ECONOMIC ANALYSIS OF THE SPATIAL INTEGRATION OF PIGEON PEA MARKETS IN MALAWI

MASTER OF ARTS (ECONOMICS) THESIS

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UNIVERSITY OF MALAWI

CHANCELLOR COLLEGE

APRIL, 2011

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Master of Arts (Economics) Thesis

By

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DECLARATION

I, the undersigned, hereby declare that this thesis is my original work and has not been submitted to any other institution for similar purposes. Where other studies have been used, acknowledgments have been made.

Admire Katunga

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Signature

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Date

CERTIFICATE OF APPROVAL

The undersigned certify that this thesis represents the student's own work and effort and has been submitted with my approval.

Signature: _____Date:_____

Levison Chiwaula , Ph.D (Lecturer)

Supervisor

DEDICATION

I dedicate this work to late Phillip Milanzi, my former primary school Teacher who by his inspiration I have reached this far. Your amazing encouragement gave me foresight to look beyond merely attaining basic education. I will always remember you till, when we meet again in eternity (RIP).

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ABSTRACT

Despite the potential of pigeon pea as an alternative cash crop, no adequate information on spatial market integration of the product has been documented. Motivated by wide pigeon price margins among spatially separated markets in the country this study conducted an economic analysis of the spatial integration of pigeon pea markets in Malawi. A total of seven pigeon pea markets namely; Balaka, Limbe, Luchenza, Nchalo, Ngabu, Nsanje and Zomba were analyzed. The research used average monthly pigeon pea retail prices for the period January 2005 to December 2008. By applying correlation analysis and co-integration approaches we tested for short-run and long-run spatial market integration of pigeon pea in the country. The analysis was extended to VECM and Granger Causality to estimate speed of adjustment and determine the direction of causality between the markets respectively.

The results of the study indicate that all markets were integrated of order 1. Johansen co-integration test procedure indicated 5 co integration relationships suggesting existing of long-rum relationship among markets. The speed of adjustment to equilibrium of markets was moderate to low in the markets. The direction of price transmission showed both bi- directional and unidirectional transmission process and that three markets were identified as market leaders. Innovations of four markets explained the forecast error variance in other markets.

These results therefore are indicative of moderate integration of the pigeon pea markets in Malawi. Two policy implications can be advanced based on the findings of the study.

Considering, the complexity and unstable market conditions of pigeon pea and its potential as an alternative cash crop it is imperative to continuously study this market to understand the relationship of markets from time. This will keep policy makers updated on changes of pigeon pea markets and their associated new markets. The current study suggests possible areas for intervention to turn the market for pigeon pea towards perfect integration. Knowledge on pigeon pea market changes will achieve the goal of transforming the legume sub-sector into a vibrant enterprise. As poor transportation and communication conditions have been indicated as the major obstacles for perfect pigeon market integration, it is therefore imperative for government and the private sector to continue investing in transport and communication infrastructure such as roads and telephones. This will improve the flow of both pigeon pea grain and price information in the markets. If market participants can efficiently respond to changes in the market on time, then efficiency will be obtained in the marketing system.

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ADD	Agricultural Development Division
ADMARC	Agricultural Marketing Corporation
NSO	National Statistic Office
VECM	Vector Error Correction Mechanism
ECT	Error Correction Term
OLS	Ordinary List Square

CHAPTER ONE

INTRODUCTION

1.0 Background

Agriculture is the mainstay of Malawi economy. The sector contributes close to about 40 per cent of gross domestic product (GDP) and 90 per cent of export earnings (NSO, 2000). It constitutes smallholder and large scale sub-sectors that are responsible for 80% and 20% of the total agricultural production respectively (NSO, 2000). Maize is the main staple occupying 70% of the cultivated land area and mostly produced by the smallholder sub-sector. In addition to maize the smallholder also produces other crops such as groundnuts, beans and pigeon pea.

However, maize production has been decreasing over the years due to several factors which include: (1) loss of soil fertility (2) little use of inorganic fertilizer (3) low real commodity price and (4) terminal drought and short rainfall duration experienced by some areas of the country (Conroy and Kumwenda, 1994; Lungu, 1998). Tobacco, tea and sugar are the main cash crops with tobacco being emphasized as potential option for improving income and food security for rural households in Malawi (Zeller et.al., 1998). However, current global anti-smoking campaign leaves the future of the tobacco industry in suspense, thus putting the economic livelihoods of the majority population in jeopardy.

On the other hand, tea and sugar require huge capital outlay as such production of these crops is dominated mainly by estate sub sector. From the above we clearly see that food insecurity problem will continue to affect majority of the country's population, especially rural inhabitants who make up the majority of the country's population, if no alternative cash crop is promoted. One of the strategies available is to promote production of high value cash crops such as pigeon pea and link producers to profitable markets. This can only be achieved if the marketing system is efficient. Moreover pigeon pea has relatively high real commodity price such that farmers would benefit from increased cash incomes (Lungu, 1998). The ability of pigeon pea to with stand harsh weather conditions also make the crop ideal enterprise for smallholder farmers that may not afford use of irrigation facilities. Considering that the domestic agro processing industries have established good links with the international market (Makoka, 2009), efficient performance of pigeon pea markets would greatly contribute to achievement of one of the Malawi Growth Development Strategy of increased economic growth.

While there has been much emphasis on agronomic aspects of pigeon pea in Malawi, little is known about its marketing system, especially on how prices in spatially separated markets relate to each other. Market price information for pigeon pea would channel information to producers and other players in the supply chain and this in turn affects both production and marketing decisions. In a market economy such as that of Malawi, movement of prices from one market to the other directs and controls what, how and how much to produce, consume, and bring to the market (Ghafoor et.al., 2009).

In this vein investigating the link between prices of spatially separated markets and how quickly market price deviation come to equilibrium is an important economic analytical approach to understand agricultural output markets better, especially that of pigeon pea.

Information on market price linkage may also be used as a proxy to measure how efficient the agricultural marketing system is (Golletti and Babu, 1994). This implies that overall performance of the market may be indicated by spatial price behavior can be further evaluated in terms of its price relationship and the subsequent movement of commodities between the markets. Fackler and Goodwin (2001), Barrett and Li (2002) on the other side relate the concept of efficiency to the degree to which demand and supply shocks originating from one market are transmitted to another. From the above discussion it was imperative to conduct an economic analysis of the spatial integration of pigeon pea markets in Malawi to generate information on price movements between spatially separated markets useful to decision making for all participants in the production and supply chain of pigeon pea in the country.

1.2 Problem Statement and Motivation

In an efficient marketing system, prices move together and trade takes place if price in the importing region equals price in the exporting region plus the unit transport cost incurred by moving the products between the two markets (Ravallion, 1986). In this case information on price of commodities that is accurate and timely transmitted help market participants in decision making. This flow of market activities is dependent on price signals to guide and regulate production and trade. Understanding markets through examining co-movements of prices and commodities equips policy makers with strategies to improve the efficiency of the marketing system (Takele, 2010).

However, few studies have attempted to investigate the efficiency of the market system of legumes in Malawi. For example Simtowe et.al, (2003) examined prospects of the pigeon pea sub-sector in Malawi. On the other hand Kumchulesi (2004) analyzed economic efficiency in the marketing channels of the groundnut value chain. The study used cost and selling price of all value addition activities to compute mark-up values for each participant in the value chain to determine efficiency of the market. Further, Makoka (2009) assessed small farmers' access to high-value markets in the Malawi pigeon pea market. All these studies adopted the value chain approach which is merely a description of the full range of value-adding activities required to bring a product from its conception to the final consumer is done.

While results of these studies provide insights about the marketing system, they do not give enough information to understand the interaction and feedback effects between market prices, especially that of pigeon pea. Despite the potential importance of pigeon pea as a source of and income generation, little attention has been paid on its price transmission mechanism. Systematic and adequate information on market integration of pigeon pea has not been handled. Hence, this study attempts to fill this knowledge gap to measure spatial marketing integration of pigeon pea in some selected markets of the country, using co integration analytical approach in a vector error correction (VEC) frame work.

The motivation of this study is that in Malawi, pigeon pea production is dominated by smallholder farmers and its high real commodity price relative to maize would enable the farmers to generate more cash incomes for poverty alleviation and general economic well being.

It was therefore ideal to examine the extent of market integration of pigeon pea to generate information that would be used by various actors in the production and supply chain.

1.3 Objectives of the Study

The main objective of this study was to conduct economic analysis of the spatial integration of pigeon pea markets in Malawi in order to generate adequate information that would assist all actors in pigeon pea production and marketing chain to realize fair incomes and to sustain their livelihoods. The specific objectives of the study were;

1. To analyze the short-run and long-run integration of pigeon pea markets in Malawi,
2. To estimate the speed of adjustment of the prices to the long-run equilibrium,
3. To investigate the direction of price transmission of pigeon pea markets, and
4. To determine lead (central) market of pigeon pea that influences prices changes of other markets.

1.4 Hypotheses of the Study

The following hypotheses were tested;

1. Pigeon pea markets are not integrated both short run in the long-run and,
2. The pigeon pea market prices do not adjust
3. There is no reversal direction in Pigeon pea market price transmission, and
4. There is no central market for pigeon pea.

1.5 Organization of the Study

From this point the structure of the study proceeds as follows: Chapter 2 presents a brief view of the agricultural sector, which includes the pigeon pea sub-sector in Malawi. Theoretical and empirical literature review is given in Chapter 3. In Chapter 4 we provide research methodology, which include data sources, estimation procedure, and data analysis. Chapter 5 gives results, interpretation and discussion. Summary, conclusion and policy implications are presented in Chapter 6.

CHAPTER TWO

OVER VIEW OF THE PIGEON PEA SUB-SECTOR IN MALAWI

2.0 Introduction

This chapter presents an overview of the pigeon pea sub- sector in Malawi, with some discussions of the contribution of the crop to the economy..

2.1 The Grain Sector in Malawi

In Malawi agriculture is the major source of livelihoods for more than 85 percent of the population which is mostly rural based. The sector comprises of the smallholder and the estate sub-sectors that contribute more than 70 percent and less than 30 percent to gross domestic respectively (Chirwa, 2007). Maize is the main food crop as well as cash a crop. With dwindling maize price grain legumes such as pigeon pea becomes an important substitute for cash generation.

Apart from generating income for producers, pigeon pea is a cheap source of vegetable protein and vitamins which is ideal to for maintaining household nutrition. Pigeon pea also enhances soil fertility through atmospheric nitrogen fixation in the soil. Such symbiotic system can be a major source of nitrogen in most cropping systems. In this case the country can reduce expenditures on inorganic fertilizers through such exploitation of the atmospheric biological nitrogen. Most importantly, is that pigeon pea is a relatively high value crop compared to most cereals.

Thus, farmers can generate more cash income from sales of the product. Furthermore, there is potential market in the region and beyond for pigeon pea and this can greatly contribute to the economy's narrow foreign exchange earnings.

2.2 Pigeon peas Production and Marketing

Pigeon peas (Cajanus cajan) is important legume crop grown in many parts of the world. For the period 1991-2006 Malawi remained one of the largest producers of pigeon pea in Africa, producing about 78,000 metric tons per year, which accounted for about 28% of the continent's production. In terms of area of cultivated pigeon pea ranked as the third most important legume crop after groundnut and beans in the period of 1991-2006 in Malawi (Simtowe et. al., 2003). It is grown mainly in the southern region of Malawi where it occupies a significant proportion of the farming system, contributing up to about 20% of farmers' income (Simtowe et.al., 2003). Blantyre and Machinga Agricultural Development Divisions (ADDs) accounted for about 90% of the total pigeon pea area cultivated in 2005-2008. These areas are characterized by short rainfall duration and terminal drought with high temperatures (Makoka, 2009). Its nitrogen-fixing ability and deep taproot to recycle nutrients in the soil, as well as its use as a protein-rich food and livestock feed make pigeon pea a very important crop to smallholder farmers (Makoka, 2009).

However, yields of pigeon pea have been growing at an annual rate of 1% with average yields of 700kg ha^{-1} between 1961 and 2006. The growth in the yields translates to annual production of 52,000 metric tons to 79,000 metric tons between 1961 and 2006 (Simtowe et.al., 2003). Following the worst drought that hit the country between 2003 and 2005 production of pigeon pea slumped to e record low (Denning, 2009).

However, the general pattern of growth in production has followed increase in the area of land cultivated as indicated in Figure 1 below.

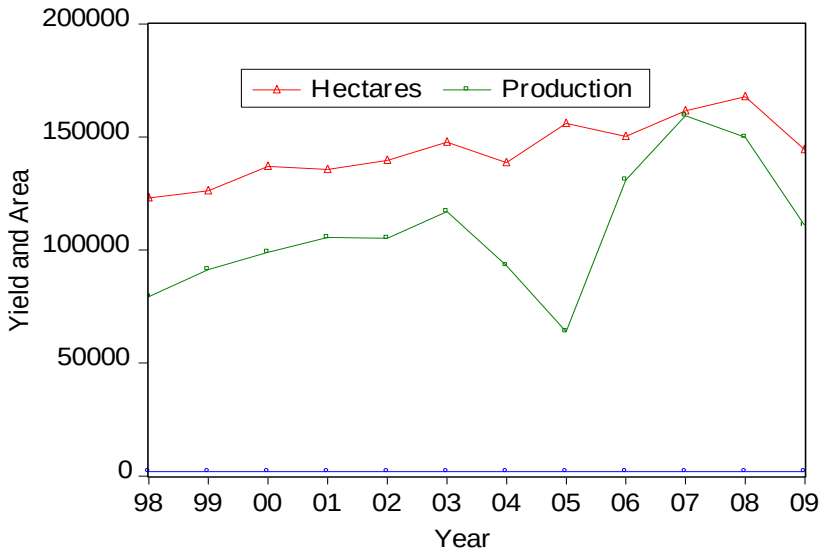

Figure 1: Production Trend for Pigeon pea in Malawi

Source: Ministry of Agriculture and Food Security, 2008.

In terms of utilization, it is estimated that 65% of the pigeon pea produced in Malawi is consumed on-farm by the farm households either as cooked dry peas or as immature pods and green seeds cooked as vegetables.

However, farmers are primarily interested in pigeon peas as a market crop. An estimated 10% of Malawi's pigeon pea production is sold to the domestic market and 25% is exported (Simtowe et.al., 2003), making it a potential product for increased export earnings.

The growing demand of the crop on both the domestic and international market has also increased the producer price (Simtowe et. al., 2003). Before liberalization of agricultural marketing Agricultural Development and Marketing Cooperation (ADMARC) controlled produce marketing including pigeon pea (Kumchulesi, 2004). However, with liberalization on the domestic market marketing is mostly conducted by private traders. The most prevalent pigeon pea marketing system include small and large scale producers, intermediate buyers, farmers association, processors and consumers (Simtowe et.al., 2003). Muli Brothers Limited, Transglobe Export Limited and Rab processors and ADMARC remain major traders of pigeon pea (Estrada, 2004).

CHAPTER THREE

LITERATURE REVIEW

3.0 Introduction

This chapter presents theoretical and empirical review of the relevant literature on market integration. It includes a discussion on the concept of market integration, its importance and various methods that measure integration of the market.

3.1 The Concept of Market Integration

Market prices are used as a major policy to change levels of production. Apart from being a guide for production decisions movements in market prices help traders to know how much to sale, where and at what time of the year (Ghafoor et.al., 2009). Differences in market prices trigger transfer of commodities from surplus to deficit areas. It is this co-movement of prices and the flow of commodities from areas of surplus to deficit areas which is considered as market integration (Goletti and Babu, 1994). However, following Barrett and Li (2000), from a more formal approach, integration may be defined as tradability or contestability between markets. This would imply the transfer of demand excess for goods from one market to the other, the transmission of shocks in prices between markets, or both. From this approach, an actual physical transfer of goods does not need to be observed to assure that markets are spatially integrated.

Several authors distinguish among spatial, inter temporal and vertical market integration. Spatial market integration concerns the degree to which prices in different

commodity markets move together (Minot, 2010). Without digressing from Minot description Barrett and Li (2002) consider spatial market relationships in terms of prices, trade volumes, or both. Sometimes appropriate aggregation of spatial units by reference to trade volumes and co movement among prices from spatially distinct markets is established. However, Laping (2001) regard spatial market integration as a reflection of the effects of price change in one market on another. Theoretically, when two regions engage in trade the product price in the consumption region will equal to the price in the supply region plus transportation cost (Laping, 2001). In this case the price change in the export region will trigger a price change in the importing region in the same direction and of the same degree. If this happens the two markets are said to be completely integrated.

On the other side, inter temporal approach refers to how prices are related across periods of time (Uchezuba, 2005). This means that temporal market integration reflects the effect of present price change on future prices. As studies of temporal market integration are still in the theoretical research stage this study will not dwell much on it. Finally vertical market integration is described as movement of prices of one commodity at different points in the supply chain, such as wholesale and retail prices (Minot, 2010). Because only retail price data is available vertical market integration was not considered in this study, instead the study followed spatial market integration orientation in investigating pigeon peas markets in Southern region of Malawi.

Spatial market integration therefore refers to a long run relationship of prices of the same commodity over two or more geographically separated regions. Thus we can define spatial integration as the smooth transmission of price signals and information

across spatially separated markets (Goletti et.al., 1995). For instance, two trading markets are assumed integrated if price changes in one market are manifested to an identical price response in the other market (Goletti et. al., 1995; Barrett 1996). Market integration can also be viewed as a measure of the extent to which demand and supply shocks in one location are transmitted to other locations (Negassa et.al. 2003). However, knowledge about the degree of integration of such markets is also important. In this regard Gonzalez-Riveria and Helfand (2001) consider the reaction time to remove disequilibria in the market as constituting market integration. A measure of reaction time that is commonly used is impulse response function. Impulse response functions simulate the effect of a shock in one time-series on itself and another time-series in a system over time (Franken and Parcell 2003; Happer and Goodwin 1999). Thus, we examine impulse response functions to determine how quickly prices at one location adapt to shocks in prices at another location.

However, it is not only prices that determine the extent to which markets are integrated. Several factors may explain the way different markets relate to each other. Ravallion (1986) argues trade barriers such as information asymmetry or risk aversion may have huge impact on the degree of price transmission. On his part Feng (2008) considers transportation conditions, government interference (policy), inflation and development of private commodity economy as other factors that affect co movement of price and goods. These factors, which are generally known as transaction or transfer costs are very important in determining the extent of market integration and also the speed at which price information is channeled across markets (Feng, 2008). In support for the role that transaction costs play in market integration Uchezuba (2005) points out that price relationship

between spatially separated competitive markets depend on the size of transaction costs. This implies that transaction costs play a key role in the study of spatial price relationships and should not be ignored. On this note Shrestha and Frechette (2003) consider that market integration studies that ignore the influence of these factors would give biased results.

This study has not considered transactions costs because they are unobservable and data on them are unavailable, as such use on data on market price alone has been made. The results of this study should be therefore interpreted with caution. However, because VAR models are used in this study, the extent to which pigeon pea market is integrated would still be captured through error correction terms and variance decomposition.

3.2 The Importance of Market Integration

Ravallion (1986) views measurement of market integration as a basic tool for an understanding how markets work. Information on how prices of a commodity are related and transmitted between spatially separated markets is therefore important for many reasons. Goodwin and Schroeder (1991) assert that because price transmission conveys unbiased information on prices to agricultural producers, it is a prerequisite for a good allocation of resources.

In this regard incomplete price transmission therefore creates biased incentives to producers, which in turns leads to suboptimal decision-takings and reduced agricultural productivity. Dutoit et.al (2009) support the usefulness of market integration information by pointing out that many policy reforms are implemented through the price channel such

that lack of integration along the marketing chain prevents reforms from reaching agricultural producers in the supply chain.

On their part Goletti et.al (1995) contend that market integration outcomes help to identify groups of integrated markets, so as to avoid duplication of intervention. To this effect, by giving a more detailed picture of the process of transmission of incentives across the marketing chain, knowledge of market integration is relevant to the success of policies such as market liberalization or price stabilization (Fackler and Goodwin, 2001).

Furthermore, the integration of markets can have implications on price discovery and the operation of the market since persistent deviations from integration may imply riskless profit opportunities for spatial traders (Goodwin and Piggot, 2001). More generally market integration ensures that a regional balance occurs among food-deficit and food-surplus regions, and regions producing nonfood cash crops. This is supported by Ravallion (1986) and Mphatso (2007) who points out that if price transmission does not occur, the localized scarcities and abundances may result in excessive strain on the population.

3.3 Measures of Spatial Market Integration

Various methodologies have been developed and tested to measure the degree of market integration.

These are correlation analysis, co-integration, error correction models and granger causality, autoregressive dynamic lag distributed models and threshold models. Each of these approaches is appropriate in modeling market integration outcomes depending on the nature of time series variables being considered and the extent of market integration measured.

In this study use is being made of correlation and co integration techniques because of their ability to measure degree of price association, extent of market integration, speed of price adjustment from deviation to equilibrium and direction of the price transmission process. Moreover, granger causality is able to detect lead (central) market whose influence affects price changes in other markets.

Correlation analysis is the basic and simple technique in measuring market integration. This methodology captures how closely linked market prices of a commodity are in different markets. The approach considers the existence of higher correlation coefficients to be an indicator of strong market integration and a low coefficient to mean weak association (Goletti and Babu 1994). In this case correlation coefficients near to one would indicate perfect integration between markets. On the other hand a zero correlation coefficient would imply segmentation (independence) of markets, that is to say the markets in question are not integrated.

Although correlation coefficients are easy to compute and interpret, Goletti et.al (1995) and Mphatso (2007) perceive them as only rough indicators of integration and efficiency and not a proof to market integration. In line with such sentiment several criticisms have been advanced towards their use in market integration studies.

In the first place, correlation analysis assumes existence of linear relationship between price series in so doing this approach inhibits presence of other important factors such as general price inflation, seasonal variations and policy changes (Timmer 1974; Harris 1979; Mphatso, 2007). Moreover, most studies have found time series agricultural price data to be non-stationary and this may influence prices being investigated. Thus according to Goodwin and Piggot (2001) high correlation coefficients values may suggest that

markets are integrated even if they are not. Faye, (2005) therefore cautions that testing market integration using correlation coefficients only could lead to biased results.

Another pitfall of correlation analysis is advanced by Sanogo (2006) and Barrett (1996) who point out that correlation analysis can neither measure the direction of price integration between two markets, nor can it account for trade reversals, which are common where infrastructure is poor. In this regard Goletti et.al., (1995) suggest that to do away with spurious correlation, analysis of prices be based on price difference since they would eliminate technical problems associated with spurious correlation emanating from presence of common trends, an assertion also supported by (Mphatso, 2007).

To overcome the pitfalls of use of correlation analysis, Engel and Granger (1987) proposed co integration techniques as a measure for market integration. This widely used approach focuses on existence of stable relation among price in different localities. This means that in addition to examining price relationship in the short term long run behavior would also be investigated. Such price movements from time to time subject their margins to various shocks (Mphatso, 2007). Thus existence of long run linear relationship among different price series entails that the series are co integrated (Barret, 1996).

On the same note, Pardo et.al (1999) consider that two price series (markets) are integrated if a co integrating structure exists between them. In this case co-integration is an indicative of market interdependence, in other words its absence implies market segmentation.

To further estimate the speed of adjustment to deviations from the long run relationship between spatial separated markets in co integration techniques, Dutoit et.al (2009) suggested incorporation of an error correction term in the co integration regres-

sion. Error correction models are capable of estimating causality relations between spatially distributed markets as an indication of extent of integration (Gupta and Mueller 1982). Moreover, the model assesses whether price movement follows a well defined path, for instance if price movement starts around demand or production zones and spreads across other markets (Faye, 2005).

Despite the superiority of co integration methods over correlation analysis, they too suffer from the assumption of non linearity of time series data. Since most time series are non-stationary co integration approaches are therefore not appropriate in modeling such time series variables (Meyer, 2004). In this case, the hypothesis of co integration could be rejected while it should be accepted. Also, co integration itself cannot be used to make assumptions about the direction of price spread between markets (Ravallion, 1986).

Some authors still contend that co integration analysis may not give information sufficient enough to conclude that markets are integrated. According to Goletti et.al (1995) what is important is to know the extent to which markets are integrated. Thus the critical issue here is to measure the magnitude of price transmission.

This means that immediate impact of price shocks should be distinguished from the one that builds over time (Mphatso, 2007). In this regard Ravallion (1986) suggests an expansion of the static bivariate methods to a dynamic model of spatial price differentials, the autoregressive dynamic lag distributed model. This model allows each localized price series to have its own dynamic structure as well as an inter-linkage with other local markets (Mphatso, 2007). We may however, consider this dynamic model as a radial market structure model in which we are able to establish relationships of local markets that surround a central market.

The implication of this model is the existence of a central market whose influence dictates changes in market price of other localized markets. As claimed by Sakker and Sasaki (2000) this dynamic approach provides adequate information on dynamic nature of market integration which simple correlation methods fail to do. Thus the superiority of the model is that one can obtain integration degree in both the short term and long-term, but also the model determines the leading market among local markets in addition to measurement of market price adjustment speed (Feng, 2008).

In spite of the good attributes that the autoregressive dynamic lag distributed model posses, its application is not without some limitations. Zho and Wan (1999) observes that the model assumes that the price of the centre market must be an exogenous variable, which is contrary to the actual situation. Although price changes of local markets may be influenced by the central market, price changes of the local markets may also influence each other, such that any application of the Ordinary Least Squares (OLS) may obtain results that deviate from the expectation.

Secondly, the model depends on use of continuous time sequence price information. In this case using discontinuous information may cause deviation of study conclusions. Lastly, the model requires assumption of a local market and a fixed centre market. However, in real sense things may not be so always. Sometimes mutual influence of several markets may affect the centre market. In other cases there will be alternation of roles played by the markets in which one market becomes a centre market at one period and vice versa.

Recognizing the importance of transaction costs in market integration studies attempts are being made to apply threshold models to incorporate the impact of such costs

in price adjustment process. It is argued by Meyer (2004) that economic analyses of market integration that are based on price data alone inhibit the influence of transaction costs on the degree of price transmission between markets that are spatially separated.

Goodwin and Piggot (2001) contend that the presence of transaction costs may lead to a neutral band within which prices are not linked to each other. In this case price equalizing arbitrage activities are triggered only when localized shocks result in price difference that exceeds the neutral band (Goodwin and Piggot, 2001). Furthermore, according to Van Campenhout (2006) the existence of transaction costs split market integration process into two thus, transaction costs and speed of adjustment. However, threshold models are only appropriate with high frequency data, that is data collected on weekly basis and that it requires a large sample size, which allows to estimate the adjustment parameters more precisely by reducing the aggregation bias typical in studies using monthly price series data (Van Campenhout 2006; Goodwin and Piggot, 2001; Taylor, 2001).
Because transaction costs are unobservable and therefore its data not available, and that the study failed to find appropriate commands for threshold models, this study did not apply these models in its attempt to measure market integration of pigeon pea in Malawi. Instead, use has been made of co integration methods in the VAR frame work because they are capable of estimating speed of price adjustment and reaction time.

3.4 Empirical Literature Review

In assessing market integration of maize markets in the context of liberalization in Malawi Goletti and Babu (1994) applied correlation coefficients and co-integration analysis. Results of correlation analysis show that the price level correlations were quite high, suggesting strong integration between markets. But when the series were differenced

their correlation were much low, implying existence of spurious association. From these observations Goletti et.al (1995) and Mphatso (2007) recommends differencing price series.

Nonetheless, such results suggest that use of correlation analysis in price level is prone to spurious results due to time trends, inflation, and non-stationary of the price series. On the other side co-integration tests indicate that most of the markets in the study had a stable long-term relations over the period of analysis, and that there were major markets that detected prices changes in other smaller markets. Results of these two approaches implies that exclusive reliance on one measure of market integration may be misleading and suggests the need of considering alternative measures that explore various aspects of the price transmission process (Goletti and Babu 1994).

Preliminary test of market integration for fresh cassava in some selected markets of central region of Malawi, using correlation coefficients Mphatso (2007) reports high and low coefficients at price level and differences respectively, similar results as obtained by Goletti and Babu (1994). The study also established that 84.4% of the market links were co integrated in both directions, even though the series were seen to be wandering and their margins differed. Using autoregressive distributed lag model Mphatso (2007) found that 88.8% of the tested market links were segmented from each other, which implies none of the designated central markets influenced prices in the local markets. The study also noted that price changes in one market were not immediately passed to another market, showing that there was no short term market integration of fresh cassava. While testing for long run market integration, no evidence was found to support that the markets

were related in the long run. This suggests the presence of other factors that may have impacted on the speed of adjustment of prices. However, the study found a lot of variation in the way market pairs were integrated.

In their study on fruit and vegetable spatial integration in Bangladesh using the autoregressive dynamic lag distributed model Sakker and Sasaki (2000) observed that major potato and banana wholesale markets, though not segmented, were poorly integrated with the central wholesale market. However, overall banana markets were found to be poorer integrated than the markets for potato, due to perishable nature of bananas and lack of required infrastructure for transportation that should have reduced wastage. The study concluded that lack of seasonality was the major reasons for weak integration of fruit and vegetable markets in Bangladesh.

Goodwin and Piggot (2001), Van Campenhout (2006) applied threshold models to investigate the extent of market integration of corn and soybeans in USA and on maize in Tanzania respectively. Results of the study by Goodwin and Piggot (2001) found that market for corn and soybeans were strongly integrated which confirms the significance of threshold effects and that their presence may significantly influence spatial price linkages. On the other hand, Van Campenhout (2006) found that 4 out 6 pairs of Tanzania maize markets were integrated with the magnitude of price transmission increasing with decreasing transaction costs. The study concludes that threshold auto regression models allow a researcher to differentiate transaction costs and speed of adjustment which critical components to inter- market arbitrage.

Ghafoor et.al (2009) applied co-integration and Granger causality approaches in assessing integration of mango markets in Pakistan. The study found evidence of integration among mango markets in Pakistan. Estimates of the speed adjustment were between 16% to 68% which implied that it took two to six months to remove any disequilibrium to move back to long –run equilibrium. On which market causes influences in the changes of the other markets the study established both bidirectional and unidirectional casual links among Pakistan's mango markets.

CHAPTER FOUR

RESEARCH METHODOLOGY

4.0 Introduction

This chapter discusses the methodology to market integration in 7 pigeon pea markets in Malawi. Firstly, descriptive statistics and correlation analysis are conducted to examine whether price series are associated. Statistical tests such as unit root and contegration are discussed. Vector Error Correction Model (VECM) is estimated to understand the long run and short run relationships between markets. Finally the study conducts Granger causality tests and innovation accounting to understand price causality in these markets.

4.1 Study Area, Sample Size and Description

The analysis is based on monthly time series nominal price data obtained from the Ministry of Agriculture and Food Security for eight pigeon pea grain markets for 4 years (from 2005 to 2008). The markets included are Balaka, Limbe, Luchenza, Nchalo, Nga-bu, Nsanje and Zomba. These markets were selected based on availability of price data with minimum gaps for the period of study. The study focused on grain pigeon pea mar-kets in Southern region of Malawi, which is the major pigeon peas production area in the country. This region has 13 districts which are under 3 Agricultural Development Divi-sions (ADDs) in the Ministry of Agriculture and Food Security.

These ADDS are Machinga, Blantyre and Shire Valley. These markets are connected by both tarred and earth roads.

4.2 Analytical Techniques

The study applied two methodological approaches, correlation analysis and co in-tegration techniques to measure market integration for pigeon pea in Southern Malawi.

According to Goletti et.al (1995) correlation of prices is a basic and simplistic approach and in this study it aimed at establishing a rough indicator of integration and efficiency of pigeon pea markets in Southern Malawi.

4.2.1 Correlation analysis

As indicated above correlation of price analysis was performed to get a rough indicator of integration and efficiency of the price series two market say i and j. First the analysis was performed in price levels form and later in difference form. As indicated before a measure of market integration in price levels obtains spurious results. As suggested by Goletti et.al (1995) the price series should be differenced to remove the problem of spurious. In both cases correlation coefficient (ρ) was computed from data sets of price series whose expression is illustrated as:

$$\rho(P_i, P_j) = Cov(P_i, P_j) / (\sigma P_i . P_j) \quad (1)$$

Where, ρ is the correlation coefficient, P_i and P_j are the prices for markets *i* and *j* respectively, Cov (P_i, P_j) is the covariance of the commodity prices in markets *i* and *j* $\sigma(P_i)$ and $\sigma(P_j)$ is standard deviations of the respective price series. A high (ρ) is indicative of markets integration (Goletti and Babu, 1994).

However, non-stationarity time series price data and inflation may influence prices being investigated such that high (ρ) values may suggest that markets are integrated even if they are not. As noted already in order to avoid spurious correlation first differences of the price series were taken.

4.2.2 Unit root test

Several unit root tests are available to determine the order of integration of the price series. The study used the Phillip –Perron (PP) test to determine the number of times the price series should be differenced to make it stationary. In this study the test was seen to be appropriate with the data at hand as other tests obtained contradictory re-

sults. According to Gujarati (2003), modeling non stationary time series will result into spurious findings since the series are originating from different distributions. The study assumed pigeon pea price series to be non stationary. Failure to reject the null hypothesis of unit root in levels indicates non staionarity of prices, while rejection of the null in first difference means integration of prices of order 1. The study estimated Equation 2 below to test for unit root.

$$\Delta x_t = \alpha + \phi x_{t-1} + \sum_{i=1}^{m} \beta_i \Delta x_{t-i} + \varphi_t + \upsilon_t \qquad (2)$$

Where x_t is the variable being tested for stationarity, t is trend term. ϕ, β, φ are slope coefficients is an intercept, Δ is the first difference operator, υ is the white noise error term. The study tested the null hypothesis that x_t has a unit root ($\phi = 0$) against the alternative that it has no unit root.

4.2.3 Diagnostic tests

When conducting empirical econometric studies it is always important to perform diagnostic tests to establish if classical assumptions of econometric modeling have been violated or not and remedial measures should be taken if violation is detected in order to obtain meaningful results. In this vein the study conducted normality test and autocorrelation test. The normality test was conducted to determine if the series were normally distributed. Breusch-Godfrey Serial Correlation LM Test was performed to determine the presence of serial correlation.

4.2.4 Co-integration analysis and error correction model

Co integration analysis was performed to overcome the problems of spurious regression as proposed by Engel and Granger (1987). This analysis aimed at establishing existence of stable relation among price in different localities in the long run. Using Johansen co-integration test the expression which is specified in equation 3 as follows;

$$P_i,_t = \alpha + \beta P_{j,t} + \mu_t \quad (3)$$

Where $P_{i,t}$ and $P_{j,t}$ are price series for market i and j in period t respectively and μ_t is an error term assumed to be stationary, α is a constant which is assumed to account for transport and other transfer costs while β is the parameter to be tested. If μ_t is stationary and β is unity, we can conclude that the markets are completely integrated and this implies that a price change in one market will be transmitted to the other market.

Equation 3 was further modified to a vector error correction mechanism (VECM) was to determine whether markets adjust to equilibrium after deviation.

Apart from speed of adjustment, VECM are useful for estimating both short term and long term effects of one time series on another. These VECMs models are appropriate on integrated data, but can also be used with stationary data Engel and Granger (1987). The structure of the VECM is expressed as in equation 4 below.

$$\ln \Delta P_{i,t} = \theta_1 + \alpha ECT_{t-1} + \sum_{j=1}^{p} \theta_{2i} \ln \Delta P_{i,t-1} + \sum_{j=1}^{p} \theta_{3i} \ln \Delta P_{j,t-1} + \mu_t \quad (4)$$

Where $P_{i,t}$ and $P_{j,t}$ are price series for market i and j in period t respectively and μ_t is an error, α is adjustment coefficient and ECT is the error correction term.

4.2.5 Granger causality

Granger causality test was conducted to determine the direction of price adjustment (Bassolet and Lutz, 1999). The test results should determine the existence of central markets in the process of price transmission. This is essential for policy intervention to avoid duplication of activities in spatially separated markets. The expressions for price causality is as indicated in equations 5 and 6 below.

$$P_{i,t} = \sum_{s=1}^{n} \alpha_s P_{i,t-1} + \sum_{s=1}^{n} \beta_i P_{j,t-s} + \mu_t \quad (5)$$

$$P_{i,t} = \sum_{s=1}^{n} \alpha_s P_{i,t-s} + \mu_t \quad (6)$$

Where, Pit- is the price in market *i* at time t Pjt-s- is the sth lag of the price in market *j*, n is the number of lags. If β_i is significantly different from zero then there is casual relationship existing between Pi and Pj.

CHAPTER FIVE

PRESENTATION AND DISCUSSION OF RESULTS

5.0 Introduction

This chapter presents the empirical findings of the research and interpretation of the results. It focuses on results on summary statistics and correlation coefficients, diagnostic tests and co integration test in order to achieve the objectives of the study.

5.1 Descriptive Statistics

Summary statistics as presented in Table 1 show that mean prices for pigeon pea in the study period ranged between elasticity of 4.03 and 4.45 in Luchenza and Limbe markets respectively. The minimum and maximum values of mean price varied from 2.76 and 3.86 in Nsanje and Limbe markets to 4.81 and 5.42 in Zomba and Balaka markets respectively. The minimum standard deviation in price was recorded in Zomba at 0.337 and the maximum was 0.432 for Limbe and Nsanje.

Table 1: Summary Statistics of Average Prices of Pigeon pea in Malawi.

Market	Mean	Median	Maximum	Minimum	Std. Dev.
Balaka	4.262	4.168	5.285	3.786	0.420
Limbe	4.455	4.308	5.423	3.862	0.432
Luchenza	4.033	4.007	4.699	3.196	0.330
Nchalo	4.176	4.223	4.872	3.132	0.378
Ngabu	4.171	4.237	4.536	3.331	0.280
Nsanje	4.063	4.126	4.848	2.763	0.432
Zomba	4.170	4.124	4.811	3.380	0.337

Further to this descriptive analysis in Appendix 1 we present graphs of the price series in which we observe an increasing trend in prices over the study period virtually for all pigeon pea markets except for Zomba which exhibited high prices between 2005 and, 2006 and low prices between 2007 and 2008.

5.2 Correlation of Pigeon pea Market Prices

Correlation of prices in levels and differences are reported in Table 2 and 3 below. All correlation coefficients in levels are positive suggesting a positive association between markets. However, a strong association exists among six market pairs which are in close proximity to one another. Similar results were obtained by Goletti and Babu (1994) in which strong and positive correlation were observed in maize markets that were close to each other. To support this view this study reports lowest correlation coefficients between Zomba and Nsanje which are very far from each other. Limbe and Balaka still indicate positive and strong link between markets price in differences suggesting a possibility of flow of pigeon pea grain and price information between the markets.

Negative correlation coefficients exhibited among most of the markets indicates a negative relation among them. This suggests that little or no trade takes place between these markets.

The finding of high and low correlation coefficients in price levels and differences respectively seem to support the view that correlation of prices in levels is prone to biased result due to time trends, inflation, and non-stationarity of the price series. In this regard it is recommended that when using correlation analysis as a proxy of market integration price series should be differenced in order to eliminate spurious correlation (Goletti et.al 1995; Mphatso 2007).

Table 2: Correlation Coefficients of Pigeon pea Prices in Levels and Differences

	Balaka	Limbe	Luchenza	Nchalo	Ngabu	Nsanje	Zomba
Balaka	1.						
Limbe	0.856	1					
Luchenza	0.604	0.709	1				
Nchalo	0.509	0.617	0.739	1			
Ngabu	0.271	0.355	0.696	0.746	1		
Nsanje	0.483	0.562	0.784	0.759	0.823	1	
Zomba	0.463	0.336	0.092	0.239	0.098	0.234	1

Table 3: Correlation Coefficients of Pigeon pea Prices in Differences

	Balaka	Limbe	Luchenza	Nchalo	Ngabu	Nsanje	Zomba
Balaka	1						
Limbe	0.551	1					
Luchenza	-0.094	-0.337	1				
Nchalo	0.189	0.362	-0.334	1			
Ngabu	-0.229	-0.197	-0.070	-0.006	1		
Nsanje	-0.234	0.132	0.038	0.171	0.074	1	
Zomba	0.295	0.109	-0.056	0.255	-0.148	0.042	1

5.3 Unit Root Test

The Phillip Perron test confirmed non stationarity of all price series in levels. After the first difference all the series became stationary suggesting that they are integrated of order 1 and that there is long run stable relationship among the markets. Results of the unit root test are shown in the Table 4 below.

Table 4: Results of Unit Root Test for Pigeon pea Markets in Malawi

Prices in Levels		Prices in Difference
Markets	Phillips-Perron test Statistic	Phillips-Perron test Statistic

Balaka	-0.922036	-8.163873*
Limbe	-0.451144	-6.307688*
Luchenza	-1.930142	-7.754072*
Nchalo	-1.741573	-6.908317*
Ngabu	-2.472526	-6.078783*
Nsanje	-2.511862	-6.33956*
Zomba	-2.623593	-8.217047*
Critical values: -2.925169		Critical Values: -2.926622

* denotes rejection of the null hypothesis at 5% level.

5.4 Results of Johansen Co integration Test

If markets are co-integrated there is evidence of long run relationship and that their prices in the long run will not drift far apart from each other. Such co-integrating relation in the price levels was analyzed using the Johansen co-integration test procedure. The test was s mainly to detect the presence of co-integration equations. Trace statistic and maximum eigenvalue statistic indicated 5 and 4 co integration equations respectively.

Given these results it can be concluded that there is evidence of long-run co-integration relationship in the pigeon pea market prices. This long run relationship implies that a price rise in one market will lead to a price decrease in the other market (Nyongo, 2009). Furthermore, the co integrated markets belong to the same economic market (Gonza'lez -Riveria and Helfand 2001). The results of the co integration test are presented in Table 5 below.

Table 5: Results of Johansen Contegtration Test of Pigeon pea Markets in Malawi

Trace Statistic			
Null hypothesis	Alternative	Trace Statistic	5% Critical Value

r=0	r≥1	252.1756	134.6780
r≤1	r≥2	167.1549	103.8473
r≤2	r≥3	111.6999	76.97277
r≤3	r≥4	66.27795	54.07904
r≤4	r≥5	35.94500	35.19275
r≤5	r≥6	18.17471	20.26184
r≤6	r≥7	6.982082	9.164546
Maximum eigenvalue Statistic			
r=0	r≥1	84.02073	47.07897
r≤1	r≥2	55.45495	40.95680
r≤2	r≥3	45.49721	34.80587
r≤3	r≥4	30.33295	28.58808
r≤4	r≥5	17.77029	22.29962
r≤5	r≥6	11.19262	15.89210
r≤6	r≥7	6.982082	9.164546

5.5 Diagnostics Tests

Two diagnostic tests the LM-Statistic and Jague-Bera normality test were carried out in this study in order to find out if the estimated models are fit for meaningful interpretation. The results of the LM-Statistic failed to reject the null hypothesis of no serial correlation in the in all equations at 5 percent level. The study used 6 lags for 3 markets, Balaka, Limbe and Luchenza and 11 lags for Nchalo, Ngabu, Nsanje and Zomba markets. All equations reported insignificant LM-Statistics at 5% level indicating that that the error terms are not serially correlated. Likewise the Jarque-Bera normality test indicated the residuals of the equations to be normally distributed.

Table 6: Results of Serial Correlation and Normality Test

	Breusch-Godfrey Serial Correlation LM Test			Normality Test	
Equation	Lag order	Obs*R-squared	F-statistic	P-Value	Jarque-Bera
Balaka	6	6.852134	0.568798	0.733773	0.619112
Limbe	6	6.382306	0.523352	0.883979	0.246643
Luchenza	6	3.970233	0.306422	0.297592	2.424062
Nchalo	11	19.09673	0.938296	0.499619	1.387817
Ngabu	11	16.53337	0.739198	0.523291	1.295236
Nsanje	11	17.49013	0.89170	0.733229	0.620594
Zomba	11	17.40673	0.802878	0.997972	0.004061

5.6 Results of Vector Error Correction Model (VECM) Estimation

Following the identification of the co integrating relations the short-run dynamics are analyzed by accounting for the error correction term of the long-run relations in a vector error-correction model (VECM). Therefore, the study estimated a VECM with 5 co-integrating relationship. The VECM specification, allows for short run adjustment dynamics to take place. The table below presents results of the VECM estimation in which error correction terms for the markets used in the study are reported. The results indicate that each of the market equations has at least one error correction term with the expected negative sign and is significant. This implies that pigeon market prices adjust to some equilibrium after a shock. In a month Balaka and Limbe return to equilibrium at error correction terms 2 and 4 respectively, with significant error terms at 4 for Balaka and 2 for Limbe.

The magnitude of speed of adjustment of these two markets has an elasticity of above 0.5 which may indicate a moderate speed of adjustment. One reason for such mod-

erate speed of adjustment of the market price to equilibrium may be that access to market information is symmetric to all market participants. There is also good road net work between these markets and other surrounding markets such as Zomba and Luchenza that make co-movement of pigeon pea easy once there are changes in demand and supply conditions in the markets.

On the other hand, Luchenza and Nchalo adjust at 5 error correction term with

Regressand	$ECT_1(-1)$	$ECT_2(-1)$	$ECT_3(-1)$	$ECT_4(-1)$	$ECT_5(-1)$

speed of adjustment of above 0.5 elasticity and significant. The same reason of good road network and information symmetry may be advanced for this moderate speed of adjustment. Nsanje and Ngabu have lower speed of adjustment of about 0.2 elasticity a month at 2 and 1 correction terms and significant. These markets are difficult to access due to poor road infrastructure despite good opportunity for trade arbitrage. However, Zomba adjusts instantaneously with elasticity of 1.

This may be attributed to its close proximity to Limbe where most demand of pigeon pea originates because of the processing companies located there. The above analysis has therefore shown that most of the markets considered in the study adjust to equilibrium at error terms 2 and 4. The error correction terms are reported in table 7 below.

Table 7: Results of VECM Estimation for Pigeon pea Markets in Malawi

dlnBalaka	0.169513	-0.324493	1.148712*	-0. 644119*	0.760053*
dlnLimbe	0.118947	-0.536278*	0.709782*	-0.419087	1.232312*
dlnlLuchenza	0.101867	0.220362*	-0.594777*	0.209019	-0.025828
dlnNchalo	0.418048	0.182588	-0.358704	-0.695645*	1.0338821*
dlnNgabu	-0.201934*	0.190753**	-0.374585	0.255960	-0.383904
dlnNsanje	0.488274*	-0.235390*	0.367577	-0.190742	-0.140626
dlnZomba	0.175475	-0.149712	0.874634*	-1.260803*	0.055216

*(**) denotes significance at 5% (10%) level

5.7 Results of Granger Causality for Pigeon pea Markets

Results of the Granger causality of pigeon pea markets are reported in Table 7. The price transmission process from the Granger causality test indicates a bidirectional relationship among 4 market pairs and these markets are Limbe-Balaka, Ngabu-Balaka, Zomba-Nchalo and Ngabu-Limbe. Such causal relationship implies that each of the markets Granger causes the other and this may mean that at some point one market is a production as well as consumption area. In other words, demand and supply conditions of pigeon pea may originate from either direction.

At the same time the results show that 7 market pairs depict unidirectional transmission price process. Markets that Granger causes other markets as indicated in the Table are normally importing regions such that any changes in the demand and supply conditions of these regions will be transmitted to the exporting regions. From these results two markets, Limbe and Ngabu seem to be market leaders as they are seen to Granger cause other markets more than they are Granger caused by other markets. As already pointed

out, most pigeon pea processing companies are located in Limbe where demand for the product originates. On the other side, Ngabu is a collection point for most of the pigeon pea produced in the Lower Shire before it is transported to Limbe. When small traders buy the grain in the rural markets they re-sale it to large traders who are located in big markets such as Ngabu, hence becoming a demand originating point as well.

Table 8: GrangerCausality Test Results for Pigeon pea in Malawi

Market pair	Direction of Price Transmission
Limbe ⟷ Balaka	bi -direction
Ngabu ⟷ Balaka	bi -direction
Zomba ⟷ Nchalo	bi -direction
Ngabu ⟷ Limbe	bi -direction
Nsanje ⟶ Limbe	uni-direction
Ngabu ⟶ Nchalo	uni direction
Nsanje ⟶ Ngabu	uni- direction
Nchalo ⟶ Nsanje	uni -direcyion
Limbe ⟶ Zomba	uni -direction
Luchenza ⟶ Zomba	uni- direction
Nsanje ⟶ Zomba	uni- direction

5.9 Variance Decomposition

Variance decomposition was computed to separate the variation in the markets in-to the component shocks to the VECM models and provides information about the relative importance of each random innovation in affecting the markets in the VECM frame work. Table 8 (a to g) below report 12 months period horizon variance decompositions for all the markets that were estimated in the VECM framework. Appendix 1 presents show variance decomposition for various markets at 3, 6, 9 and 12 month period. Only

results of innovations that explain a higher proportion of the forecast error variance in other markets are discussed.

Forecast error variance for Balaka is explained by innovations of Ngabu, Luchenza and Limbe. On the other side, innovations to Balaka, Ngabu and Luchenza explain the forecast error variance in Limbe. The variance decomposition results further Indicate that Luchenza receives most of the forecast error variance from the innovations of Ngabu, Limbe and Balaka. Ngabu, Luchenza, Limbe and Balaka innovations continue to explain forecast error variancein Nchalo. While Ngabu forecast error variance is explained by innovations of Luchenza, Limbe and Balaka. Further, Ngabu, Luchenza, Limbe and Balaka innovations explain forecast error variance of Nsanje, while innovations of Luchenza and Limbe explain forecast error variance in Zomba.

The findings of the variance decomposition indicate Limbe, Ngabu, Luchenza and Balaka as the markets whose innovations explain much of the forecast error variance in most of the markets. These results also conform to findings of the Granger causality test which again shows these markets Granger causing changes in most of the markets.

The reasons for this may be two fold. In the first place, Limbe is near Blantyre where most of pigeon pea processing companies are located which suggest that an increased demand for the grain in the processing industries triggers increased flow of both price information and the commodity. Moreover, Limbe is the home for major pigeon pea exporting companies such as Transglobe Export Limited and Bharati, which also help to explain increased demand for the commodity. Secondly, markets such as Luchenza, Balaka and Ngabu are buying points for medium traders who do not want to face difficulties in transporting pigeon pea from rural markets. In some cases the traders may engage in

price war fare by offering higher prices than their rivals, thereby increasing supply of pigeon pea in these markets while reducing supply in other markets.

5.10 Summary

This chapter presented the empirical findings of the research and interpretation of the results. It focused on results on summary statistics and correlation coefficients, diagnostic tests, co integration test. It also carried out VECM estimates, Granger causality tests and variance decomposition of the estimated VECM.

Results of the summary statistics established all markets have nearly the same elasticity of means, median, minimum and maximum mean prices. However, Ngabu was observed to have lowest price variation while Limbe and had Nsanje. In terms of price correlation in levels all markets recorded positive correlation coefficients with strong association obtained among six markets. In difference form most markets were found to have negative coefficients which implies negative link existing among these markets.

Unit root test using Phillip- Perron revealed that all the markets were integrated of order 1 which non stationarity of price series in levels.

The markets were also tested for co integration by applying the Johansen test and the results indicated 5 co integration equations showing that there is a long run stable relationship existing among the market. The VECM was also tested for serial correlation and normality which gave insignificant LM- test statistic at lag orders 6 and 11. The study was also failed to reject the null hypothesis of normally distributed error terms.

The VECM estimation had at least one correction error term with the expected negative sign with significant coefficients, an indication that in the short run all markets are able to adjust to equilibrium after a shock. However, few markets recorded high

speed of adjustment coefficients. The Granger causality test reveals both bi-direction and uni-direction price transmission process. In addition, Balaka, Limbe and Ngabu are market leaders as they were observed to Granger cause price changes in other markets. These results were also confirmed by variance composition in which Balaka, Ngabu and Limbe innovations explain much of the forecast error variance in all other markets. The conclusion of these findings is that integration of the pigeon pea markets is moderate.

Several factors may explain this situation. According to Sexton et al. (1991) and Lutz et al. (1995) physical barriers for trading and incomplete information may be obstacles for an efficient arbitrage. This may be caused by poor road net work between markets and lack of communication devices among market participants. In addition, these markets may also be located far apart from each other, making it difficult for physical transfer of goods between markets or passage of market information among market participants. This in turn increases transaction costs in the marketing system. In this case there is a high price differential between localities and as such the arbitrage process between regions would be blocked causing markets segmentation.

For example, Balaka and Nsanje are very far apart from each other and that the road net work to Nsanje with other markets is poor. Furthermore, because of high tariffs on the use of mobile phones small entrepreneurs cannot easily access market price information. Also as observed by (Fafchamps and Gabre-Maldrin 2005) that many enterprises in Malawi are very small such that transport constitute a larger share of the marketing cost. All these factors would indeed impede perfect spatial market integration for pigeon pea in Malawi.

Secondly, imperfect competition of the structures in the markets under analysis may constitute barriers to entry that would prevent price arbitrage. Thus revelation by Estrada (2004) and Makoka (2009) that the marketing system of grain legumes in Malawi is controlled by few major traders supports this view. These traders may collude to prevent free movement of both products and price information between markets. Another factor that may explain weak association of pigeon pea markets in the country is the quantity of the grain available on the market.

As reported by Simtowe et.al (2003) about 65% of the pigeon pea produced in Malawi is consumed on-farm by the farm households either as cooked dry peas or as immature pods and green seeds cooked as vegetables, while only 10% is sold on the domestic market. This means that there is very little movement of pigeon pea among the domestic markets. Although traders may have information on better price in some markets, there is little they can do because the grain is just not there. In this case we would expect the market for pigeon pea to be weakly integrated.

Finally, in Malawi the grain market in general lacks brokers and agents that are organized in commodity exchanges (Fafchamps and Gabre-Maldrin 2005).

The market commodity exchanges are information bureau for quantities, prices and location of commodities. Market participants do not need to travel to physical market location to purchase what they want or sell what they have. Such transactions are facilitated by the commodity exchange. Availability of such structures that would aid smooth and fast price information flow would indeed result to moderate market integration.

CHAPTER SIX

CONCLUSION AND POLICY IMPLICATIONS

6.0 Summary and Conclusion

This study has attempted to conduct an economic analysis of the spatial integration of pigeon pea markets in Malawi by estimating price linkages among seven geographically separated pigeon pea markets in the country. The markets included in the study are Balaka, Limbe, Luchenza, Nchalo, Ngabu, Nsanje and Zomba. Data used for

the analysis are monthly retail pigeon pea prices for the period January 2005 to December 2008. Price correlation analysis and co-integration method in the VECM framework were used to explore the market linkages.

To understand market linkage better, the study tested four specific hypotheses. The first hypothesis was that pigeon pea markets are not integrated both in short run and long-run. Results of price correlation analysis show that there is a positive correlation among market in price levels. However, in price difference most markets exhibit negative link, indicating possibility of spurious correlation when markets are analyzed in level form. This result is an indication of weak integration of markets. Co integration test reveal 5 co integrated equations showing that there is a long run stable relationship among markets.

Secondly, the study hypothesized that markets do not adjust after a deviation from the equilibrium. Results of the VECM analysis indicate the existence of few markets whose correction error term coefficients that are above the elasticity of 0.5, showing some moderate adjustment. The overall picture is therefore of slow adjustment.

In the third case, the study attempted to investigate the direction of price transmission of Pigeon pea markets. In this regard Granger causality test has established both unidirectional and bidirectional transmission process of markets. Furthermore, the study hypothesized the existence of no central market whose price change influences changes in

other markets. Again the Granger causality test results reveals 3 lead markets that Granger cause other markets.

Finally, variance decomposition of markets show innovations from 4 markets (Ngabu, Limbe, Balaka and Luchenza) explaining much of the forecast error variance in other markets. This result conforms to what was obtained in the Granger causality that indicated these markets to be lead markets. The study therefore concludes that pigeon markets are moderately integrated.

Several factors may explain the existence of moderate integration a opposed to a perfect one. Physical barriers and incomplete information may obstruct markets to integrate perfectly. The physical barriers include poor road net work between markets. Distance between markets makes it difficult for physical transfer of commodities between markets. This in turn increases transaction costs in the marketing system thereby leading to an imperfect integration. Furthermore, high tariffs on the use of mobile phones impacts on access of market price information for small entrepreneurs.

Secondly, imperfect competition of the structures in the market system constitutes barriers to entry and these traders may collude to prevent free movement of both products and price information between markets. Weak association of pigeon pea markets in the country may also be explained by small quantities of the grain that is traded on the domestic market. Consequently there is little movement of pigeon pea among the domestic markets. In this case we would expect the market for pigeon pea to be moderately integrated.

Finally, in Malawi the grain market in general lacks brokers and agents that are well organized. Absence of such structures to aid smooth and fast price information flow would indeed result to moderate market integration.

6.1 Policy Implication

This study has established moderate integration of pigeon pea markets. From these findings two key points can be highlighted for policy intervention to improve pigeon pea market integration. In the first place, the market for pigeon pea appears to be unstable. Considering the importance of pigeon pea as both a food and a cash crop few studies on the performance of the marketing system have been undertaken in the country, it therefore imperative to continuously study this market and understand how the markets are related. These results therefore are indicative of moderate integration of the pigeon pea markets in Malawi. Some policy implications can be advanced based on the findings of the study. Considering, the complexity and unstable market conditions of pigeon pea and its potential as an alternative cash crop it is imperative to continuously study this market to understand the relationship of markets from time.

Knowledge on changes of pigeon pea market will achieve the goal of transforming the legume sub-sector into a vibrant enterprise. The current study suggests possible areas for intervention to turn the market for pigeon pea towards perfect integration. As poor transportation and communication conditions have been identified as the major obstacles for perfect pigeon market integration, it is therefore imperative for government and the private sector to continue investing in transport and communication infrastructure such as roads and telephones. This will improve the flow of both pigeon pea grain and price information in the markets. If market participants can efficiently respond to changes

in the market on time, then efficiency will be obtained in the marketing system. Unless information is available on how pigeon pea markets relate to one another it is difficult to turn pigeon pea as an alternative enterprise for cash generation.

6.2 Limitation of the Study and Future Research

This study is not without some limitations. In the first place, the data used had some gaps and the missing values were interpolated and this could affect the outcome of the study. Secondly, the existence of transport and other transfer costs which vary over time may seriously affect the market integration tests. Ideally, these costs should be incorporated in the model. However, this was not done because the relevant cost data were not available. Nonetheless, some researchers have used proxy variables for transaction costs (Goodwin et al., 1990; Nyongo 2009) or have tried to establish a link between some price differentials and transport costs by relating them in a co-integration framework (Baffes, 1991). We could not also use proxies of the transaction costs, such as fuel costs and distances between markets, because they may create more problems than they solve. Such being the case the findings of this research should be taken with caution because they may not reflect the exact picture of the extent of market integration of pigeon pea markets in the study areas. From these limitations it is therefore recommended that future research on market integration should strive to use data that is very consistent over the study period, and that data collection at source should include transaction costs.

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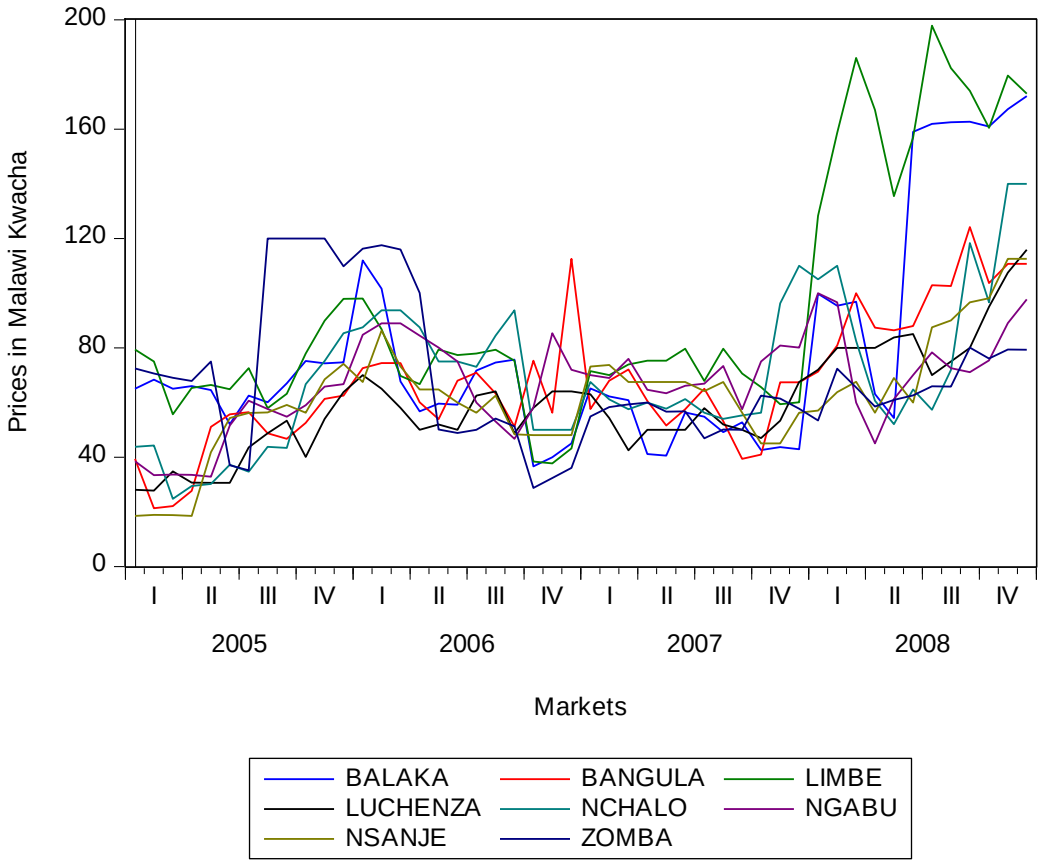
APPENDICES

Appendix 1: Trends in price for Pigeon pea Market in the Study Areas



Appendix 2: Variance Decompositon

Period	Variance Decomposition of Balaka							
	S.E.	Balaka	Limbe	Luchenza	Nchalo	Ngabu	Nsanje	Zomba
3	0.309857	44.99424	0.708123	23.65871	0.849770	25.80910	1.227259	2.752802
6	0.476832	33.20074	8.349251	29.51389	0.820411	24.93903	0.816431	2.360249

9	0.644055	27.52788	10.71930	33.30296	0.620262	24.79764	0.515006	2.516955
12	0.811616	24.24594	12.43101	35.18520	0.392147	24.80064	0.401316	2.543746
Variance Decomposition of Limbe								
	S.E.	Balaka	Limbe	Luchenza	Nchalo	Ngabu	Nsanje	Zomba
3	0.315619	23.35440	20.10935	17.35742	2.089905	34.74786	0.492201	1.848876
6	0.444311	15.64191	17.10551	19.32904	1.415287	43.60177	1.195900	1.710585
9	0.544900	15.96535	18.25474	22.34585	1.320290	39.50065	0.960223	1.652892
12	0.653368	15.17726	18.28534	23.86596	1.124992	39.12468	0.888176	1.533585
Variance Decomposition of Luchenza								
	S.E.	Balaka	Limbe	Luchenza	Nchalo	Ngabu	Nsanje	Zomba
3	0.123198	6.677861	22.48451	61.06011	3.997352	3.885324	0.372800	1.522043
6	0.216560	14.93150	10.25245	23.09092	10.37084	38.61886	1.564119	1.171311
9	0.280896	16.43213	10.92691	20.68545	6.377744	43.11489	1.552959	0.909920
12	0.379592	18.45949	13.47986	24.18177	3.831724	38.09222	0.938544	1.016397
Variance Decomposition of Nchalo								
	S.E.	Balaka	Limbe	Luchenza	Nchalo	Ngabu	Nsanje	Zomba
3	0.219042	5.012730	5.051272	8.443091	52.40590	25.91273	0.541833	2.632446
6	0.266685	5.060482	4.144704	6.332316	35.75340	43.52467	2.911557	2.272866
9	0.357206	12.33557	13.53330	20.03439	20.19138	30.53720	1.839477	1.528687
12	0.479345	14.74226	14.90554	26.02025	11.44300	30.42994	1.165007	1.294014
Variance Decomposition of Ngabu								
	S.E.	Balaka	Limbe	Luchenza	Nchalo	Ngabu	Nsanje	Zomba
3	0.150944	12.47598	4.723302	17.27046	10.43226	45.01182	9.920479	0.165700
6	0.170815	15.42367	8.003319	19.62553	11.52552	36.54041	8.413188	0.468373
9	0.215819	16.12613	11.97916	24.14620	8.370799	33.14512	5.835527	0.397078
12	0.251044	19.28334	11.20330	23.72285	6.636659	34.37170	4.318868	0.463291
Varaince Decomposition of Nsanje								
	S.E.	Balaka	Limbe	Luchenza	Nchalo	Ngabu	Nsanje	Zomba
3	0.140901	19.84149	26.46981	9.654783	5.949094	13.63925	23.74091	0.704669
6	0.222346	24.74904	17.17293	30.69351	5.086469	11.80364	10.12816	0.366257
9	0.347960	31.16643	12.53612	36.63651	2.102817	12.59704	4.358971	0.602101
12	0.468534	29.63397	10.25147	34.33512	1.390288	20.81210	2.412067	1.164984
Varaince Decomposition of Zomba								
	S.E.	Balaka	Limbe	Luchenza	Nchalo	Ngabu	Nsanje	Zomba
3	0.292654	4.890065	11.16105	37.58855	10.16553	6.906707	4.687381	24.60071
6	0.405890	4.344910	18.79221	44.29855	8.465266	4.347470	4.141066	15.61052
9	0.509900	5.271060	18.14169	49.26989	10.57091	3.135942	2.678825	10.93168
12	0.555356	6.531659	16.40507	52.04853	9.817403	3.000630	2.455045	9.741670

Appendix 3: Data for Nominal Retail price of Pigeon pea Markets used in the Study

Months	Balaka	Zomba	Limbe	Luchenza	Ngabu	Nchalo	Nsanje

1	65.00	72.40	79.38	28.03	38.48	43.77	18.53
2	68.33	70.59	75.00	27.80	33.44	44.27	18.86
3	65.00	69.00	55.70	34.82	33.65	24.75	18.80
4	66.00	67.81	65.30	30.66	33.49	29.41	18.44
5	64.59	75.00	66.40	30.60	32.87	30.24	41.77
6	52.05	37.01	64.83	30.59	51.59	37.26	54.29
7	62.50	35.18	72.50	43.57	60.61	34.65	56.19
8	60.00	120.00	57.90	48.70	57.64	43.75	56.33
9	67.00	120.00	63.13	53.33	54.76	43.33	59.06
10	75.22	120.00	77.92	40.00	58.97	66.67	56.25
11	74.27	120.00	89.92	54.00	65.84	75.20	68.44
12	74.70	109.77	97.92	63.75	66.67	85.30	74.06
13	112.00	116.25	98.00	70.00	84.72	87.50	67.50
14	101.57	117.51	86.80	65.00	88.89	93.75	86.25
15	67.65	115.93	69.70	58.00	88.89	93.75	73.13
16	56.72	100.00	66.70	50.00	84.45	87.50	64.69
17	59.57	50.05	79.41	52.00	80.00	75.00	64.69
18	59.16	48.79	77.31	50.00	75.00	75.00	60.00
19	71.66	50.04	77.93	62.50	60.00	73.00	56.25
20	74.55	54.14	79.26	64.00	53.00	84.45	62.50
21	75.67	51.26	75.29	48.75	46.67	93.75	48.33
22	36.67	28.69	38.35	58.00	58.22	50.00	48.00
23	40.00	32.35	37.70	64.00	85.27	50.00	48.00
24	45.00	36.03	43.20	64.00	72.00	50.00	48.00
25	65.10	54.83	71.51	63.00	70.00	67.50	73.13
26	62.22	58.30	70.00	54.29	68.90	61.13	73.75
27	60.84	59.25	73.92	42.50	75.91	57.50	67.50
28	41.09	60.00	75.23	50.00	64.60	60.00	67.50
29	40.51	56.67	75.23	50.00	63.33	57.75	67.50
30	56.37	56.75	79.70	50.00	66.06	61.25	67.50
31	54.79	46.83	67.81	57.94	66.86	56.25	64.17
32	49.16	50.05	79.67	52.00	73.34	54.00	67.50
33	52.71	50.00	70.62	50.00	57.56	55.31	56.25
34	42.57	62.50	65.64	47.00	75.00	56.25	45.00
35	43.70	61.40	59.33	53.33	80.79	96.25	45.00
36	42.87	57.73	60.00	67.50	80.00	110.00	56.25
37	99.73	53.43	128.23	72.00	100.00	105.00	57.00
38	95.36	72.30	158.60	80.00	96.67	110.00	63.75
39	96.87	65.50	186.02	80.00	60.00	82.50	67.53

40	63.08	58.52	166.99	80.00	45.00	60.63	56.25
41	54.31	60.97	135.49	83.75	61.25	52.00	68.91
42	158.95	62.57	156.85	85.00	70.00	64.75	60.00
43	161.94	65.94	197.78	70.00	78.33	57.30	87.50
44	162.48	65.83	182.32	75.00	72.50	71.88	90.00
45	162.70	80.00	174.01	80.00	71.09	118.33	96.67
46	160.96	76.09	160.44	95.00	75.36	96.67	98.13
47	167.29	79.40	179.52	107.50	89.03	140.00	112.50
48	172.09	79.30	172.91	115.81	97.70	140.00	112.50