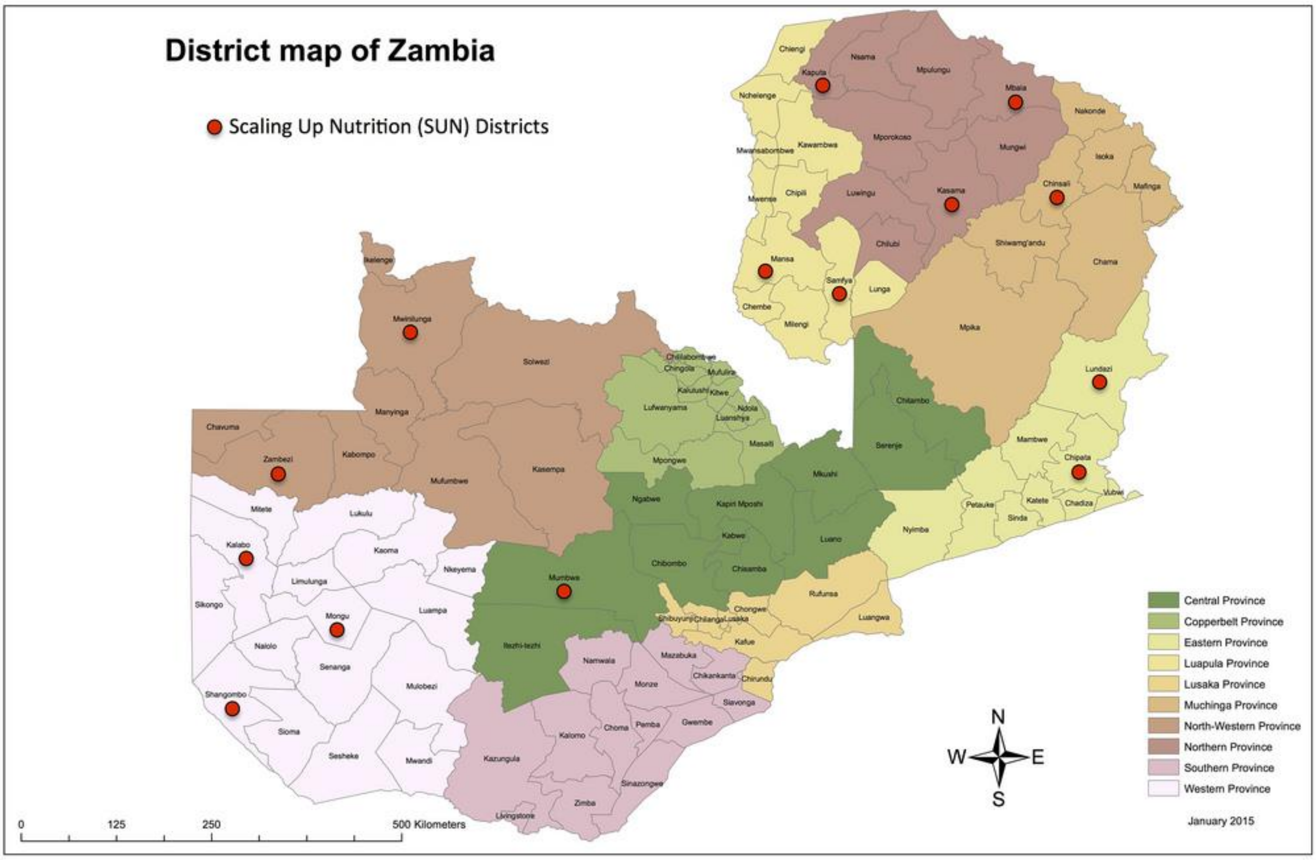

Figure 3: Map of surplus and deficit areas in Zambia

Source: Google maps 2017

3.2 Data Collection

The study used secondary time series data that was collected from Zambia's Central Statistics Office (CSO) and the Ministry of Agriculture and Livestock (MOA). Both the CSO and MOA provided retail monthly price data of groundnuts. The data used average monthly prices that are deflated and seasonally adjusted to cater for inflation during the period of study. The sample data covered the period from January 2001 to March 2017.

3.3 Methods of Data Analysis

To answer the objectives, data was collected, entered, cleaned and analyzed using Excel, Statistical Package for Social Scientists (SPSS), Eviews and STATA. The monthly price for groundnuts was deflated using the consumer price index (CPI 2008 = 100). Firstly, data were analyzed using descriptive statistics. This enabled the study to show the maximum and minimum values of the groundnuts average monthly prices over the study period. The mean values were used to compare prices in the six markets, as it is regarded as a measure of central tendency. The coefficients of variation depicted the spread or dispersion of prices in different markets. Skewness was used to understand how asymmetric the groundnut prices are and Kurtosis enabled the study to show how tailed the groundnut prices are and whether they tend to be closer to the mean or otherwise. Graphical analysis was also used to ascertain the trend of groundnut prices over the study period. Finally, Correlation analysis was employed to determine the nature of the relationship among the variables.

3.4 Augmented Dickey-Fuller (ADF) test for Stationarity

ADF test was performed to ascertain the presence of unit root that is, testing for stationarity. It is very crucial to test for stationarity for any econometric studies involving time series data because non-stationary series could result in spurious regressions and also stationarity or non-stationarity of a series can influence the behaviour and properties of a series, for example, the persistence of shocks would be infinite for non-stationary series. In addition, if the variables are non-stationary, this will entail that t-ratios will not follow the t-distribution, therefore, hypothesis tests about the regression parameters cannot be undertaken reliably. The null hypothesis for stationarity is that a series has a unit root. Therefore, failing to reject the null hypothesis leads to a conclusion that the series is non-stationary. In this case, the data series follows a certain trend (increase or decrease) over time (Dickey and Fuller, 1981).

There exist two types of stationarity, which are covariate stationary and difference stationary. A series is covariate stationary if we reject the null hypothesis that the series is non-stationary in its original form (data). A series is difference stationary if we reject the null hypothesis of presence of unit root in series after differencing the data series. Stationarity tests are important because they help determine the order of integration. Covariate stationary series are integrated of order 0, which is I (0), while that are I (1) become stationary only after the first difference. This is very important in co-integration analysis. Testing for stationarity is the first step in testing for co-integration.

After taking the natural logs, the Augmented Dickey-Fuller (ADF) was employed in order to check the order of integration. ADF is based on a linear regression of the form:

$$\Delta y_t = \beta_t + \mu_t + \delta y_{t-1} + \sum_{j=1}^{k} \alpha_i \Delta y_{t-i} + \varepsilon_t \tag{2}$$

y_t = Price of groundnuts of a given region in the logarithm form at time period t. Δy_{t-i} is the price expressed in first differences with k number of lags, ε_t is the white noise error term with a mean of zero and non-varying variance. The coefficients (μ, β, δ, α) are parameters that will be estimated.

The rejection of null hypothesis is solely based on the MacKinnon critical values. This means that, whenever the probability (p-value) is smaller than the significance level, the null hypothesis is rejected. In other words, when the estimated coefficient of δ is significantly smaller than zero, the null hypothesis can be rejected, implying that there is stationarity. In the same way, if we fail to reject the null hypothesis. Otherwise, the series would be non-stationary (Dickey and Fuller, 1981).

3.5 Kwiatkowski, Philips Schmidt and Shin (KPSS) test

The study also used KPSS method to confirm the findings of Augmented Dickey Fuller test. This procedure tests the null hypothesis of stationarity against its alternative of non-stationarity. The Kwiatkowski Philips Schmidt and Shin test is a langrage multiplier (LM) procedure for testing $\delta_u^2 = 0$ that is the stationarity hypothesis (Kwiatkowski *et al.*, 1992). The model equation used in the study was as follows;

$$y_t = \xi t + r_t + \varepsilon_t \tag{3}$$

Where $r_t = r_{t-1} + u_t$

r_t represents random walk, u_t is independent and identically distributed(iid), y_t is the price series to be tested for stationarity, ξ is a coefficient the coefficient of t, t is the parameter with a deterministic term and ε_t is the error term.

This study adopted Kwiatkowski *et al*. (1992) approach by using the one-sided langrage multiplier (LM) test statistic in test the null hypothesis of stationarity that is $H_0 : \sigma_u^2 = 0$ against the alternative denoting non-stationarity ($H_0 : \sigma_u^2 > 0$). Kwiatkowski (1992) represented the LM test statistics as follows;

$$LM = \sum_{t=1}^{T} \frac{S_t^2}{\hat{\sigma}_e^2} \tag{4}$$

where $S_t = \sum_{i-1}^{t} \hat{e}_i$

Here $\hat{\sigma}_t^2$ denotes error variance estimator and $\hat{e}_i$ represents the residual of the regression. The null hypothesis is rejected when the LM Statistic is greater than it is critical value. In that case, the conclusion is that the time series variable non-stationary. On the other hand, the series is stationary if we fail to reject the null hypothesis.

Unfortunately, the major disadvantage of KPSS test is that it has high rate of Type 1 errors. Konya (2004), indicated that KPSS test is characterised by low power limitation. However, for confirmatory purposes, the test was used together with other unit root tests such as ADF and PP for stationarity testing. When the results from tests statistic (ADF and KPSS) suggest that the series is stationary, then the times series is stationary.

3.6 Test for Co-integration

The Engle-Granger Two Step Estimation method and Johansen's Co-integration test are used to test the presence of co-integration in time series data. The Johansen's Co-integration test method is based on the Maximum Likelihood Method. It use uses the Trace Statistic and the Maximum Eigenvalue Statistics to conclude on hypothesis testing. Although the Two Step Estimation Method is easy to run, it requires a larger sample size in order to minimize the likelihood of making estimation errors. This method can only be run on a maximum of two variables (Dolado *et al*., 1991; Charemza *et al*., 1992; Brooks, 2008). Another weakness of Two Step Engle-Granger test is that it restricts testing for co-integrating relationships, unlike Johansen's method (Books, 2008). However, one drawback of Johansen's test of co-integration is that it is difficult to interpret results.

Johansen (1988) co-integration test was deployed to test the presence of a long-run relationship. The test was chosen because of its ability to test the association between more than two variables simultaneously. Johansen Co-integration test is typically based on maximum likelihood estimation and two statistics namely: maximum eigenvalues and a trace-statistics. It stems from the theory and concepts of the rank of a matrix. In this case, the study was interested in the rank of the matrix, which indicates the number of co-integrating relationships among the price variables.

Multivariate Johansen co-integration is derived from the Vector Autoregressive (VAR) model which states that, if y_t is a vector of n stochastic variables, then a p-lag vector auto-regression with Gaussian errors of the following (VAR) form order P (Johansen and Juselius, 1990) as shown below;

$$y_t = \mu + \pi_1 y_{t-1} + ... + \pi_p y_{t-p} + \varepsilon_t \qquad (5)$$

where y is an n×1 vector of n variables that are integrated of order one, that is, I (1) and *p* makes the error term white noise. According to Chang (2000), the VAR model is reparameterized in the error correction form as follows;

$$\Delta y_t = \sum_{t=1}^{p=1} \Gamma_1 \Delta y_{t-1} + \Pi y_{t-p} + e_t \qquad t = 1,...,T \tag{6}$$

Where $\Gamma = \left[\left(I + \pi_1 \right), \left(I + \pi_1 + \pi_2 \right), ..., \left(I + \pi_1 + ... + \pi_k \right) \right]$

Such that $\Pi = I - \pi_1 - \pi_2 - ... - \pi_k$ and I is the identity matrix. From the above equation, that is ECM (p) with an error correction component, Πy_{t-p} the matrix Π is of main interest for two major reasons. Firstly, the rank of Π indicates the basis of determining the existence on a long-run relationship among the variables. If the variables are not cointegrated, the rank of Π is equivalent to zero (that is $rank\Pi = 0$) and the model will be similar to the VAR in first difference. If $0 < rank\Pi < n$, then the covariates or variable factors are cointegrated. And if the $rank\Pi = n$, then the variables are said to be stationary and the model will be equivalent to a VAR in original form (Chang, 2000).

Secondly, the Johansen testing procedure decomposes Π into two matrices α and β such that $\Pi = \alpha\beta'$ and β reflects the cointegrating relationships. If $\beta' y_t = 0$ the system is said to be in equilibrium. $\beta' y_t$ shows a deviation from the long-run equilibrium which is said to be stationary in a cointegrated system (Johansen and Juselius, 1990). The matrix of the speed of adjustment coefficients is denoted by α which characterizes the long-run dynamics. If a is denoted by a huge value, then the system will have a rapid adjustment from the long-run equilibrium and also, if α is a small value, the speed of adjustment from the long-run equilibrium will be slow. Otherwise, if $\alpha = 0$ then the corresponding variable is said to be weakly exogenous and thus, does not respond to the equilibrium error (Chang, 2000).

According to Johansen and Juselius (1990), Johansen's Maximum Likelihood procedure was prosited and therefore, determining the number of co-integrating vectors involved the usage of two test statistics. The first statistic is trace test which hypothesises (that is the null hypothesis) that co-integrating vectors are less than or equal to q against unrestricted alternatives $q = r$. Mathematical presentation is as follows:

$$\lambda_{trace(r)} = -T\sum_{i=r+1}^{p} 1n(1-\lambda_i) \quad (7)$$

Where, T is the number of valid and usable observations, and λ_i are eigenvalues derived from or estimated from the matrix. The other statistic test is the maximum eigenvalue test computed as follows:

$$\lambda_{\max(r,r+1)} = -T1n(1-\lambda_{r+1}) \quad (8)$$

In this test, the null hypothesis denotes that there are r co-integrating vectors against the alternative that $r+1$ co-integrating vectors will be tested.

3.7 Residual Test of Co-integration

Engle and Granger (1987) suggested one of the common tests of Co-integration. Consider the following model:

$$y_t = \beta_0 X_t + u_t (*) \quad (9)$$

Assuming that all the individual times series variables in the above equation are non-stationary or integrated of order one that is I (1). Estimate equation $y_t = \beta_0 X_t + u_t$ using the Ordinary Least Square (OLS) method and then save the residuals obtained from the regression $\hat{u}_t$.

$$\Delta u_t = \vartheta * u_{t-1} + \sum_{i=1}^{p-1} \vartheta_i u_{t-i} + v_t (**) \quad (10)$$

Note that if the deterministic components such as constant or time trend are included, they are added in only one of the equation (*) or (**) and not in both equations. The null hypothesis and alternative hypothesis of the above unit root equation are as shown below;

$$H_0 : \hat{u}_t \sim I(1)$$

$$H_1 : \hat{u}_t \sim I(0)$$

The null hypothesis suggests that there is the presence of unit root in the co-integrating regression residual against the alternative hypothesis that suggest that is there is stationarity in the residuals. Therefore, rejecting the null hypothesis implies that a stationary linear combination of the non-stationary variables has been founded. Thus, the non-stationary variables are co-integrated.

3.8 Granger Causality Test

Granger (1980) causality test gives us the relationship between two time series variables. This relationship is the direction of causation between the two time series variables. Apart from showing the association between the two time series variables, it also determines what causes what between the two time series variables. Granger causality test is based on the following Vector Autoregressive (VAR) system:

$$Y_t = \alpha_2 \sum_{i=1}^{n} \beta_i X_{i-1} + \sum_{i=1}^{n} \gamma_i Y_{t-1} + \varepsilon_{1t} \quad (11)$$

$$X_t = \alpha_2 \sum_{i=1}^{n} \theta_i X_{i-1} + \sum_{i=1}^{n} \delta_i Y_{t-1} + \varepsilon_{2t} \quad (12)$$

Where, ε_{it} are white Gaussian random vector. In this case, *x* and *y* are the prices that will be tested. This VAR system, if log of *y* variable in equation 11 is not significant and log of *x* in equation 10 is significant; it means that there is a unidirectional causation running from *x* to *y*. And if the log of *y* variable in equation 11 is significant while the log of x in equation 10 is not significant, there is also a unidirectional relationship that runs from *y* to *x*. Bi-direction causational relationship exists when the logs of both variables are significant in the two equations. Finally, if the logs of two variables are not significant then, there is no causation between the two variables.

3.9 Vector Error Correction Model

After establishing the presence of co-integration between the price series, the vector error correction model was estimated. Since co-integration regression on long run relationships between the series of variable, the Error Correction Model (ECM) was developed to measure short run dynamics between the first differences of the time series variables. Ikudayisi and Salman (2014) stated that VECM examined the dynamic adjustment of time series variables towards their equilibrium. If the ECM has a negative and significant coefficient, this suggests that short-term fluctuations eventually culminate into a stable long-run association between the series. The basic error correction term is represented as follows;

$$e_t = y_t - \beta x_t \quad (13)$$

Here e_t denotes the error term after regressing y_t on x_t, and β represents the cointegrating coefficient. Thus the Error Correction Model can be defined as;

$$\Delta y_t = \alpha e_{t-1} + \gamma \Delta x_t + u_t \qquad (14)$$

Where u_t is independent and identically distributed ($i.i.d$) and first difference of the dependent variable is explained by the lagged e_{t-1} and Δx_t. e_{t-1} represents the value of the lagged residuals. For cointegrated times series variables, ECM measures the speed of adjustment towards the long run equilibrium and it also offers an added independent variable to explain the first difference of y_t.

In this study, the VECM took the following form:

$$\Delta Rp = \alpha_0 + \sum_{i=1}^{p} \beta_0 \Delta Rp_{t-i} + \sum_{i-1}^{p} \beta_1 \Delta Up_{t-i} - \lambda (Rp_{t-1} - Up_{t-1}) + \varepsilon_{1t} \qquad (15)$$

$$\Delta Up_t = \alpha_1 + \sum_{i=1}^{p} \beta_{2i} \Delta Rp_{t-i} + \sum_{i=1}^{p} \beta_{3i} \Delta Up_{t-i} - \lambda (Rp_{t-1} - Up_{t-1}) + \varepsilon_{2i} \qquad (16)$$

Where Rp_t and Up_t are rural prices that is prices from surplus areas (Chipata, Chadiza, Petauke and Kasama) and urban market prices which are in the deficit areas (Lusaka and Kitwe). Δ Denotes the first difference operator, α_0 and α_1 are constants, β_0, β_{1i}, β_{2i} and β_{3i} are the short run coefficients, λ is the error correction term that measures the speed of adjustment and ε_t is the error term also referred to as white noise.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Introduction

This chapter presents the findings of the study. These findings have been written according to how the research objectives are outlined. The general objective is to investigate the degree of integration and price transmission among geographically separated groundnut markets in Zambia in order to enhance the flow of market information among groundnut market participants. The first specific objective is to characterize the spatial price differentials of groundnuts between deficit and surplus areas. The second objective is to determine the extent of market integration between the deficit and surplus areas. The last objective is to determine the speed of adjustment in the retail prices between the deficit and surplus areas.

To analyze spatial integration, the study used real groundnuts monthly prices spanning from January 2001 to 2017 March. The prices were valued in Zambian Kwacha. Unit root tests using ADF and KPSS tests were done. Cointegration test was run to ascertain whether there is a long-run association between the market pairs. The VECM was used to determine the speed of adjustment or the short-run dynamics between the markets.

4.2 Descriptive statistics on price differentials of groundnuts in deficit and surplus areas.

Price variability has been at the core of comprehending price behaviour in several markets. It emanates from either natural factors such as weather changes or economic factors such as transportation costs, market agents and changes in market structure. From Table 2, Lusaka and Kitwe had the highest nominal mean prices of K12.32 and K8.82 per Kg respectively, while Petauke and Chipata recorded the lowest mean prices of K6.21 and K6.43 respectively. The high prices in both Lusaka and Kitwe were as a result of urban demand of groundnuts that outpaced supply (Mukuka *et al*., 2013). In addition, the high prices in these districts were also reflecting the high transaction costs incurred by traders during transportation of groundnuts from producing areas to consuming regions (WFP, 2016). The low prices recorded in Chipata, Chadiza and Kasama can be attributed to the fact that the markets are located in the main groundnut growing regions across the country. In addition, the low groundnut prices in Chipata were also attributed to the inpouring of groundnuts from neighbouring countries such as Malawi and Mozambique that have recorded significant growth in groundnut production and export in recent years (Mukuka *et al*., 2013).

Table 2: Nominal monthly groundnuts prices from 2001 to 2017, (K/kg)

Markets	Mean	Min	Max	CV (%)	Std. Dev.	Skewness	Kurtosis
Lusaka	12.32	2.47	29.59	50.00	6.10	0.91	0.76
Kitwe	8.82	2.39	24.12	54.00	4.76	1.22	1.35
Chipata	6.43	1.20	25.00	74.00	4.77	2.00	3.98
Chadiza	8.36	0.80	31.25	77.00	6.45	1.57	1.94
Kasama	6.73	1.51	29.01	85.00	5.73	1.94	3.46
Petauke	6.21	1.00	26.31	79.00	4.92	1.81	3.37

Note: CV denotes the coefficient of variation, Min and Max show the Minimum and Maximum nominal prices. Std. Dev. is the Standard deviation.

In Table 2, Kasama market had the highest price variability (85 percent) while Lusaka recorded the least price variability of 50 percent over the considered period. The difference between the highest and lowest variability of groundnuts prices was 35 percent. This implies that the behaviour across all the markets was significantly different. In general, there was a large price variation among all the markets indicating variability in production. Skewness is a measure of data asymmetry. Groundnut prices in all the markets are positively skewed with insignificant difference between the sizes of the skewness. A study by Otoo (2012) indicated that positive skewness in all the series meant that the series were frequently controlled by periods of high prices which were not offset by periods of low prices of the same magnitude. Lastly, on kurtosis which is a measure of how tailed the data is, Chipata, Kasama and Petauke had values greater than three, meaning the distribution was leptokurtic. This implies that the distribution of prices tended to be closer to the average price. On the other hand, Lusaka, Kitwe and Chadiza had platykurtic distribution, meaning that the prices are far away from the average.

Figures (4) and (5) show nominal groundnut price fluctuations both in the deficit and surplus regions. Prices in Lusaka and Kitwe were much higher than those in the producing regions, thus the graph was steeper. Generally, there has been a similar trend in prices across all the six markets, indicating that the groundnut prices moved in the same direction over the years. These results confirm the findings of Mukuka *et al*. (2014) that showed national groundnut prices trending upwards from 2002. A visual inspection reveals that there is a continuous upward movement of prices, which possibly implies spatial market integration among markets in both deficit and surplus areas.

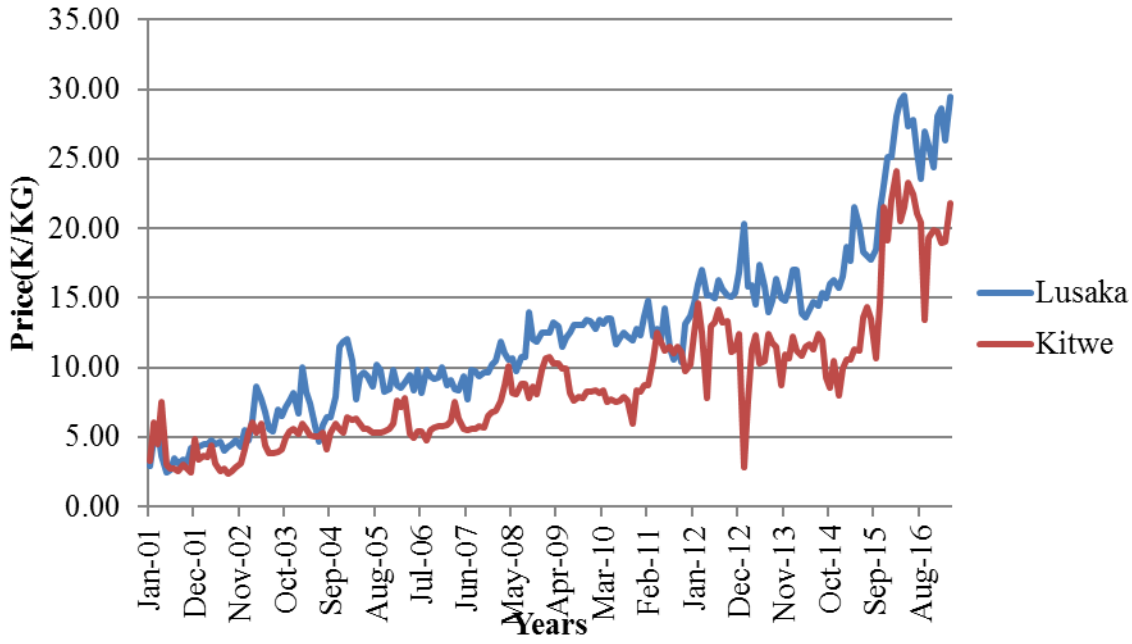

Figure 4: Groundnuts, nominal prices in deficit areas, 2001 to 2017, (K/KG)

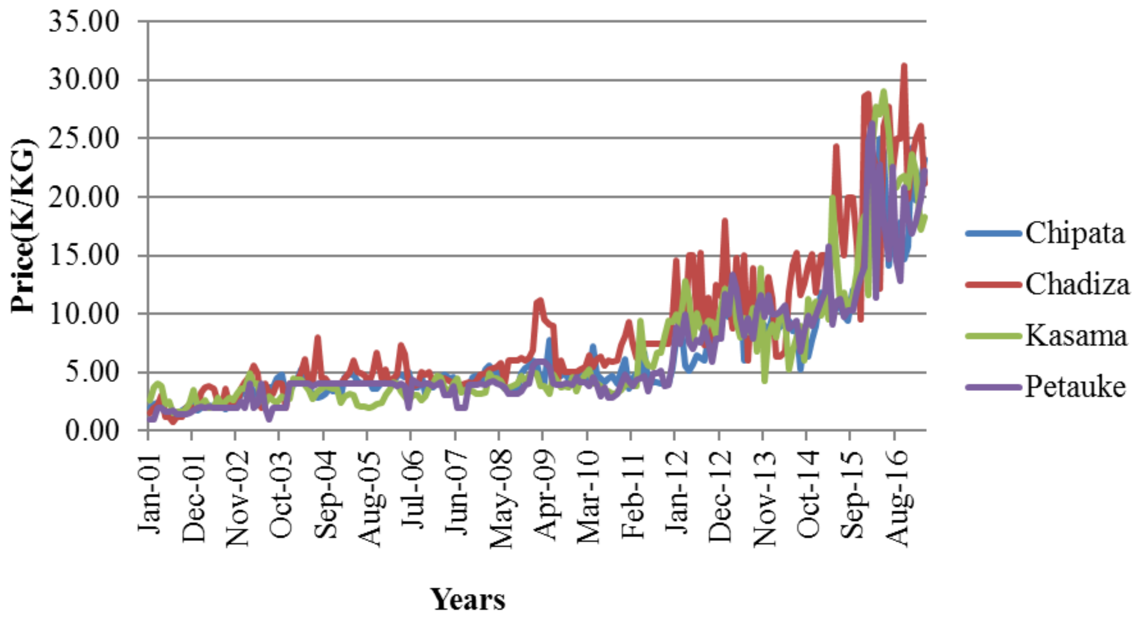

Figure 5: Groundnuts, nominal prices in surplus areas, 2001 to 2017, (K/KG)

Figure 6 shows seasonality index of groundnut across the country. Agricultural commodities usually show seasonal patterns as a result of seasonality. Groundnut as an agricultural commodity is no exception. Groundnuts prices are lowest in May, June, July and August. Their prices begin to rise above the annual average in November reaching the peak in December to April because the supply of groundnuts is limited. However, after harvesting the crop in May, its prices begin to fall below the annual average. In support of these findings a study done by Mukuka *et al*. (2013) found that groundnut prices have been normally very low towards May or June which is the beginning of the marketing season until September when its supply trended downwards. The study also observed that groundnut prices reached their peak in February up to April. Therefore, this pattern is an indication that groundnuts prices follow a general seasonal pattern which is dependent on the changes in demand and supply. Thus, the pattern shows the normal patterns of price variability as a result of production.

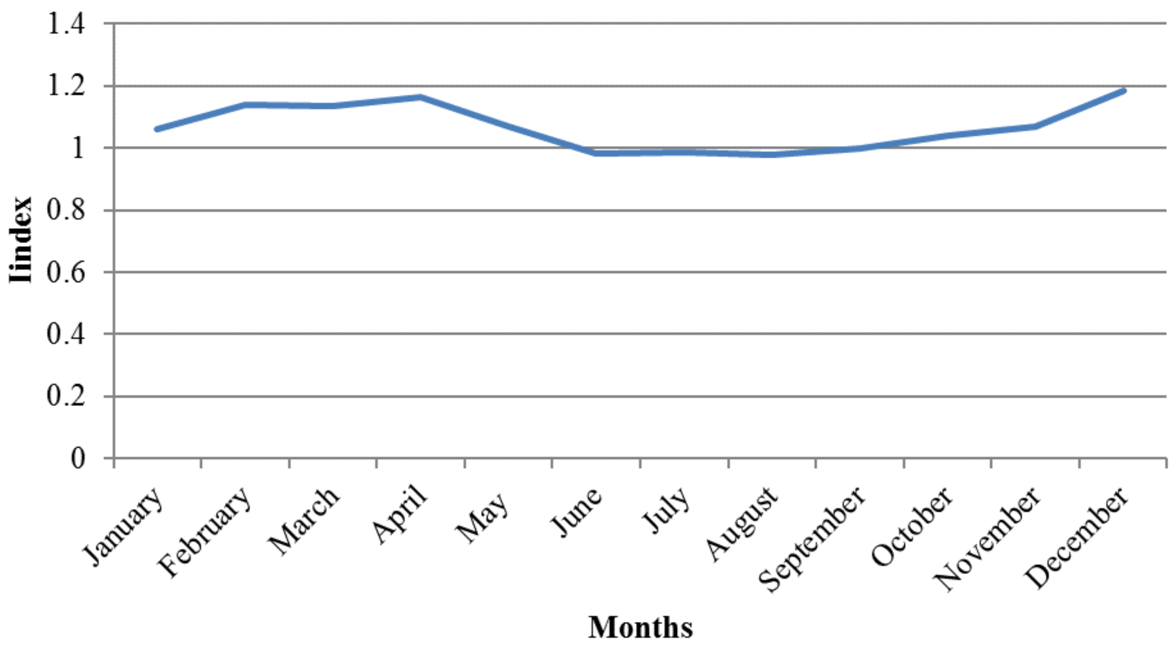

Figure 6: Groundnuts Price Index by month.

Price correlation matrix for testing market integration

Stigler and Shervin (1985) proposed the use of price correlation to measure market integration. A high coefficient value implies market integration. However, price correlations lower than 0.9 are unreliable (Steffen, 1994). Table 4 shows the Pearson's bivariate correlation coefficients which were significant at 1%. The coefficients show a strong relationship between deficit and surplus regions. Lusaka and Chipata pair had the highest coefficient (0.91) suggesting a high level of integration and a strong level of interdependence. This is because the market pair is connected to the main highway linking Zambia and Malawi through Chipata. The highway is intended to move groundnuts to Lusaka and Kitwe. Other markets exhibited integration because they also meet the highway from the feeder roads during transportation of groundnuts.

Table 3: Bivariate correlation coefficients

	Lusaka	Kitwe	Chipata	Chadiza	Kasama	Petauke
Lusaka	1					
Kitwe	0.91***	1				
Chipata	0.91***	0.88***	1			
Chadiza	0.89***	0.84***	0.85***	1		
Kasama	0.90***	0.87***	0.91***	0.87***	1	
Petauke	0.89***	0.87***	0.93***	0.87***	0.88***	1

Note: *** denotes statistical significance level at 1 percent.

Several studies have used correlation coefficients to determine the degree of market integration (Fafchamps and Gavian, 1995; Bopape and Christy, 2002; Mbene, 2005; Ddungu, 2015). However, the non-stationarity of agricultural time series price data and other factors such as drought and inflationary pressures can influence prices in markets in such a way that correlation coefficients may suggest market integration even if markets are not really integrated. Hence, testing for market integration by only using correlation coefficients could lead to biased results. Therefore, superior tools such as stationarity test, cointegration analysis, granger causality test and vector error correction model were used during data analysis.

4.3 Stationarity test

The groundnut price data was tested for stationarity before running a co-integration analysis. This was important to avoid spurious regression. In addition, using non-stationary price data leads to unreliable policy-making decisions and is not suitable for long-run predictions (Yusuf and Falusi, 1999). Table 4 shows results for both Augmented Dickey-Fuller (ADF) test and Kwiatkowski Philips Schmidt Shin (KPSS) tests on individual variables spanning from January 2001 to March 2017. When prices in the six markets were tested for stationarity using ADF test, it was found out that prices at Chadiza, Chipata, Kasama and Petauke were non stationary in their original form while Kitwe and Lusaka prices were found to be stationary at level. However, after suppressing the constant term, Lusaka and Kitwe were not stationary at level. Prices at the six markets were all stationary after the first difference. Since all variables were stationary after first difference, meaning that they were integrated of order

1, that is to say I (1). This is one of the conditions for testing co-integration that depicts the existence of a long-run relationship among the six groundnuts markets. Similarly, Kwiatkowski Philips Schmidt Shin (KPSS) found the same results with ADF tests.

Table 4: Test for Stationarity using ADF test and KPSS test

	ADF		**KPSS**	
	Level	**First Difference**	**Level**	**First Difference**
Chadiza	-2.86	-13.23***	0.80	0.06***
Chipata	-3.25	-12.84***	0.39	0.32***
Kasama	-3.43	-20.08***	0.53	0.17***
Kitwe	-7.29***	-8.39***	0.26***	0.12***
Lusaka	-6.48***	-16.44***	0.21***	0.12***
Petauke	-2.027	-17.21***	0.68	0.21***

Note: For the ADF test; triple, double and single asterisks indicate statistical significance at 1, 5 and 10 percent level. On the other hand, triple, double and single asterisks for the KPSS show significance at all levels, two levels and one level respectively. The critical values for the ADF at 1, 5 and 10 percent levels are -3.465, -2.877 and -2.575 respectively. The critical values for the KPSS are 0.739, 0.463 and 0.347 at 1, 5 and 10 percent respectively.

4.4 Lag Selection Criteria

Selection of appropriate lag is regarded as one of the crucial steps that must be done before running Co-integration and Granger Causality tests. Therefore, a multivariate lag selection criteria was used to determine the appropriate lag length. Five criteria were used to determine the optimum lag. These criteria include Akaike information criterion (AIC), Hannan-Quin information criterion (HQIC), Schwarz's Bayesian information criterion (SBIC), LR and FPE. In STATA, a vector auto-regression that is *varsoc* command on differenced groundnut prices was applied, and the appropriate lag length with the least values was chosen. Bivariate models for individual market pairs were tested for optimum lag length. For Lusaka-Chipata market pair, AIC and FPE chose the optimum lag of two. With this, a lag length of two was used to run both co-integration test and Granger Causality tests. Similarly, AIC, FPE and LR selected an optimum lag of four for Lusaka-Chadiza market pair. Lag two was chosen as an appropriate lag length for the Lusaka-Kasama market pair. Furthermore, an optimum lag length of three was selected between Lusaka and Petauke market.

The Schwarz's Bayesian Information and Hannan-Quin Information Criterion were selected as the appropriate lag length for the Kitwe-Chipata market pair. Also, for Kitwe-Chadiza market pair, Akaike Information criteria and Final Prediction Error chose five as an optimum lag. Lag length of one was selected by Schwarz's Bayesian Information Criterion for the Kitwe-Kasama market pair. Lastly, for Kitwe-Petauke market pair, Akaike Information Criterion, Final Prediction error, Hannan-Quin Information Criterion and Schwarz's Bayesian Information Criterion chose the lag of three as an optimum lag.

4.5 Johansen test for co-integration

Table 5 shows the results of co-integration analysis using Johansen multivariate analysis. The results are based both on trace and maximum eigenvalue statistics. Both statistics, that is the trace and maximum eigenvalue statistics reject the null hypothesis of zero co-integrating co-integrating linear equations among Lusaka-Chipata, Lusaka-Chadiza, Lusaka-Kasama, Lusaka-Petauke, Kitwe-Chipata, Kitwe-Chadiza, Kitwe-Kasama and Kitwe-Petauke market pairs. This means that there was utmost one co-integrating equation among the eight market pairs. It then follows that price signals are transmitted across these markets and, therefore, any shock occurring in one market transmits signals to another market. This also suggests that there exists a long-run equilibrium relationship among the eight markets pairs. Thus, in the long-run, the relationship of these variables was stable and predictable.

In addition, the existence of a long-run relationship between these market pairs suggests that there was supply of groundnuts from the surplus areas like Chipata, Chadiza, Kasama and Petauke to deficit areas such as Lusaka and Kitwe. These results are similar to those of Ahmed and Gjolberg (2015) who found long-run relationship in rice markets in Pakistan. Also, Mayaka (2013) found that there was a long-run co-integration between Nairobi-Nakuru, Nairobi-Eldoret, Nairobi-Kitale, Nakuru-Kitale and Eldoret-Kitale market pairs in a study conducted in Kenya. Mayaka (2013) observed that co-integration between the markets justified the supply of dry beans from surplus to deficit areas, especially during production periods because prices were low. Thus, assemblers had an incentive to transport dry beans to deficit areas expecting higher profit margins. However, these results contradict the findings of Mockshell and Egyir (2010) who found that the groundnut markets were not integrated both in the short and long-run and that the groundnut's distribution channel was large leading to increased transaction costs that was eventually transferred to the final consumer.

Table 5: Results of Johansen Co-integration for Trace and Maximum eigenvalue test

Market pairs	Test	Test Statistics
Lusaka-Chipata	$\tau_{trace} = r = 0$	36.73 **
	$\xi_{\max} = r = 0$	36.68 **
	$\tau_{trace} and \xi_{\max} = r = 1$	0.05
	ADF residual test	-7.96
Lusaka-Chadiza	$\tau_{trace} = r = 0$	17.44**
	$\xi_{\max} = r = 0$	17.33 **
	$\tau_{trace} and \xi_{\max} = r = 1$	0.11
	ADF residual test	-6.92
Lusaka-Kasama	$\tau_{trace} = r = 0$	15.28 **
	$\xi_{\max} = r = 0$	15.27 **
	$\tau_{trace} and \xi_{\max} = r = 1$	0.01
	ADF residual test	-6.75
Lusaka-Petauke	$\tau_{trace} = r = 0$	19.19**
	$\xi_{\max} = r = 0$	18.98**
	$\tau_{trace} and \xi_{\max} = r = 1$	0.22
	ADF residual test	-7.07
Kitwe-Chipata	$\tau_{trace} = r = 0$	45.23**
	$\xi_{\max} = r = 0$	45.15**
	$\tau_{trace} and \xi_{\max} = r = 1$	0.06
	ADF residual test	-7.68
Kitwe-Chadiza	$\tau_{trace} = r = 0$	16.92**
	$\xi_{\max} = r = 0$	16.77**
	$\tau_{trace} and \xi_{\max} = r = 1$	0.16
	ADF residual test	-7.62
Kitwe-Kasama	$\tau_{trace} = r = 0$	48.70**
	$\xi_{\max} = r = 0$	48.70**
	$\tau_{trace} and \xi_{\max} = r = 1$	0.00
	ADF residual test	-8.49

Kitwe-Petauke	$\tau_{trace} = r = 0$	21.53**
	$\xi_{\max} = r = 0$	21.31**
	$\tau_{trace} and \xi_{\max} = r = 1$	0.22
	ADF residual test	-7.63

Note: τ_{trace} and $\xi_{\max}$ denotes both the trace and maximum eigenvalue test respectively. r indicates the number of cointegrating equations. The ADF test critical value is -2.876277. Triple, double and single asterisks show statistical significance at 1%, 5% and 10% level respectively.

4.6 Granger Causality

Since co-integration analysis does not show the direction of the relationship, it is important to run granger causality tests which show the nature of the relationship among the markets. More so, economic theory assures the presence of granger causality in at least one direction (Order and Fisher, 1993). Goletti and Babu (1994) argued that granger causality denotes the direction of the market relationship as it supplements co-integration analysis. In addition, Mtumbuka *et al*. (2015) explained that granger causality recognizes the price formation direction between market pairs and the movements of groundnuts to adjust for these price differences. Granger causality can either be bidirectional or unidirectional causation. Bi-directional causation occurs when shocks between the markets are transmitted in either direction while unidirectional causality occurs especially when shocks are one-way and cannot be reversed between two markets. In this study, granger causality is applied to eight market pairs. The Kitwe-Chadiza market was the market pair that showed bi-directional causation. Five market pairs indicated unidirectional causation while two market pairs showed no causality relationship.

From Table 6, the first null hypothesis is that groundnuts prices at Kitwe market do not granger cause prices at Chadiza groundnuts market. Looking at the p-value (that is 0.01), we reject the null hypothesis that groundnuts prices at Kitwe markets do not granger cause markets at Chadiza market. In this case, any change in prices at Kitwe groundnut market transmits signals to Chadiza. Chadiza district happens to produce groundnuts more than Kitwe district in Zambia. In Kitwe people prefer food made of groundnuts such as *visashi* (vegetables mixed with pounded groundnuts) and also packaged groundnuts from supermarkets, making the demand to be high. This is why any price shock occurring at Kitwe is likely to transmit price signals to Chadiza market. On the other hand, any price changes in Chadiza are also transmitted to Kitwe. Thus, results in the table showed bidirectional causation between Kitwe and Chadiza market pair. This implies that there is trade between the market pair and price in Kitwe could be predicted using Chadiza market prices and vice versa. That is, any shock in either market is simultaneously translated to the other market pair.

Furthermore, it was observed that Lusaka-Chipata, Lusaka-Chadiza, Lusaka-Petauke, Kitwe-Chipata and Kitwe-Kasama market pairs showed a unidirectional relationship. Any price shock in either Chipata or Chadiza market were transmitted to Lusaka. Similarly, any price shock in Lusaka was transmitted to Petauke.

Finally, Lusaka-Kasama and Kitwe-Petauke market pairs showed no causal relationship between them. This implies that there was absence of interdependence between these markets. This result corroborates that of Ani (2015) who found that there was no interdependence or any form of causality between the prices in one market to the price of the other market. Thus, an increase in price in one market in the short-run could not bring about an increase in price in another market. This implied that prices in both markets were slowly and inefficiently transmitted with the interaction of demand and supply that was regulating the prices. However, the study indicated that lack of causality could not mean an absence of price transmission in the long-run.

Table 6: Pairwise Granger Causality for all markets

Market Pairs	**F**	**df**	**Prob>F**	**F**	**Prob>F**	**Direction**
Lusaka-Chipata	1.62	2	0.20	6.47	0.00***	Unidirectional
Lusaka-Chadiza	0.67	4	0.62	2.03	0.09*	Unidirectional
Lusaka-Kasama	1.60	2	0.21	1.55	0.22	Independent
Lusaka-Petauke	3.52	3	0.02**	2.00	0.12	Unidirectional
Kitwe-Chipata	0.77	1	0.38	5.03	0.03**	Unidirectional
Kitwe-Chadiza	3.18	5	0.01***	2.19	0.06*	Bidirectional
Kitwe-Kasama	0.55	1	0.46	10.83	0.00***	Unidirectional
Kitwe-Petauke	0.90	3	0.44	1.50	0.22	Independent

Note: Values with single, double and three asterisks denote the level of significance at 10%, 5% and 1% respectively. Prob>F indicates the presence of Granger causality.

The bi-directional causality between Kitwe and Chadiza markets suggested that there was efficiency and market information among the market participants. On the other hand, the existence of independent causation among Lusaka-Kasama and Kitwe-Petauke market pairs meant lack of market information and lack of efficiency. Bannor and Sharma (2015) found that bi-directional causality in Rajasthan was because farmers sold their groundnuts through the channel of producers, wholesalers, and processors.

Mayaka (2013) found that the presence of independent causation between Nairobi-Eldoret, Nairobi-Nakuru, Nakuru-Kitale, Nakuru-Eldoret and Eldoret-Kitale justified the existence of inefficiency and lack of market information. Therefore, Tione (2011) suggested that providing market information, incentive structure and infrastructural development would attract both large and small scale trader interaction causing instantaneous price transmission across markets, thereby promoting competition.

To achieve objective three, which determines the speed of adjustment in the retail prices between the deficit and surplus areas, the Vector Error Correction Model was used. VECM helps to ascertain the nature and character of the long run relationships between markets and useful in attaining the speed of adjustments in the retail prices between the deficit and surplus regions. The test of auto-correlation indicated that the model was free from serial correlation. This meant that the chosen model had included the major determinants in the equation.

Table 7 explicitly shows the results for both the short-run and long-run estimates of the VECM. The results indicated that Chipata market had the short-run influence of 0.049 albeit insignificant and long-run influence of -0.544 on Lusaka prices. This implied that a percentage increase in Chipata groundnuts retail prices, in the long-run, increased Lusaka retail prices by 54 percent. In the short-run, it would lead to a 4.9 percent increase. Despite Lusaka traders buying groundnuts from Chipata, they also purchased groundnuts from other districts such as Petauke, Chadiza and other surrounding districts. This, however, explained the insignificance of the short-run influences between Lusaka and Chipata market pair.

Error correction model indicates the time it would take the previous period’s disequilibrium in groundnuts prices to be corrected in the short-run. The adjustment parameter should be a negative sign. In this case, Lusaka prices had a negative and significant sign. This means that after an exogenous shock, 43.7 percent would be restored towards equilibrium within a month. On the other hand, the adjustment coefficient of Chipata was positive (10.7 percent) as expected.

Table 7: The Vector Error Correction Model of long and short-run relationship between Lusaka and Chipata retail prices

Long run estimates		
Regressors	**CointEq1**	
Lusaka Retail Prices	1.00	
Chipata Retail Prices	-0.544(-4.55***)	
Constant	-2.190	
Short-run Estimates		
Error Correction Model	**Lusaka Price Model**	**Chipata Price Model**
CointEq1	-0.437(-6.55***)	0.107(1.78*)
D(lnlusaka) -1	0.073(1.03)	-0.005(-0.08)
D(lnchipata) -1	0.049(0.63)	-0.262(-3.69)
Constant	0.000(0.06)	0.000(0.28)

Note: triple, double and single asterisks denote significance at 1%, 5% and 10% respectively. Values in parentheses indicate the t values.

It is important to note that Lusaka prices had faster adjustment than Chipata prices. The speed of adjustment for Lusaka prices and Chipata prices where 43.7 and 10.7 percent respectively. With regards to the threshold of perfect adjustment of 100 percent, the adjustment parameters were relatively weak. The low adjustment coefficient suggested minimal arbitrage between Lusaka and Chipata markets. These results conform to the findings from a study by Ani (2015) which emphasized that the speed of adjustment between Benue and Enugu markets was low indicating low arbitrage. Furthermore, the immediate previous prices of groundnuts had no influence on the future groundnuts prices. On the contrary, a study by Ani *et al.* (2017) found that immediate previous prices of soybeans in Benue rural market had zero influence on the future prices while Enugu market prices influenced its future prices.

Table 8 shows the short run and long-run estimates of the vector error correction model. Chadiza prices had a short-run influence of -0.086, -0.034 and -0.105 but not significant while its long-run estimate was -0.359. This implies that a one percent change in Chadiza prices would bring about 9, 3 and 10.5 percent increase in prices in the short run and 36 percent change in the long run. The low short-run estimates were as a result of low arbitrage. This means that traders in Lusaka bought food stuff in other markets because other markets offered lower prices. In addition, low arbitrage can be attributed to exogenous shocks such as high transaction costs incurred by the traders.

Table 8: The Vector Error Correction Model of long and short-run relationship between Lusaka and Chadiza retail prices

Long run estimates		
Regressors	**CointEq1**	
Lusaka Retail Prices	1.00	
Chadiza Retail Prices	-0.359(-2.80***)	
Constant	-3.048	
Short-run Estimates		
Error Correction Model	**Lusaka Price Model**	**Chadiza Price Model**
CointEq1	-0.330(-4.71***)	0.116(1.01)
D(lnlusaka)-1	0.008(0.10)	0.067(0.51)
D(lnlusaka)-2	0.003(0.04)	-0.123(-1.02)
D(lnlusaka)-3	-0.063(-0.92)	-0.081(-0.72)
D(lnchadiza)-1	-0.086(-1.82)	-0.548(-7.08)
D(lnchadiza)-2	-0.034(-0.69)	-0.350(-4.30)
D(lnchadiza)-3	-0.1049535(-2.39)	-0.260(-3.62)
Constant	0.000(0.18)	0.000(0.32)

Note: triple, double and single asterisks denote significance at 1%, 5% and 10% respectively. Values in parentheses indicate the t values.

The adjustment coefficients measuring the speed of adjustment for Lusaka had an expected negative sign of 33 percent. On the other hand, adjustment coefficient of Chadiza had a positive sign (12 percent). More so, Lusaka prices of groundnuts adjusted faster than Chadiza prices of groundnuts. The adjustment coefficients of 33 and 12 percent were weaker in comparison to perfect adjustment threshold of 100 percent. This means that there was some delay in the transmission of prices between the markets. Therefore, the speed at which equilibrium goes back to normal after an exogenous shock was relatively low. This was as a result of low arbitrage between Lusaka market and Chadiza market. Furthermore, the previous Lusaka and Chadiza prices were all insignificant meaning that the past prices did not influence the future prices. A study by Ahmed and Gjolberg (2015) found that insignificant short-run coefficients was because of the direction of causality, infrastructure and distance between the marketing pairs, thereby, leading to either low speed of adjustment or weak market integration.

Table 9 shows results for both the Short run and Long run estimates. Petauke prices had short-run influences of -0.087 and 0.066, and not significant, but with long-run estimates of -0.304 on Lusaka prices. This implies that one percent change in Petauke Retail price would increase Lusaka prices by 9 and 7 percent with an increase of 30 percent in the long run. On the contrary, Lusaka prices short-run influences of 0.179 and -0.553, and significant. Non-significance and no short-run influences on Petauke prices were mostly as a result of low and insufficient arbitrage. Most Lusaka traders would purchase groundnuts and other goods in alternative markets where they offered lower prices. This explains the low arbitrage since traders would seek other markets. However, this behaviour, in the long run, would cause a minimal increase in the prices.

Table 9: The Vector Error Correction Model of long and short-run relationship between Lusaka and Petauke retail prices

Long run estimates		
Regressors	**CointEq1**	
Lusaka Retail Prices	1.00	
Petauke Retail Prices	-0.304 (-2.19**)	
Constant	-3.310	
Short-run Estimates		
Error Correction Model	**Lusaka Price Model**	**Petauke Price Model**
CointEq1	-0.392(-5.69***)	0.031(0.49)
D(lnlusaka)-1	0.031(0.41)	0.044(0.61)
D(lnlusaka)-2	0.006(0.08)	0.179(2.68***)
D(lnpetauke)-1	-0.087(-1.23)	-0.553(-8.33***)
D(petauke)-2	0.0655551(0.94)	-0.382(-5.81***)
Constant	0.000(0.04)	0.000

Note: triple, double and single asterisks denote significance at 1%, 5% and 10% respectively. Values in parentheses indicate the t values.

From the results above, adjustment coefficient for Lusaka prices was negative (-0.392). This means that 39% of the disequilibrium was restored within a month after an exogenous shock. Similarly, Petauke adjustment coefficient was positive (0.032). It was observed that Lusaka prices adjusted faster than Petauke prices. The speed of adjustment of both Lusaka (39%) and Petauke (3%) were weaker in comparison to the perfect adjustment threshold of 100%. This means that there were some delays in the transmission of prices between the markets. Therefore, the speed at which equilibrium goes back to normal after an exogenous shock was relatively very low. This was as a result of low arbitrage between Lusaka market and Petauke market. Contrary to these results, Ikudayisi and Salman (2010) found that close markets were more integrated and that the speed of adjustment was low for distant markets. Furthermore, the lagged Petauke prices were all insignificant meaning that the past prices did not influence the future prices. On the contrary, immediate past two values of Lusaka prices were significant. This means that immediate past prices of Lusaka had an influence on the future prices.

Table 10 further shows results for short run and long relationships. These results show that Kasama Prices had a short run influence of 0.090 and a long-run influence of -0.054 on Lusaka prices. This implies that one percent increase in Kasama price would increase Lusaka prices by 9 % in the short run but will increase by 5 percent in the long-run. On the other hand, Lusaka prices had significant short-run influences of 0.153 on Kasama prices. The low and insufficient arbitrage was mostly attributed to the distance between Lusaka and Kasama. Long distances are mostly accompanied with high transaction and transport costs. These results conform to the findings of Alemu and Biacuana (2006) who suggested that transactions costs are higher in distant markets and also in those markets connected by poor roods.

Table 10: The Vector Error Correction Model of long and short-run relationship between Lusaka and Kasama Retail prices

Long run estimates		
Regressors	**CointEq1**	
Lusaka Retail Prices	1.00	
Kasama Retail Prices	-0.054(-0.48)	
Constant	-4.478	
Short-run Estimates		
Error Correction Model	**Lusaka Price Model**	**Kasama Price Model**
CointEq1	-0.359(-5.92***)	-0.097(-1.46)
D(lnlusaka) -1	0.018(0.25)	0.153(1.95*)
D(lnkasama) -1	0.091(1.47)	-0.370(-5.46***)
Constant	0.000(0.04)	-0.000(-0.13)

Note: triple, double and single asterisks denote significance at 1%, 5% and 10% respectively. Values in parentheses indicate the t values.

The adjustment coefficient of Lusaka prices was negative (-0.359). This implies that 35% of the disequilibrium was restored within a month. On the contrary, the adjustment coefficients of Kasama prices were also a negative -0.097. Although the results suggested a long run relationship, it is imperative to note the absence of short-run relationships. This further explains the low and insufficient arbitrage between the markets.

Table 11, below shows the short run and long-run relationships between Kitwe and Chipata markets. The long-run influence of Chipata prices was -0.427 and significant. This means that a one percent change in Chipata retail prices would increase Kitwe prices by 43 percent. The estimated adjustment coefficients were -0.483 and -0.034 for Kitwe and Chipata respectively. This implies that if there is a positive deviation from long-run equilibrium, the system responds with an increase in both Kitwe and Chipata markets. In addition, the adjustment coefficients of -0.483 and -0.034 shows that prices in Kitwe adjust relatively faster than Chipata prices. By implication, the corrections were primarily done in the urban market (Kitwe market). These results corroborate with the findings of Ojiako *et al*. (2014; 2013) who found that the estimated adjustment coefficients for Cassava prices and processed dry products such as *garri* showed significant adjustment coefficients in both the rural and urban markets' prices in Nigeria.

Table 11: The Vector Error Correction Model of long and short-run relationship between Kitwe and Chipata retail prices

Long run estimates		
Regressors	**CointEq1**	
Kitwe Retail Prices	1.00	
Chipata Retail Prices	-0.427(-3.15***)	
Constant	-2.701	
Short-run Estimates		
Error Correction Model	**Kitwe Price Model**	**Chipata Price Model**
CointEq1	-0.483(-7.67***)	-0.034(-0.73)
Constant	-0.000(-0.02)	0.000(0.29)

Note: triple, double and single asterisks denote significance at 1%, 5% and 10% respectively. Values in parentheses indicate the t values.

Table 12, shows both the short run and long-run estimates of Kitwe and Chadiza retail prices. Chadiza prices had short-run influences of -0.023, 0.007, -0.021 and -0.098, and not significant, but with long-run estimates of -0.253. This implies that one percent change in Chadiza Retail price would increase kitwe prices by 2, 0.6, 2 and 10 percents in the short run but with an increase of 25 percent in the long run. On the contrary, Kitwe prices had short-run influences of 0.140, 0.310, 0.046 and 0.097 that were all insignificant but one. Non-significance and no short-run influences on Chadiza prices were mostly because of low and insufficient arbitrage. Most Kitwe traders would purchase groundnuts and other goods in alternative markets where they offered cheaper prices. This explains the low arbitrage since traders would seek other markets. However, this behaviour, in the long run, caused a minimal increase in the prices.

Table 12: The Vector Error Correction Model of long and short-run relationship between Kitwe and Chadiza Retail prices

Long run estimates		
Regressors	**CointEq1**	
Kitwe Retail Prices	1.00	
Chadiza Retail Prices	-0.253(-2.16**)	
Constant	-3.510	
Short-run Estimates		
Error Correction Model	**Kitwe Price Model**	**Chadiza Price Model**
CointEq1	-0.380(-5.25***)	0.093(0.80)
D(lnkitwe)-1	-0.040(-0.56)	0.140 (1.22)
D(lnkitwe)-2	-0.022(-0.33)	0.310(2.83***)
D(lnkitwe)-3	0.036(0.55)	0.046(0.663)
D(lnkitwe)-4	0.046(0.80)	0.097(1.04)
D(lnchadiza)-1	-0.023(-0.47)	-0.572(-7.39***)
D(lnchadiza)-2	0.007(0.13)	-0.436(-5.20***)
D(lnchadiza)-3	-0.021(-0.42)	-0.352(-4.36***)
D(lnchadiza)-4	-0.098(-2.21)	-0.134(-1.87*)
Constant	0.000(0.23)	0.000(0.58)

Note: triple, double and single asterisks denote significance at 1%, 5% and 10% respectively. Values in parentheses indicate the t values.

The adjustment coefficient in the Table above reflects the speed of adjustment. Kitwe market has the expected negative sign of -0.380. This means that 38 percent of the disequilibrium is restored towards equilibrium within a month. On the other hand, the adjustment coefficient of Chadiza had the expected sign of a positive sign (0.093 or 9 percent). In this case, the adjustment was done by both Kitwe and Chadiza retail prices. Moreso, the low speed of adjustment means that there was inadequate arbitration between Kitwe and Chadiza markets. Furthermore, the lagged previous prices for both Kitwe and Chadiza were insignificant. This suggests that the immediate previous prices could not significantly influence future prices. These results agree with the findings of Ojiako *et al*. (2012) that found that after an exogenous shock in the commodity market, the long-run equilibrium is restored by the corrections that are made by the urban market.

Results in Table 13, shows the short run and long-run relationships between Kitwe and Kasama markets. The long-run influence of Kasama prices was -0.468 and significant. This meant that a one percent change in Kasama retail prices would increase Kitwe prices by 46.8 percent. The adjustment coefficient had an expected sign of -0.515. Thus 51.5 percent of the disequilibrium was corrected within a month. The magnitude of the speed of adjustment reflected that exogenous shocks played a critical role in price transmission. Although the adjustment coefficient was the highest among all market pairs, 51 percent was weaker as compared to the perfect adjustment threshold of 100%. In regard to this, there were delays in price transmission between Kitwe and Kasama markets. These adjustments were both done by Kitwe and Kasama markets.

Table 13: The Vector Error Correction Model of long and short-run Relationship between Kitwe and Kasama Retail prices

Long run estimates		
Regressors	**CointEq1**	
Kitwe Retail Prices	1.00	
Kasama Retail Prices	-0.468(-5.52***)	
Constant	-2.512	
Short-run Estimates		
Error Correction Model	**Kitwe Price Model**	**Kasama Price Model**
CointEq1	-0.515(-7.97***)	0.083(1.33)
Constant	3.76e-06(0.00)	0.000(0.02)

Note: triple, double and single asterisks denote significance at 1%, 5% and 10% respectively. Values in parentheses indicate the t values.

Lastly, Table 14 explicitly shows the short and long-run relationship between Kitwe and Petauke markets. Petauke prices had short-run influences of 0.090 and -0.005 on Kitwe prices, and not significant, but with long-run estimates of -0.221. This indicates that one percent change in Petauke Retail price would increase Kitwe prices by 9 and 0.5 percent in the short run but with an increase of 22 percent in the long-run. On the contrary, Kitwe prices had short-run influences of 0.078 and 0.063 that were all insignificant. Non-significance and absence of short-run influences on Petauke prices were mostly because of low and insufficient arbitrage. Most Kitwe traders would purchase groundnuts and other goods in alternative markets where they offered cheaper prices. This explains the low arbitrage since traders would seek other markets. However, this behavior, in the long run, caused a minimal increase in the prices.

The speed of adjustment coefficient for Kitwe had the expected negative sign (-0.412) and significant. This implies that 41 percent of the disequilibrium would be restored towards equilibrium within a month after a shock. On the other hand, the adjustment coefficient of Petauke had the expected sign of a positive sign (0.010 or 1 percent). In this case, the adjustment was done by both Kitwe and Petauke retail prices. However, Kitwe prices adjusted faster than Petauke. The low speed of adjustment means that there is inadequate arbitration between Kitwe and Petauke markets. This insufficient arbitration suggests the presence of exogenous shocks such as high transaction costs and weather shocks. Furthermore, the lagged previous prices for both Kitwe and Petauke were all insignificant. This suggests that the immediate previous prices could not significantly influence future prices.

Table 14: The Vector Error Correction Model of long and short-run relationship between Kitwe and Petauke retail prices

Long run estimates		
Regressors	**CointEq1**	
Kitwe Retail Prices	1.00	
Petauke Retail Prices	-0.221(-1.46)	
Constant	-3.664	
Short-run Estimates		
Error Correction Model	**Kitwe Price Model**	**Petauke Price Model**
CointEq1	-0.412(-5.96 ***)	0.010(0.17)
D(lnlusaka)-1	-0.170(-2.19**)	0.078(1.21)
D(lnlusaka)-2	0.075(1.11)	0.063(1.11)
D(lnpetauke)-1	0.090(1.11)	-0.552(-8.16***)
D(petauke)-2	-0.005(-0.06)	-0.397(-5.86 ***)
Constant	0.000(0.01)	0.000(0.64)

Note: triple, double and single asterisks denote significance at 1%, 5% and 10% respectively. Values in parentheses indicate the t values.

As noted above, Kitwe-Kasama market pair had the highest speed of adjustment of 52 percent while Lusaka-Chadiza had the lowest speed of adjustment of 33 percent. The market pairs had negative signs as expected, which is as a result of the reaction of prices in the short run due to exogenous shocks. The magnitude of the speed of adjustment among all the market pairs (that is, Lusaka-Chipata, Lusaka-Chadiza, Lusaka-Petauke, Lusaka-Kasama, Kitwe-Chipata, Kitwe-Chadiza, Kitwe-Petauke and Kitwe-Kasama) was different. Thus, the prices in the market pairs respond differently to an exogenous shock. In essence, these results showed that there was integration in the short run. In support of these findings, Jyoti and Yeledhalli (2015) found out that the prices of groundnuts between markets in India were highly integrated in terms of price movement. The author noted that the prices were not only governed by commodity arrivals, but also by other factors such as transportation and communication network. These results disagree with the findings of Bannor and Sharma (2015) who found the highest speed of adjustment of 87 percent between two groundnuts market pair in India while the lowest of 50.3 percent. The study also found that most nonco-integrated groundnuts markets were not integrated in the short-run. Also, Mockshell and Egyir (2010) found that groundnut markets were not integrated both in the short and long run. As observed by Habte (2017) the differences in the speed of adjustment had a clear implication on how efficient and equitable a marketing system can be.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATION

5.1 Summary

This chapter provides the conclusions and the accompanying policy recommendations based on the research findings of this study. The chapter begins by summarizing the research findings and their conclusions. This summary of results and conclusions follow each objective at a time in the order in which they appear in the first chapter of the study. The chapter then proceeds to give an outline of the general and the policy recommendations based on the research findings. The chapter ends by suggesting areas for further studies that will allow further understanding and improvement of groundnut spatial market integration and price transmission in Zambia.

5.2 Conclusions

1. The urban regions had highest prices because they are the consuming regions while the rural regions had the lowest prices because they are the producing regions.
2. All the markets investigated are integrated in the long-run implying that price signals are transmitted from one market to the other.
3. In the short-run, the speed of adjustment was relatively low, implying that there were differences in arbitrage opportunities.

5.3 Policy recommendations

The government and other relevant stakeholders must continue with their efforts in enhancing the flow of information, which plays a crucial role in spatial integration among the markets. Since long distances mostly separate these markets, it is necessary to ensure development and constant use of market information centres. This is very important because market information centres tend to reduce information asymmetries between the market participants, thereby making these markets more efficient. The efforts in promoting online trading platform like EMsika in Zambia is a step in the right direction. However, these innovations should be made available in all the provinces in order for the farmers to fully benefit from it.

The study recommends for provision of quality infrastructure and road network in rural markets in order to reduce the fluctuations of groundnut prices. Also, investing more in the groundnut production and development of market infrastructures such as modern stores, warehouse receipt systems and groundnut factories between the urban markets and rural markets. This would ensure protection of stored produce from the vagaries of bad weather, pests and rodents, prevent quantity and quality losses, regulation of price levels through the control of groundnuts supply and demand, and finally, offering price, demand and supply information to market participants for the development of effective and profitable strategies. Thus, encouraging farmers to produce more groundnuts and participate in groundnuts marketing, hence, enabling farmers to determine the movement of groundnut prices.

The Market Support Services under the Ministry of Agriculture and Co-operatives should consistently collect price information on weekly and monthly basis and this information should be available to the farmers. This would motivate farmers to produce more groundnuts as well as plan their production.

5.4 Areas for future research

The study focused on spatial market integration and price transmission among selected groundnuts markets in Zambia and only included six markets. Future studies should include more than six markets to see the flow of market price information. In addition, future studies should focus on the same crop by attempting to quantify actual transaction costs that should include negotiation costs, transportation costs, costs of acquiring information, bargaining costs, and costs of enforcing contracts between market participants such as consumers and producers. Furthermore, future studies should also focus on how the quality of infrastructure affects the speed of adjustments of markets in an event of a shock.

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