

ANALYSIS OF SPATIAL MAIZE MARKETS INTEGRATION IN MALAWI

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DECLARATION

I hereby declare that this thesis is my own work and effort and that it has not been submitted anywhere for any other award. Where other sources of information have been used, they have been duly acknowledged.

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CERTIFICATE OF APPROVAL

We hereby declare that this thesis is from the student's own work and effort and all other sources of information used have been acknowledged. This thesis has been submitted with our approval.

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ABSTRACT

Agricultural market liberalisation in Malawi like her other developing counterparts, saw the increase of private sector participation in the agricultural input and output markets. This necessitated the institutionalisation of agricultural market information system so that the market participants must be well informed on relevant market conditions including prices and demand among many things. It was against this background that the government through the Ministry of Agriculture put in place an MIS to facilitate agricultural market efficiency in the new liberalised market environment. More recently, some non-governmental organisations like IDEAA-Malawi and NASFAM have also come in to support government in providing market information to farmers and potential agricultural market participants to enhance market integration. Free flow of market information is expected to influence market efficiency in price transmission and hence market integration.

This study was done to determine the extent to which agricultural markets were integrated as an indicator of market efficiency in Malawi. The study used maize as a model crop because of its significance to national food security. It employed bivariate correlation coefficients of maize price levels and price differences and the Engle-Granger cointegration approach to determine the extent of maize market integration. It also used the Granger causality test to determine the causal relationships in prices among spatially distinct maize markets in Malawi. The study also decomposed the maize price series into their seasonal and trend variability characteristics in order to get insights about the general movement of the prices intra- and inter-years.

Results of Engle-Granger cointegration test show that markets within regions were well-integrated. However price information flows as indicated by the Granger Causality test were more of unidirectional in the Southern Region as opposed to bidirectional flow of information in the Central and Northern Regions. Using correlation of price levels and price differences as measures of market integration, results indicated that within regions, maize markets were integrated regardless of whether there was a maize price band policy or not. However, the correlation coefficients were a bit higher on average when the price band policy was removed. The study results further showed that maize prices varied seasonally peaking between December and March and reaching the lowest between May and July. The prices also portrayed an increasing trend over the study period.

From these findings, it is concluded that the maize market in Malawi is efficient in prices and that there is good flow of price information among spatially separated markets except in the Southern Region. It is therefore recommended that government and non-governmental organisations should strengthen the current MIS especially in the Southern Region to enhance information flows among markets. Because of the failure (to include transfer and transactions costs) of the method used in this study, it is also recommended that future research in the areas of agricultural market integration to employ models that incorporate these costs such as threshold cointegration or parity bounds model.

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DEDICATION

To Mum,

Anne Mpando

Amoya,

F.B. Nausa

Azakhali, Anambewe

Ethel Sopo

Thanks for seeing me through. God Bless you!

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LIST OF ACRONYMS

ACE	Agricultural Commodity Exchange
ADDs	Agricultural Development Divisions
ADMARC	Agricultural Development and Marketing Corporation
APIP	Agricultural Productivity Improvement Programme
CPI	Consumer Price Index
EU	European Union
FEWSNET	Famine Early Warning Systems Network
GDP	Gross Domestic Product
GoM	Government of Malawi
IDEAA	Initiative for Development and Equity in African Agriculture
IFAD	International Fund for Agricultural Development
IMF	International Monetary Fund
MACE	Malawi Agriculture Commodity Exchange
MIS	Marketing Information System/Service
MoA	Ministry of Agriculture
MoAFS	Ministry of Agriculture and Food Security
MoAI	Ministry of Agriculture and Irrigation
NASFAM	National Association of Smallholder Farmers in Malawi
NGO	Non-Governmental Organisation
NSO	National Statistical Office
OLS	Ordinary Least Squares
PBM	Parity Bounds Models

SAPs	Structural Adjustment Programmes
SARRNET	Southern African Root Crops Research Network

CHAPTER 1

1.0. INTRODUCTION

1.1. Agriculture in Malawi

Agriculture sector is the backbone of Malawi's economy. It employs over 80% of the economically active population and accounts for about 33% of the total gross domestic product (GDP) (NSO, 2006). It contributes significantly, 90%, of the foreign exchange earnings and through supply and demand linkages with the non-agricultural sector; the growth of this sector stimulates that of the country's overall economy.

Agricultural sector is dualistic in structure consisting of the smallholder and the estate sub-sectors. The smallholder sub-sector is done under customary land tenure system and comprises about 1.8 million farm families engaged in subsistence farming and takes up 1.8 million hectares of land, (Ng'ong'ola *et. al.*, 2003). They further observed that smallholder farmers concentrate on growing the low yielding local maize variety which accounts for nearly 50% of the total cultivated area under customary tenure system and that hybrid maize account for about 14% of the total cultivated area. The estate sub-sector takes up more than 9% of the total cultivated land area of Malawi on leasehold and freehold tenure systems. Much of this land is under tobacco production.

Maize is the main food crop and occupies 70% of the cultivated land while cassava is a staple food for about 30% of the population especially along the lakeshore areas of Nkhatabay, Nkhonkhotakota, Karonga and Rumphi, (SARRNET, 2003). NSO (2006) reported that maize is grown by 97% of the smallholder farming households. Other food crops that

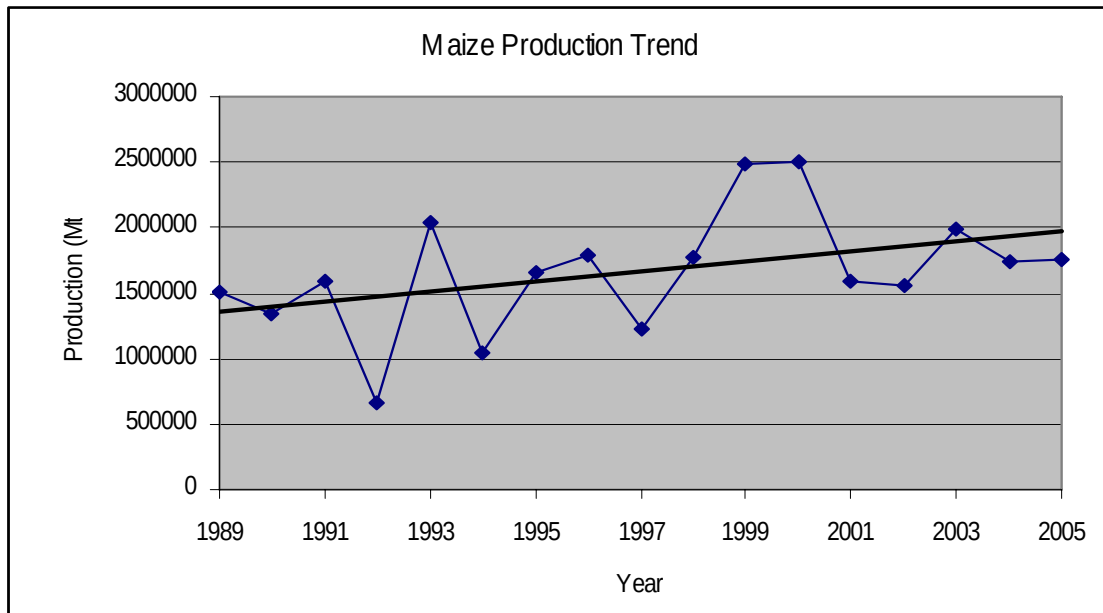
are most widely grown are pulses, which are grown by 50% of the households, followed by groundnuts grown by 37% of the households, and cassava grown by 22% of the households and other grains, which are grown by 20%.

1.2. Maize Production Trend

The dominant trend in maize production over the recent years has been a decline in production leading to food deficits at national level. However in the 1998-99 growing season a national staple food surplus of an estimated 500,000 metric tones was realised. This surplus could be attributed to the combined effect of the Starter Pack Program and the Agricultural Productivity Investment Program (APIP) coupled with favorable rainfall conditions and expansion of cultivated land as argued by Nakhumwa, (2004). Despite the impressive growth in maize production over the past three years, large portions of the rural and urban populations remain food insecure due to low incomes to purchase food (NSO, 2006).

Government of Malawi (GoM), (2002) estimated that 25% of the smallholder farmers cultivate less than 0.5 hectares on average; 30% cultivate between 0.5 and 1.0 hectare; 31% cultivate between 1.0 and 2.0 hectares; and only 14% cultivate more than 2.0 hectares. A very large portion of these smallholder households cannot grow sufficient food to feed themselves the whole year in the event of a poor harvest. The market dependent population, that is, the population that depends on the market for all or part of its food supply is high although they may be limited by their purchasing power (Nakhumwa, 2004). Almost all urban consumers are dependent on the functioning of

agricultural markets to acquire their food. It is clear that an inefficient marketing system entailing substantial costs to consumers will have detrimental effect on the food security and well being of the poor. Figure 1 highlights the maize production trend for Malawi between 1989 and 2005.



Source: FAO STAT 2006

Figure 1: Graph of production trend of maize

More recently, however, there has been a tremendous increase in maize production and the country has registered maize surpluses due to the reintroduction of fertilizer and seed subsidies.

1.3. Agricultural Market Reforms in Malawi

Throughout the world, governments are attempting to loosen their grip on agricultural markets with the consequence of exposing farmers to the exigencies of market forces. At the same time, farmers are increasingly being encouraged to improve their marketing, and some commentators appear to view the application of modern business marketing techniques at the farm level as a substitute for government agricultural marketing policies (Ritson, 2002).

Between 1981 and 1994, Malawi implemented several structural adjustment programs (SAPs) supported by the International Monetary Fund (IMF) and World Bank. SAPs have implied, *inter alia*, liberalisation of pricing and marketing policies which entail: allowing the private sector to play an active role in marketing of agricultural inputs and outputs; decontrol of prices of agricultural inputs and outputs; and removal of subsidies. Liberalisation was expected to encourage efficient marketing through competition and increasing efficiency of resource allocation and utilisation by allowing market forces and prices to play a more dominant role in production and consumption decision making (Crawford, 1997). Given that Malawi is an agro-based economy, many of the reforms were focused on the agricultural sector. The key reform was the price decontrol, which was aimed at allowing market forces to drive resource allocation in production. Secondly, market liberalisation was intended to foster competition and ensure that smallholder farmers get good input and produce prices (Ng'ong'ola *et. al.*, 2003).

In the process, Agricultural Development and Marketing Corporation (ADMARC), a government parastatal, got restructured several times to allow freer markets under the liberalised environment (Ng'ong'ola *et. al.*, 2003). The degree of smallholder farmer dependence on ADMARC for the purchase of inputs and marketing of crops declined steadily and private sector participation increased. However, the impact of these reforms on the smallholder farmers have been very conflicting due mainly to inefficiencies in both input and output markets as a result of poor infrastructure, poor macroeconomic environment, and lack of market information, *inter alia*.

Noteworthy, among many challenges facing the development of the agricultural sector in Malawi, agricultural marketing ranks high. The Ministry of Agriculture and Irrigation (MoAI) (1999) singled out lack of aggressive marketing strategies and limited market information as one of the problems that reduces farmers' competitiveness and premium received from both traditional and non-traditional commodities. The Ministry found out that to develop efficient agricultural markets, the liberalised markets needed to be strengthened by undertaking activities in a number of areas including development of functional market information system, which would transmit timely and efficient market information to both buyers and sellers.

1.4. Commercialisation of Agricultural Sector and Agricultural Markets

In its efforts to obtain household food security in a sustainable manner and increasing the productivity of the agricultural sector, the GoM recognises the need for the commercialisation of the agricultural sector, (MoAI, 1999). However the markets of

maize and other agricultural commodities in Malawi cannot be considered in isolation. Most farmers grow these crops as one of a mix of crops partly to provide a mixed diet for themselves, partly to provide food in different growing seasons and partly as a security measure to ensure they have production if one crop fails. In addition, traders do not specialise in just one product. Traders in these crops also deal in other agricultural products such as pulses, grains and other dry products. When the price of one food product increases, consumers switch, in whole or in part, to other food products. This is the reason why the pilot project called the Malawi Agriculture Commodity Exchange (MACE) envisaged by Initiative for Development and Equity in African Agriculture (IDEAA) has expanded to include many agricultural products including livestock.

In a commercialised agricultural system, market information services have the function of collecting and processing market data systematically and continuously, and of making it available to market participants in a form relevant to their decision-making. According to Ozowa, (2006) market information needs of small-scale farmers include: information on product planning, current prices, and forecasts of market trends. This type of information assists farmers in planning their market products. Furthermore, farmers and traders need information on sales timing and information on improved marketing practices. This assists them in ensuring that they do not cause a market glut. It enables them to stagger harvesting and quantity for marketing.

1.5. Agricultural Market Information Systems and/or Services in Malawi

1.5.1. Past Initiatives

Several initiatives to provide market information have been undertaken in the past. For example, the Ministry of Agriculture (MoA) did one such initiative from 1988 to 1995 under agriculture Marketing and Estate Development Project. Under this project retail prices of various agriculture commodities were being collected in selected 32 markets. The information was being disseminated through the radio and newspapers once every week. When the project phased out, the ministry could not sustain the cost of disseminating the information hence the service was discontinued. After the collapse of this program the European Union (EU) also funded a seasonal price information system for farm gate prices, which also did not last long. In both cases, government enumerators were collecting the price information and in some cases especially in the EU program, temporal enumerators were being hired. The information was being disseminated to everyone for free through the papers and radios and on request. None of these two programs had built in cost recovery mechanisms and harnessing or development of the private sector to run the information system beyond the donor funding.

1.5.2. Present Initiatives

The Ministry of Agriculture and Food Security (MoAFS) still collects retail agriculture commodity market prices in selected markets through the Agro Economic Survey Department. It currently collects retail prices from over 72 markets for all major crops and livestock. However, the information does not reach the processing center called Agro

Economic Survey timely, it lacks trade information and does not reach farmers to assist them in decision making on where to sell and at what price.

Another initiative is one being undertaken by IDEAA-Malawi market information system called MACE. This project is aimed at providing market information and linking buyers and sellers of agricultural commodities in order to address some of the problems associated with marketing of agricultural produce. Among others, the project collects and disseminates agricultural market information (through the radio, e-mail, fax, short message services (SMSs) on mobile phones and information display boards) from sellers and potential buyers of various agricultural commodities through satellite centers called Marketing Information Centers (MICs) located in the three major cities of Lilongwe, Blantyre and Mzuzu and Market Information Points (MIPs) located across the country. The Ministry of Agriculture and Food Security (MoAFS) has taken advantage of this initiative to disseminate the market information specifically prices that it collects. This information includes: quantity, offer/bid prices to sell or to buy, where, when and name of bidders.

Yet another very recent initiative by the National Association of Smallholder Farmers in Malawi (NASFAM) is called the Agricultural Commodity Exchange (ACE). It was formed with the main objective of providing marketing information. It was formed to provide price discovery and dissemination i.e. prices based on the economics of supply and demand and disseminate such price information to the public via different forms of media and therefore providing an orderly internal market which encourages production,

allow free movement of the goods and reward quality. However this initiative is not yet well known by many agricultural market participants.

1.6. Problem Statement and Justification

Agricultural marketing remains one of the major problems hindering the development of the agricultural sector and hence the development of the economy as it relies very much on agriculture (MoAI, 1999). Lack of market information (price information in particular) among farmers and traders has constantly been reported in many agricultural marketing studies.

Before market liberalisation, almost all agricultural produce was sold to ADMARC where the price was given and often pan-territorial. With agricultural market liberalisation process, there was emergence of private-sector market intermediaries filling the vacuum left by the withdrawal of the state marketing board. The smallholder farmer was taken unawares and faced serious problems to adapt to the new market environment.

With little experience and skills in marketing, no information and no organisation, smallholder farmers have no basis upon which either to plan a market-oriented production system or to negotiate market prices and conditions making the idea of commercialisation and diversification nothing but a dream (IFAD, 2003). Such a situation has exacerbated farmers' problems when the trader is also the only source of information on prices and other relevant market information.

Various initiatives have been undertaken through MoAI and IDEAA to collect and disseminate price information. Despite all these efforts by government, through the

MoAFS, IDEAA and other stakeholders to provide market information, smallholder farmers and agricultural traders continue to complain of inadequate market information.

Market integration in many agricultural commodities has been studied elsewhere for the insights it provides into the functioning of markets. Like many studies of this nature, this study was conducted provide valuable information about the dynamics of market adjustments, and whether there exists market imperfections such as inadequate and costly information transmission, which may hinder the attainment of market efficiency and may constrain agricultural development and aggravate inequitable patterns of income distribution.

Furthermore, there is little research that has been conducted to establish the extent to which agricultural markets are integrated. Market efficiency studies that have widely been conducted in Malawi concentrated on the price spread analysis and distributions of costs and gains in agricultural marketing channels. Due to lack of adequate research in the area of market integration, it is not clear how price information flows among spatially distinct markets. This study aimed to examine maize market integration in order to determine how efficient maize markets are in price transmission. It used the less often and yet more acceptable econometric approach of cointegration to measure spatially distinct maize market integration in Malawi. The study also used the most recent data making its results more representative and more applicable to the current maize market conditions.

1.7. Objectives

1.7.1. Underlying Objective

The main objective of the study was to examine the extent of maize market integration in Malawi as an indicator of flow of price information between spatially separated markets.

1.7.2. Specific Objectives

Specifically the following objectives were examined:

1. To determine whether maize price flows follow its production flows with respect to season and trend
2. To determine the extent of maize market integration in Malawi
3. To determine causal relationships across spatially separated maize markets in Malawi

1.8. Hypotheses

The general hypothesis of the study was that maize markets are not well integrated in Malawi. The study specifically examined the following hypotheses:

1. There is no long run spatial integration of maize markets in Malawi
2. There are no price causal relationships among maize markets in Malawi
3. Maize markets in Malawi are not efficient in transmitting price information

CHAPTER 2

2.0. LITERATURE REVIEW

2.1. Sources of Marketing Information in Malawi

Ng'ong'ola *et. al.*, (1997) reported that in Malawi, the main source of market information to farmers and traders in their trading activities is personal contacts. This is also consistent with a more recent study by SARRNET (2003), which also found out that the most common source of market information to farmers and traders are the social networks i.e. friends, relatives and fellow businessmen. Despite the fact that price information is publicised by the Ministry of Agriculture, through the radio and newspapers, Ng'ong'ola *et. al.*, (1997), found out that these two forms of media may not be very effective for the itinerant traders and farmers who hardly have time to listen to the radio and neither do they have ready access to newspapers that are in frequent circulation in some urban areas while traders and farmers spend much of their time in rural areas.

2.2. Agricultural Markets and Marketing in Malawi

Agricultural markets in developing countries, including Malawi, are characterised by long chains of transactions between farm gate and consumers, lack of competitiveness between traders, collusion at all levels of trade and poor access to appropriate market information (IFAD, 2003). Prices received by farmers for the sale of their goods are significantly less than the price they could have received if they had not only the means of transporting it themselves to assembly markets but also information about other market outlets and prices. The extent to which smallholder farmers are able to participate in

markets is generally inequitable. They are often obliged to sell low (produce market) and buy high (input market). They have little choice regarding where they conduct transactions, with whom, and at what price (IFAD, 2003).

A lot of smallholder farmers have a poor understanding of markets, how the markets work and why prices fluctuate. They have little or no information on market conditions, prices and the quality of goods wanted in the market. Furthermore smallholder farmers lack the collective organisation that can give them the power they require to interact on equal terms with other, generally larger and stronger market intermediaries; and they have no experience of market negotiation and little appreciation of their own capacity to influence the terms and conditions upon which they trade (IFAD, 2003).

The MoAI (1999) noted that markets and market infrastructure are not only inadequate but, are also underdeveloped relative to the large number of smallholder farmers and the variety of commodities in the country. Although district and city markets provide alternative outlets to smallholder produce, most, if not all of them, were designed with a small farming and consumer population than the current one. It further noted that limited market outlets and lack of competition in the marketing of non-traditional crops such as soy beans, paprika and other crops was stifling farmers' efforts to diversify away from tobacco. In fact, in parts of the country, farmers have produce on the roadside, which is not selling. The constraints include: lack of markets, market information (intelligence), and low prices for products whilst inputs are sold at exorbitant prices.

An IFAD report, (2003) recognised that if it is true that markets, and improved market access, are of critical and immediate importance to rural poor households, it is also evident that they are a prerequisite for enhancing agriculture-based economic growth and increasing rural incomes in the medium term. It further argued that rural incomes will not be substantially increased by exclusive emphasis on subsistence food crop production; rather, more market-oriented production systems are needed and that these require the intensification of agricultural production systems, increased commercialisation and specialisation in higher-value crops. And these must be built upon the establishment of efficient and well-functioning markets and trade systems – ones that keep transaction costs low, minimise risk and extend information to all players, and that do not either exclude, or work contrary to the interests of the poor – particularly those living in areas of marginal productivity and weak infrastructure.

Poulton *et. al.*, (2005) observed that small farms' competitive advantages over large commercial farms lie principally in their low transaction costs in accessing and supervising motivated family labour and in their intensive local knowledge, but their small scale leads to high unit transaction costs in almost all non-labour transactions (in accessing capital, market and technical information, inputs and output markets, and in providing product traceability and quality assurance). These high transaction costs are exacerbated by most small farmers' poverty (with large needs for external sources of capital but limited assets for collateral), dispersion, production and health uncertainty (associated with poverty and lack of access to capital and services) and low levels of education, and by poor physical and informational communication systems and low

density of economic activity in the poor rural areas where they predominate. They asserted that small farmers struggle to deliver reliable and regular supplies of a given crop, particularly when quality is also tightly specified and in responding rapidly to changes in buyers' requirements. High transaction costs become particularly problematic where individual transactions require significant transfers of information about the source or any credence attributes of commodities being transacted. Such farmers also tend to lack political voice and market power.

2.3. The Nature and Importance of Agricultural Market Information

Information and planning are important to the more obvious functions of a marketing system of providing adequate facilities and services for the day to day commodity exchange, both domestic and export market promotion and of providing necessary controls and regulation over commodity markets. They have more fundamental implications for the diversification of agriculture. Without a strong marketing capability, it is difficult, if not impossible, for government to implement a pricing policy, to ensure pricing programmes succeed and to take decisions on such important issues as the degree to which incentives to the agricultural sector should be obtained through a price mechanism or through other means, which increase efficiency and productivity (FAO, 1982).

A market information system is defined as a set of procedures and methods designed to generate, store, analyse and disseminate anticipated marketing decision information on a regular and continuous basis (Evans and Berman, 1988). Shepherd (1997) defined

agricultural market information service as a service, usually operated by the public sector, which involves the collection on a regular basis of information on prices and, in some cases, quantities of widely traded agricultural products from rural assembly markets, wholesale and retail markets, as appropriate, and dissemination of this information on a timely and regular basis through various media to farmers, traders, government officials, policymakers and others, including consumers.

With knowledge of how markets function and marketing procedures, farmers will be able to make better choices on such immensely important subjects as what to produce, when to produce, where to sell, when to sell, to whom to sell, and at what price to sell, (Lutz, 2006). He further noted that with so many market imperfections and discrepancies in market knowledge, these make markets work far below their potential level of efficiency. The effects are lower incomes for producers, high prices for consumers and very big losses in the economy. Lutz (2006) concluded that without market information, farmers will produce crops which yield badly, have high costs of production, and are in excess supply or low demand of which all are relative to profit.

There is a growing recognition among development agencies and governments that, if farmers were more fully informed about the markets for their crops, their bargaining position with intermediate traders would be strengthened, their income would increase and less produce would go to waste. In addition, more transparent markets would help to lower transaction costs, increase the volume of trade, offer greater food security, increase import substitution and lower consumer prices leading to greater benefits for the

economy as a whole (Robbins and Ferris, 1999; IFAD, 2003; Kachule, 2004). Public support to market information programs for farmers and traders has two major justifications. First, although farmers and marketing firms are the direct beneficiaries of the programs, ultimately there are benefits to the consumer as a result of increased market efficiency and enhanced competition. Second, information has been considered ‘market equaliser’, which strengthens the farmers’ bargaining power when dealing with middlemen and other marketing firms (Kohls and Uhl, 1980).

Abbot and Makeham (1979) noted that in agriculture, market information helps agricultural market players to balance supply and demand in particular markets and thus avoid gluts and surpluses with their corresponding fluctuations in prices. They further observed that farmers need information about probable supplies and prices in order to make decisions when planning their production and sales. The knowledge that a farmer can compare prices offered by a trader with other prices elsewhere also influences buyers in offering fair prices. Access to better information enables wholesalers to develop those consumer demands and producer supplies, which might otherwise have been neglected.

Dembele *et. al.*, (2000), in the case of Malian Cereal Market Information System reported that it was realised that market information systems provide government and donors with timely information on how price and supply conditions were evolving in the context of broad-based economic reforms. It also provided private sector including consumers with needed timely, accurate, low cost information to operate effectively in a liberalised market. Furthermore, price information was needed to evaluate and adapt reforms to the

evolving macroeconomic and political context as well as to design effective policies to promote food security, higher economic growth through private investment and reduce transport costs.

A service providing market price information is seen as promoting "transparency," i.e. the full awareness of all parties involved of the prevailing market prices and other pertinent information. Transparency in a market facilitates "arbitrage", i.e. the act of buying at a lower price and reselling at a higher price (Shepherd, 1997). Two forms of arbitrage can be distinguished "spatial arbitrage", i.e. the ability of traders and farmers to ship produce to markets offering the most profitable trading opportunities; and "temporal arbitrage", i.e. the opportunity to store products in order to take advantage of likely higher prices later in the season or, in some cases, in subsequent years.

Shepherd (1997) noted that an MIS can contribute to spatial arbitrage and open up the possibility of temporal arbitrage. Availability of information should encourage new entrants into the marketing system. In the longer term it should also provide farmers with the opportunity to plan and diversify their production in line with market demand and to schedule deliveries to the market at times when returns are most rewarding. Finally, market information can be a valuable input into Early Warning Systems by highlighting food shortages which are reflected by higher prices and can also assist government planners in developing an understanding of the ways markets work.

While it is not possible to have 100% accurate market information, to be of maximum benefit, market information must meet a number of criteria, (Kohls and Uhl, 1980). The information must be complete and comprehensive. The information must be an honest market appraisal in order to earn the trust of its users. It must be relevant and in usable form. Information must be collected and packaged and disseminated with the users' interests in mind. Kohls and Uhl (1980) further observed that much market information goes unused because it is not in usable and easily accessible form. Like agricultural products themselves, market information is also highly perishable. This means that market information must be timely, in the sense of being relevant to current decisions, and must be speedily transmitted to users.

2.4. Market Performance

Marketing performance is defined as how well the marketing system performs what society and the market participants expect of it. It is the outcome that results from the group of firms in an industry pursuing their respective lines of conduct. Three steps are involved in evaluating market performance. The first step is defining the performance dimensions, that is, what types of outcomes are most important for the society. In the second step, it is important to define the performance norms, that is, what is the standard of performance against which performance can be measured. The last step is defining performance measures, that is, what metric or criteria will be used to measure actual performance against the norms.

Price coordination requires that price signal from the food industry to upstream producers or downstream consumers be appropriate for guiding their production and consumption decisions. One aspect of price coordination is how closely prices in different markets move together, as well as price differences between points in time (Tomek and Robinson, 1990). Hence, to analyse how the maize markets in Malawi are performing, one of the performance measures was used, namely the degree of integration between markets.

2.5. Market Performance Indicators

2.5.1. Market Integration

The role of markets in assuring economic welfare and food security is well known. Deficient functioning of the marketing system is one of many reasons for poor levels of production and productivity, low earnings and food insecurity. Therefore, the contribution of agriculture to the economic growth of Malawi, reducing income inequalities, and poverty, depends in part on the performance of agricultural markets. These markets in developing countries frequently suffer from many structural deficiencies, which leads to spatial market inefficiency, that is, inefficient flows of information and trade among spatially distinct markets. Hence, one of the indicators commonly used in the analyses of market performance is the level of market integration.

In a competitive environment, arbitrage will ensure that prices of a homogeneous product such as maize will be linked in two different markets. Hence, two markets are said to be integrated if prices in the importing market equal the prices in the exporting market plus marketing costs (Tomek and Robinson, 1990). This definition implies that, first, there is some trade between markets, and second, the price differentials between them cannot

exceed the marketing costs necessary to move the product from one market to another. Market integration can be seen in three dimensions, namely, spatial market integration (location), vertical market integration (product form), and temporal market integration (time).

The first case reflects the effect of a price change in one market location on the price of the same commodity in another market location. If there is no linkage between two market prices, then markets are said to be separated. Vertical market integration reflects the passage of a price change across steps in the marketing chain. A price relationship between raw and processed products is a good example of this vertical integration. In this case, the movement of a product is combined with some form of processing such as in the case of maize grain as a raw product and maize meal as a processed product. Another example of this vertical integration is a movement of a product from one level to another level without changing its form. For example, a movement of maize grain from wholesale to retail is a good example of this kind of integration. Last, temporal market integration reflects the effects of a present price change on future prices (Tomek and Robinson, 1990). This kind of integration was not analysed in this study because it was out of the purpose of the study.

Sustained efforts by market participants to exploit arbitrage opportunities can result in the maintenance of equilibrium relationships among commodity prices in distant markets. While earlier studies on market integration relied on correlations between the prices in pairs of regions (for example, Richardson, (1978)), later studies considered correlations

of price differences (for example, Stigler and Sherwin, 1985). Recent analyses of spatial price transmission have focused on integration between prices in different markets using cointegration techniques. A significant implication of the cointegration approach is that, while individual price series may wander extensively, certain pairs should not diverge from one another in the long run.

2.5.2. Importance of Market Integration

Regional market integration in many agricultural commodities has been studied elsewhere for the insight it provides into the functioning of such markets. Such studies provide valuable information about the dynamics of market adjustments, and whether there exists market imperfections, which may justify government intervention. Further, various market imperfections such as entrenched monopolies/monopsonies and inadequate and costly information transmission, hinder the attainment of market efficiency and may constrain agricultural development and aggravate inequitable patterns of income distribution (Silvapule and Jayasuriya, 1994). Markets that are isolated may convey inaccurate price information that might distort producer-marketing decisions and contribute to inefficient product movements.

In the context of Malawi, there are several reasons to analyse the performance of maize markets. First, price is a product of market performance. If a shock occurs in a market, it is expected that price will adjust in other markets to reflect the changing conditions imposed by that shock. The change in price is a signal that then facilitates market adjustment of quantities, etc. For instance, if there is a maize shortage in the Southern Region of Malawi, well-integrated markets will quickly reflect this shortage through

appropriate price relationship, creating signals for the imports of maize grain to Blantyre and other southern markets. When spatially distinct markets are not integrated, price signals among markets will be transmitted imperfectly and with delays. One of the main consequences of this poor price transmission is high price volatility that weakens the food security of both farmers and consumers. Second, in poor countries such as Malawi, market interventions are constrained by lack of financial resources. Knowing that markets are integrated and will therefore efficiently transmit information and guide trade flows between surplus and deficit areas can make it easier for governments to allow markets to work, while concentrating their scarce resources on investments that will reduce marketing costs or target needy households in a way that does not disrupt markets. Third, as stated by Golleti *et al.*, (1995), knowing the relationship among spatially distinct market prices makes forecasting analysis more doable. For instance, knowing the direction of price signals between integrated markets enables prediction changes in food security among farmers and consumers in one market as a result of changes in another market. In summary, prices in different markets are important in the decision on where to buy and sell. In other words, prices “regulate” trade flows. Therefore, the arbitrage activity of traders connects spatially separated markets, and market integration analysis provides a better understanding of the dynamic interaction of prices and the degree by which physically separated markets are connected.

2.5.3. Marketing Margins

The traditional way of assessing the efficiency of a marketing system is to assess the marketing margins. A marketing margin is the percentage of the final weighted average selling price taken by each stage of the marketing chain (Shepherd, 1993; Goetz and

Weber; 1986). It represents the value of the marketing services (transport, storage, processing, and others) that are performed on a commodity, including a normal profit. Therefore, the margin includes costs incurred by traders plus a mark-up that is added by the trader as a return to their investment, management, and risk. The level of transaction costs thus influences trade flows and prices in the markets. When transaction costs go down, as a consequence, for example, of the availability of price information, efficiency gains are achieved. The availability of correct price information and communication infrastructure will lower the traders' cost of information gathering, as well as the risk of sudden unfavorable price changes. Consequently, they will have more opportunities to prevent unprofitable transfers and this should ultimately lead to a reduction in their gross margins (Shepherd, 1993). The excessive margin in relation to the services rendered shows the inefficiency of the system.

Ideally, an efficient marketing system should provide the right good, at the right place and time, in the right quantity, and at an affordable price. In addition, profit levels should be reasonable for all participants in the chain. Hence, the analysis of marketing margins provides useful insights on how marketing costs have changed through time, and whether they are reasonable or not. Stable margins are consistent with efficiency in the market, but non-constant margins per se do not reflect lack of efficiency in the market. Brandow (1976) mentioned that a single industry should not be expected to have stable prices, output, or employment when changes in the economy impose instability upon the industry. This is true because marketing costs do not remain the same throughout the time, and therefore, neither can the final price. Thus, increasing costs in the maize

marketing system increase marketing margins, and changes on it may affect market participants in different ways, depending on their respective elasticities of supply and demand.

However this method was not used in the study because of the rudimentary nature of data on marketing costs, which many farmers do not accurately report. A FAO report by Shepherd (1993) indicated that by just comparing the farmers' prices with the final price it could be a poor indication of market efficiency since the costs involved in moving the commodity along the marketing chain from the farmer to the consumer are not taken into account. Therefore the major costs involved need to be accounted for when making a comparison of the producer and consumer price. Only then can we assess whether the marketing system is efficient or not or whether the margins are justified.

2.6. Theoretical and Empirical Review for Choice of Market Integration Analysis

Studies on the transmission of price signals are founded on the concepts related to competitive pricing behaviour. In spatial terms the classical paradigm of the Law of One Price as well as the predictions on market integration provided by the standard spatial price determination models (Enke, 1951; Samuelson, 1952; Takayama and Judge, 1971), postulate that price transmission is complete with equilibrium prices of a commodity sold on competitive foreign and domestic markets differing only by transfer costs, when converted to a common currency. These models predict that changes in supply and demand conditions in one market will affect trade and therefore prices in other markets as equilibrium is restored through spatial arbitrage. In complete price transmission arising

due either to trade and other policies, or due to transactions costs such as poor transport and communication infrastructure, results in reduction in the price information available to economic agents and consequently may lead decisions that contribute to inefficient outcomes (Rapsomanikis *et. al.*, 2006). It is widely acknowledged that the success of market reforms in underdeveloped countries depends to a large extent on the strength of price signals transmitted between markets (Abdulai, 2006). He further observed that market integration has been particularly significant in predicting the impacts of price changes in producing areas on markets in food deficit areas. Analysis of market integration relies on time series price data for spatially distinct markets.

If a time series is non-stationary, it is said that the series suffers from a unit root problem. In this case, the standard regression models such as Ordinary Least Square (OLS), cannot be used to perform regression analysis because under the presence of a unit root, statistical inferences are biased and inefficient (Pindyck and Rubinfeld, 1981). Thus, alternative models should be used, one of them being the cointegration models. The idea of cointegration is that although each of two or more price series may be individually non-stationary, a linear combination of them may have the trend terms mutually cancel out so that it becomes stationary (Intriligator *et. al.*, 1996). Basically, the cointegration analysis identifies whether or not there exists a long-run equilibrium between two or more price series. Therefore, the presence of cointegration is indicative of interdependence, and its absence indicates market segmentation (Golleti and Tsigas, 1995). The attractiveness of cointegration analysis is that it does not require that price series be transformed into stationary series. Furthermore, there is no need to check for

autocorrelation and heteroskedasticity because OLS is consistent (Tomek and Myers, 1993).

However, Abdulai (2006) concedes that the cointegration approach does not explicitly consider transactions costs, an omission that can be attributed to the difficulty in observing these costs. The omission of transactions costs in market integration analysis can lead to empirical results that are potentially misleading. Goodwin and Piggott, (1991), agreed with Abdulai and continued to say that ideally, these costs should be subtracted from the prices before applying the testing procedures. However, this is not usually done because the relevant cost data are not available, which is the case here also. Some researchers have used proxy variables for transactions costs, for example, Goodwin and Piggott (1991) while others have tried to establish the link between the price differentials and transport costs by relating them in a cointegration framework (Baffes, 1991). In the case of the markets used here, the appropriate transport and transfer cost data were not available while using proxies may create more problems than it could solve as observed by Zanas (1999).

2.7. Correlation of Prices

The bivariate correlation coefficients of prices in spatially separated markets provide a classical tool for measuring market integration (for example Lele, 1971 for India; Farruk, 1970 for Bangladesh). The magnitude and significance of the correlation coefficients have been used to indicate the level of market integration. Goetz and Weber (1986) argued that we would generally expect prices for the same product in two different

markets within the same region to exhibit similar patterns of price behaviour. They said that this can be assessed by calculating correlation coefficients between price series. Correlation coefficients range between +1.00 and -1.00. The higher the coefficient, the higher the degree of integration. Perfectly collinear price movements brought about, for example, by monopoly or pan-territorial and pan seasonal pricing rules as those practiced by ADMARC, would result in a correlation coefficient of 1.0 but it is impossible to observe this in a competitive market situation. A negative coefficient indicating a negative linear relationship between markets would imply some degree of segmentation and the absence of market integration, (Goetz and Weber, 1986). Several authors have used correlation of price levels as a measure of market integration including Golleti and Babu (1994) in Malawi.

Nevertheless, use of correlation coefficients has been challenged. The most prominent concern being that price levels, like most economic time series are usually non-stationary, that is, they have non-constant variance, mean and covariance. Other arguments against use of the coefficients are that they mask the presence of synchronous factors such as inflation, seasonality, population growth and public policy (Golleti and Babu, 1994). This being the case, coefficients derived from such correlations would simply be spurious and any conclusions drawn from such analysis would be baseless.

Various studies have suggested ways to overcome the said shortcomings of correlation of price levels. Maritim (1982) as cited by Ngugi (1997) suggests using only coefficients of 0.7 or above. Others suggest use of price differences instead (Golleti and Babu, 1994;

Stigler and Sherwin 1985). The aforesaid limitations and suggestions notwithstanding, bivariate correlation coefficients continue to be used as a measure of market integration. This study also employed the same method not so much as a tool for examining market efficiency but with the aim of comparing the results with those from other methods.

2.8. Correlation of Price Differences

Besides correlation of price levels, correlation of first price differences has also been used to examine market integration in the past studies. Golleti *et. al.* (1994) applied correlation of first price differences to examine integration of rice markets in Bangladesh. His findings were that 50% of the markets were integrated indicating a moderate degree of integration among the rice markets. Golleti and Babu (1994) used the same technique to measure integration among maize markets under liberalisation in Malawi. In their study, correlation coefficients were quite low, a thing, which as observed suggested low degree of integration.

In Egypt, Golleti, *et. al.* (1995) assessed the impact of market reform on integration for wheat, rice and maize using correlation of first price differences. They observed that coefficients are generally higher in the period after reform than they are in the period before showing that reform has increased market integration and had a positive impact on market efficiency.

Besides correlation of price levels, bivariate correlations of price differences were used in this study to measure market integration. Price differences in the market integration sense

are interpreted as interdependence of price changes in different markets. Besides, differencing removes trends and quite often induces stationarity in an otherwise non-stationary series hence solves problems of spurious correlations (Pindyck and Rubinfeld, 1981; Edriss, 2003). Correlation of price differences is therefore undoubtedly a superior technique to correlation of price levels.

CHAPTER 3

3.0. METHODOLOGY

3.1. Introduction

This chapter describes the methodology used in this study in order to address the stated objectives and test the hypotheses. It discusses the data, its sources and its limitations. It further discusses the theoretical underpinnings of the analytical models that have been used in the study.

3.2. Study Area and Sample Frame

This study analysed 13 maize markets across different geographical locations in Malawi covering all the eight ADDs. Furthermore, the markets represent some of the major maize producing areas while others represent major consumption areas. The consumption areas with market dependent populations were assumed to send price signals to the rest of the markets. The choice of the markets was also based on the availability of consistent price data with a limited number of missing values. These markets are: Chimbiya, Lizulu, Mchinji, Mitundu and Salima in the Central Region; Bangula, Luchenza, Lunzu and Ntaja in the Southern Region and Chitipa, Mzuzu, Karonga and Rumphi in the Northern Region.

3.3. Data Collection and Handling

The study made use of secondary data. The MoAFS has been collecting retail prices for major agricultural commodities including livestock for many years. Over the years, the number of markets has been increasing. Currently it is collecting prices in over 72

markets. Prices are collected by enumerators on market days each week and the averages are computed to arrive at the monthly price. However the weekly prices are more inconsistent than the monthly prices. This data was supplemented by other data from published reports. Some price data was also collected from IDEAA-Malawi Market Information System. The maize price data and production data was collected from MoAFS, Famine Early Warning Systems Network (FEWSNet), and Agro-Economic Survey Department. Some data was collected from FAO Database website.

After data collection from the stated sources, each data series was cleaned by means of adjusting the prices that were two standard deviations from the yearly means as suggested by Goetz and Weber (1986). Missing values were also approximated by linearly interpolating where there was only one to three missing values. Where there were more than three missing values, prices from a nearby market were placed for the missing values because it is hypothesised under spatial arbitrage theory that prices of the same commodity in adjacent markets tend to move in unison and that they do not divert much from each other according to Tomek and Robison (1990). The adjacent markets whose price data were used to interpolate for other markets were not considered for analysis in order to avoid bias towards market integration. The data was then split into two sets representing the period when the maize market was the partially liberalised with the maize price band policy (1994-2000) and period when the maize price band policy was completely scrapped off (2001-2006). The data was deliberately divided into those two periods for the statistical reason that prices from two different policy regimes cannot be

pooled together when analysing for market integration because such policies result into regime switching and disequilibrating an otherwise equilibrium market.

3.4. Price Deflation

There can be no doubt that the relative price of a commodity overtime can be obscured by changes in the purchasing power of the currency (Goodwin, 1994). Therefore, the study used maize real prices as opposed to nominal prices because the latter price ignores any changes that may have occurred or may be occurring in the value of the Kwacha over time as a result of inflation. The data cover the period from January 1994 to September 2006. As a result of high inflation in the period covered, all prices, expressed in Kwacha per kilogram were deflated using the food Consumer Price Index (CPI year 2006=100) deflator. The food CPI was used to correct for changes in the value of the Kwacha making year-to-year comparison feasible and meaningful. There is a whole series of indices that could be used but the food CPI was preferred because maize has a weight of over 60% in this index since it is the staple food for the majority of Malawians.

Other than correcting for inflation, deflation of the prices was also done to satisfy some statistical requirements. Considering that standard Ordinary Least Square (OLS) regression assumes homoscedasticity of the error term (Gujarati, 1995), two offsetting factors could have affected variance of the error term in the data series; firstly, improved price measurement techniques and consistency in data collection could reduce variance of the error term (difference in measurements by different people and inconsistency in price collection could affect variance of the error term). Secondly, if the prices rose over time,

then the higher absolute deviations of prices from the trend line would also have led to a higher variance of the error term (Goetz and Weber, 1986). In general, deflation of the price series reduced the magnitude of the prices, thereby reducing also the variance of the error term.

The data was then decomposed into seasonal variation and trend variations following procedures suggested by Goetz and Weber (1986) and Goodwin (1994) in order to get some insights about the behaviour of the maize prices with respect to price movement intra and inter-years.

3.5. Analytical Models

Different analytical tools were used to test the hypotheses. Simple bivariate price correlations coefficients between markets were calculated in the study to get some insights about market integration. Apart from these correlations, time series price models were also used to evaluate the performance of spatially differentiated maize markets. More specifically, Engle-Granger co-integration model was the main analytical model.

Most of economic time series such as prices, behave in a non-stationary manner, that is, the mean is not constant and the variance is time dependent (Enders, 1995). A time series is said to be stationary if its mean fluctuates around a constant long-run mean and the variance is finite. The assumption of stationarity for modeling is important because, when data mean and variance are not constant, it means that observations come from different distributions over time, which causes statistical problems.

3.5.1. The Concept of Cointegration

The concept of cointegration states that if a series X_t is non-stationary but its first difference is stationary, then it is said to be integrated of order one or simply integrated, and could be represented as $X_t \sim I(1)$. Otherwise, if X_t is stationary it is said to be integrated of order zero and denoted as $X_t \sim I(0)$ (Verbeek, 2004).

If two series X_t and Y_t are both $I(1)$ then in most cases the linear combination $Y_t - a - bX_t = \varepsilon_t$ is also $I(1)$. But it is possible that ε_t is stationary, or $I(0)$. This will only happen if the trends in X_t and Y_t cancel out when $\varepsilon_t = Y_t - a - bX_t$ is formed. If and only if this is the case then X_t and Y_t are said to be cointegrated with b as the cointegrating parameter or coefficient. In general a pair of series X_t and Y_t are said to be cointegrated if they are individually $I(d)$, d is the order of integration, but there exists a linear combination of them, $\varepsilon_t = Y_t - a - bX_t$, that is $I(0)$, (Greene, 2000). The task in cointegration analysis is therefore two fold. The first part is to find out if each of the pair of a time series is stationary and if either or both are non-stationary and secondly, to difference the series until stationarity is achieved (Edriss, 2003).

3.6. Analytical Framework for Data Analysis

To test for market integration using a cointegration approach, the Engle-Granger methodology was applied because of its simplicity and wider application by many authors (see for example, Golleti and Babu, 1994). Another method of analysing market integration is maximum likelihood procedure suggested by Johansen (1988), which relies on relationship between the rank of a matrix and its characteristic roots. However, this

method was not used in this study. Following Engle and Granger (1987), the methodology composed of two steps:

3.6.1. Diagnostic Test

In the first step, price series were tested for order of economic integration using Augmented Dickey Fuller Test (ADF). The ADF test, which tests for the presence or non-presence of a unit root, was performed by running the regression model specified as (Gujarati, 1995):

$$P_t = \beta_1 P_{t-1} + \varepsilon_t \quad 1.0$$

Where P_t is the time series price for maize grain at time t ,

P_{t-1} is the lagged time series maize price,

β_1 is the coefficient on the lagged term, and

ε_t the error term.

Subtracting P_{t-1} from both sides of this equation gives:

$$P_t - P_{t-1} = \beta_1 P_{t-1} - P_{t-1} + \varepsilon_t$$

$$\Delta P_t = (\beta_1 - 1) P_{t-1} + \varepsilon_t$$

$$\Delta P_t = \delta P_{t-1} + \varepsilon_t \quad 2.0$$

where ΔP_t is the price first difference ($P_t - P_{t-1}$), and δ is equal to $(\beta_1 - 1)$

The ADF test can also be used for testing a unit root in the presence of a drift and/or trend. In the presence of drift and no trend, the regression model is specified as:

$$\Delta P_t = \beta_0 + \delta P_{t-1} + \varepsilon_t \quad 3.0$$

where β_0 is the intercept term (drift)

On the other hand, when trend term is included in model 3.0 to make sure that the apparent lack of stationarity is not due to the presence of a deterministic trend (Bopape, 2002), the regression model is specified as:

$$\Delta P_t = \beta_0 + \beta_1 T + \delta P_{t-1} + \varepsilon_t \quad 4.0$$

where β_1 is the coefficient of the trend term, T

In these two last cases as well as in the first case (without drift and trend), the coefficient of interest is δ . If δ is equal to 0, the price series is non-stationary. In other words, the price series contains a unit root. The number of times that is necessary to difference each price series to turn it stationary gives the order of integration of the series. For instance, if a price series was differenced once to turn it stationary, this series was integrated of order 1 and is symbolised as $I(1)$.

3.6.2. Cointegration Model: Engel and Granger Model Specification

In the second step of Engle-Granger methodology, the long-run relationship between maize markets is determined. Based on the idea of co-integration, if two price series $I(1)$ can be combined and the series resulted from this combination are $I(0)$, then the series are co-integrated and exhibit a long-run relationship. If P_{jt} denote the maize price at market j at time t , and P_{kt} denote the maize price in market k at time t , the coefficient β_l in the regression model 5.0 below gives the long-run relationship between these two markets only if the error term (ε_t) in the same regression model is stationary. This can be done by applying OLS regression on one of the price series, plus a constant represented as follows:

$$P_{jt} = \alpha_0 + \beta_1 P_{kt} + \varepsilon_t \quad 5.0$$

More simple, in the second step, the OLS residual from equation 5.0 is taken and then tested for a unit root using the ADF test. The procedure is the same as testing for a unit root in a single series. The only difference is that the distribution of the test statistic is different because now the residual is used instead of the observable variable (Wooldridge, 1999).

3.6.3. Granger Causality Test

In order to assess the nature of maize price transmission across markets and causal relationships among spatially distinct markets, the Granger causality test was used. Basically, Granger Causality Test is another approach to test market integration. A time

series, price P_{kt} is said to “Granger cause” another time series, price P_{jt} if current and lagged values of P_{kt} improve prediction of P_{jt} (Gujarati, 1995). In other simple words, causality is basically a measure of the predictability of prices, that is, price movements in one market can be used to forecast price changes in other markets (Minten and Mendoza, 1998). The Granger test involved the estimation of the following regressions (Gujarati, 1995):

$$P_{jt} = \theta_1 + \sum \alpha_i P_{jt-i} + \sum \beta_i P_{kt-i} + \varepsilon_{1t} \quad 6.0$$

$$P_{kt} = \theta_2 + \sum \gamma_i P_{kt-i} + \sum \delta_i P_{jt-i} + \varepsilon_{2t} \quad 7.0$$

Where θ_1 and θ_2 are the intercept terms

α_i , β_i , γ_i , and δ_i are the coefficients on the lagged values of both P_{jt} and P_{kt}

i is the lag length used for both price series, and

ε_{1t} and ε_{2t} are the error terms.

Causation can occur in two ways, unidirectional– where shocks in one market affect another market but not the reverse – and bidirectional where shocks in one individual market are transmitted both ways. Therefore, based on models 6.0 and 7.0, four hypotheses of causality can be tested. They are:

1. Unidirectional causality from P_{kt} to P_{jt} if the coefficients β_i are statistically different from zero and the coefficients γ_i are not statistically different from zero

2. Unidirectional causality from P_{jt} to P_{kt} if coefficients β_i are not statistically different from zero and the coefficients γ_i are statistically different from zero
3. Bilateral causality (both P_{kt} and P_{jt} cause each other) if all coefficients α_i , β_i , γ_i , and δ_i are statistically different from zero
4. Independent causality (both P_{jt} and P_{kt} do not cause each other) if all coefficients α_i , β_i , γ_i , and δ_i are not statistically different from zero

To test these hypotheses of Granger causality, an F-test is used. The test is conducted first regressing P_{jt} on their own lagged values. This is called the restricted regression. Second, P_{jt} is regressed on their own lagged values and the lagged values of P_{kt} . This is called the unrestricted regression. Then, the F-test that follows the F-distribution with m and $n-k$ degrees of freedom is computed as (Gujarati, 1995):

$$F = [(SQR_r - SQR_{ur}) / m] / [SQR_{ur} / (n-k)]$$

where SQR is the sum square of the regression,

r stands for restricted,

ur for unrestricted,

m is the number of lagged values in P_{kt} , and

k is the number of parameters estimated on the unrestricted regression.

3.7. Data Limitations of the Study

This study is not without its few limitations and challenges. These limitations did not compromise the achievement of the objectives and findings hence the results are conclusive. The major limitations were to do with data inadequacy and inconsistency because each price series had some missing values. The study had to completely drop Lilongwe, Blantyre and Zomba markets because of data inconsistency and inadequacy. These markets also happen to be some of the key deficit and consumption areas. This was considered to be the biggest limitation because previous studies indicate that these are dominant markets that send signals to the rest of the markets.

However though, other well-placed markets which had consistent data like Lunzu and Mitundu were included in the analysis. Because of their closeness to Blantyre and Lilongwe, respectively, it was hypothesised that their prices would not diverge much from those of Blantyre and Lilongwe and hence they were expected to display similar characteristics.

The other limitation of the study is that it was proposed in the planning stages of the study that comparison of maize market integration would be made of the periods before and after the institutionalisation of the Market Information System of the MoAFS. However, adequate and consistent price data was not available for the period before the market information service was put in place. The little price data that was available was only for a few markets (most of which price collection was also discontinued after 1998) and the data was not consistent enough. Furthermore, the period before the MIS (before

1988) also coincided with the period in which agricultural markets were not fully liberalised and maize prices were determined solely by ADMARC. Then, ADMARC implemented the pan-territorial and pan-seasonal pricing for maize hence there were no significant price differences among spatially distinct markets. Therefore, the analysis that was done only reflects maize market integration after the institutionalisation of the MIS (1994-2006) by the MoAFS.

CHAPTER 4

4.0. RESULTS AND DISCUSSIONS OF PRELIMINARY ANALYSES

4.1. Production Variability by ADD

As portrayed by Figure 2, maize production of smallholder agriculture in Malawi has stagnated or decreased over the years until recently where we have seen an unprecedented increase in maize production due to the fertilizer subsidy. Maize production between 1994 and 2005 fluctuated a lot in all the ADDs.

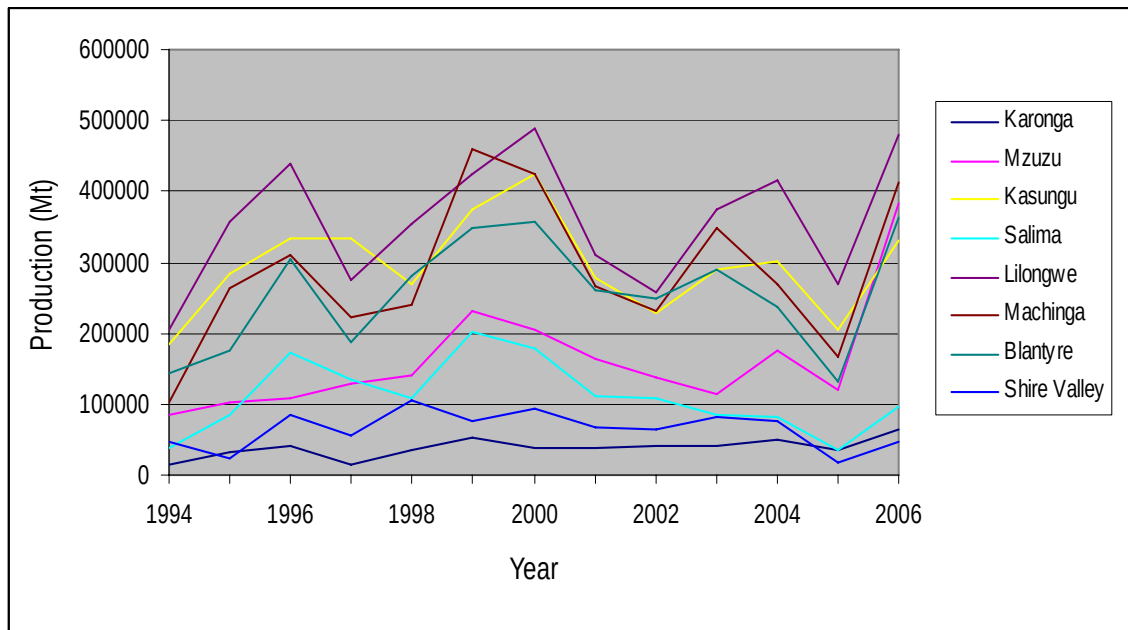


Figure 2: Graph of maize production by ADD

Arguably, many factors including erratic rainfall, droughts, limited credit, skyrocketing prices of inorganic fertilizer and many more as reported by Ng'ong'ola *et. al.* (2003) contributed to these fluctuations. Smallholder agricultural production in the Southern Region is scanty because of land shortage which arises from the high population densities

compared to the other two regions (Ng'ong'ola *et. al.* 1997) and that large concentration of tea estates in the region also contributes to land shortage.

In general Karonga ADD recorded the lowest maize production over the years. However the problem may not be as serious as the Shire Valley, which follows because rice is a staple for many people in Karonga as opposed to the Shire Valley where they depend on maize. These production levels must also be analysed relative to populations of those areas where the Southern Region has the highest population.

4.2. Price Variability

Agricultural production is characterised by seasonality related to the stochastic nature of output due to changes in weather and other agronomic factors that affect crop growth. This causes price variations over time and space. Before any analysis price, it is important to understand the variability in the prices over time and space. Price variability is a result of several factors which among others include; natural factors such as weather, economic factors like structure of the markets i.e. players involved, lengths of different marketing channels, transport and other marketing infrastructure and by a host of daily events affecting the behaviour of numerous agents participating in the marketing system. Therefore understanding price variability is important to give an insight of price behaviour within the study period. Table 1 shows the descriptive statistics and coefficient of variation of the price for the markets understudy.

Table 1: Descriptive statistics of real maize prices

	Count	Minimum	Maximum	Mean	Median	Std. Deviation	Std. Error	Coefficient of Variation (%)
Chitipa	153	6.17	40.64	16.219	14.47	6.732	0.5443	41.507
Mzuzu	153	8.29	51.37	19.209	18.28	7.065	0.5712	36.780
Karonga	153	7.35	49.98	18.643	17.07	7.107	0.5746	38.124
Rumphi	153	3.25	56.23	17.345	16.74	8.708	0.7040	50.208
Chimbiya	153	6.03	50.72	18.255	16.68	8.781	0.7099	48.102
Lizulu	153	6.43	48.11	17.498	15.89	8.473	0.6850	48.424
Mchinji	153	6.77	60.57	20.063	17.66	10.291	0.8320	51.295
Mitundu	153	5.15	51.82	16.946	14.07	8.486	0.6861	50.076
Salima	153	5.83	63.89	19.591	17.11	10.564	0.8540	53.920
Bangula	153	4.46	48.72	16.993	17.00	8.507	0.6878	50.063
Luchenza	153	1.60	48.11	20.661	19.78	9.048	0.7315	43.793
Lunzu	153	7.71	57.29	22.854	20.37	10.488	0.8479	45.892
Ntaja	153	5.67	57.56	19.965	18.14	9.500	0.7680	47.582

The highest real price for maize across markets was observed at Lunzu with a mean of MK22.85 per Kg (Table 1). However though, the maize prices seem to stabilise at MK17/Kg or thereabout, as the most prevailing median in most of the markets was MK17/Kg or thereabout. In addition, a visual inspection suggests that prices in all markets seem to be somewhat volatile, with market prices in the Southern Region (Bangula Lunzu, Luchenza and Ntaja) showing more volatility than prices in the Central and Northern regions. This situation is perhaps explained by a less stable maize supply, since the Southern Region markets are mostly supplied by districts from the Central Region as reported by Ng'ongola et al (1997) and informal cross-border trade with Mozambique (Minde and Nakhumwa, 1998; Whiteside, 1998).

As observed from Table 1, all the markets have a high variability of prices. Salima has the highest variability of 53% followed by Mchinji, Rumphi, Mitundu and Bangula with coefficients of variation exceeding 50%. The remaining markets have coefficients of variation exceeding 36%. This further depicts that the maize prices within the markets have been variable over the years. There is also a great variability in the maize prices over the years as indicated by the minimum and maximum prices. This could be as a result of scarcity of maize supplies inter and intra years and persistent maize crises which sometimes manifested themselves in simultaneous existence of maize grain surpluses in some areas and grain shortages in others over the years as was also found in an earlier study by Ng'ong'ola *et. al.* (1997) that maize trade by private traders was limited to markets that are well connected with good roads. This situation has placed great doubt on the efficiency of the Malawi food marketing system with regards to maize.

4.3. Seasonality and Trend

As suggested by Tomek and Robinson (1990), graphical methods provide a simple means of identifying trends, cycles or seasonal patterns of behaviour in time series data. Figures 3, 4 and 5 depict the graphical presentations of the real monthly retail prices for maize in the markets understudy in the Northern, Central and Southern regions respectively. All price series exhibit typical annual variability very common for agricultural commodities.

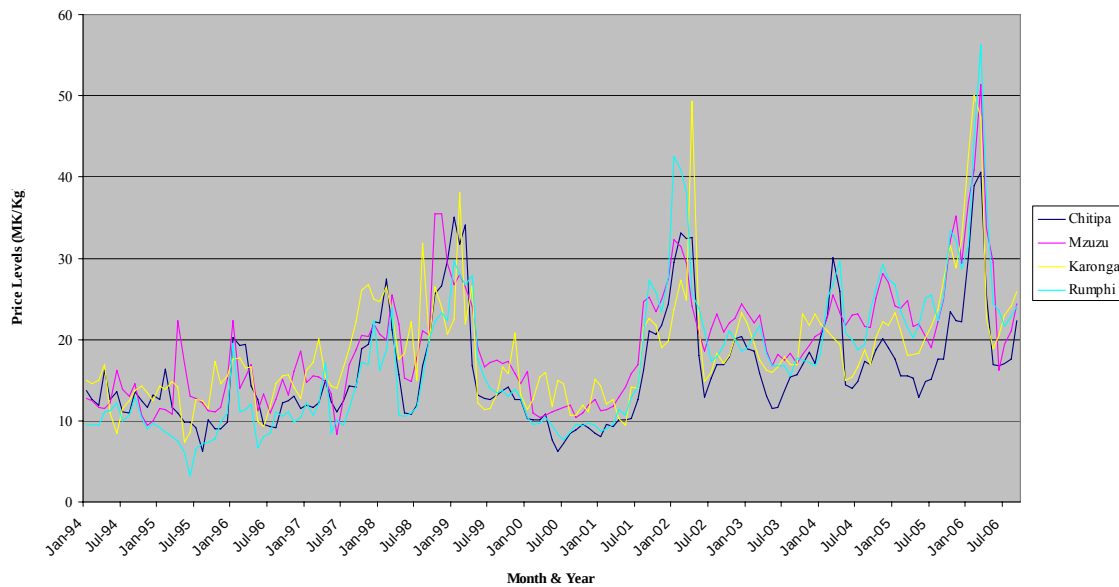


Figure 3: Graph of maize price level and time in the Northern Region

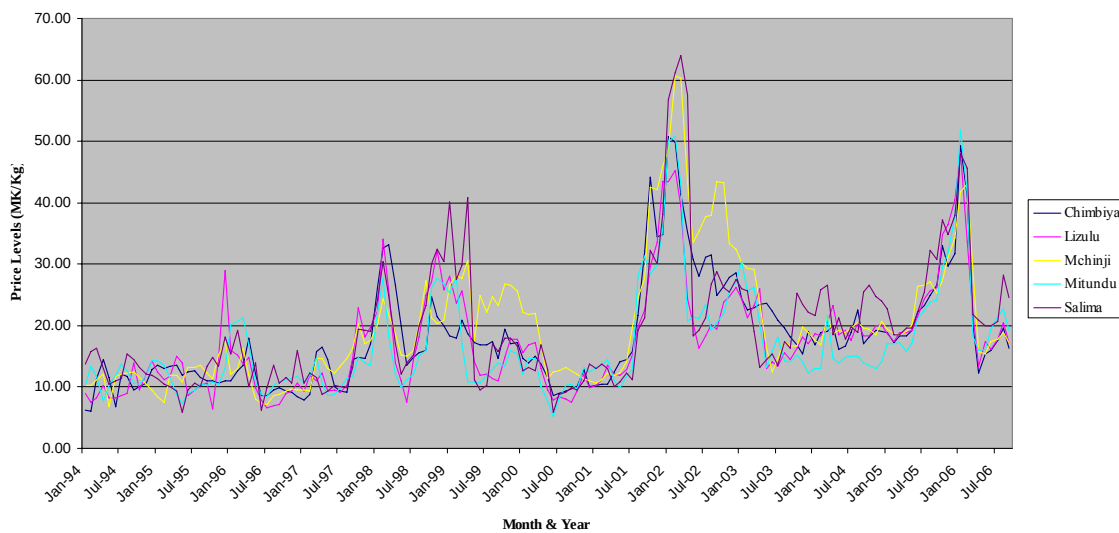


Figure 4: Graph of maize price level and time in Central Region

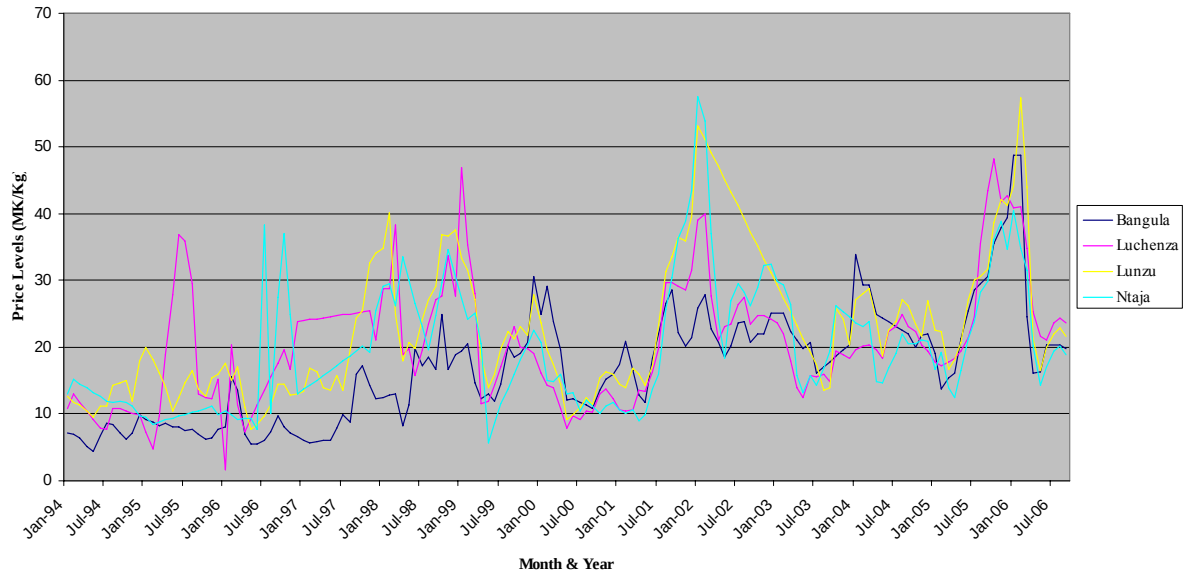


Figure 5: Graph of maize price level and time in Southern Region

4.3.1. Seasonal Variation

Seasonality is a phenomenon that occurs over one production cycle. For crops such as maize, this generally occurs within twelve months. Crop prices tend to follow a general season pattern, which is a function of relative changes in supply and demand as the marketing year progresses. Generally, crop prices set their seasonal low at harvest followed by a post-harvest rally. Post-harvest rallies occur because the supply of the crop is fixed and consumption gradually uses up that supply, causing prices to rise.

Since there were no differences in price movement overtime (as observed in Figures 3, 4, and 5) for markets in the same region, the prices were averaged out to arrive at regional averages and a national average. These regional averages and national average were

analysed for seasonal variability to give an aggregate picture of seasonal pattern of maize prices for the regions and the country. Figure 6 is a graphical presentation of seasonal indices over the twelve month period of the year. An index of 80% (for example) means the prices fall by 20% of the annual average for that particular month. Similarly an index of 110% means that the price increases by 10% of the annual average price for a given month (Goodwin, 1994).

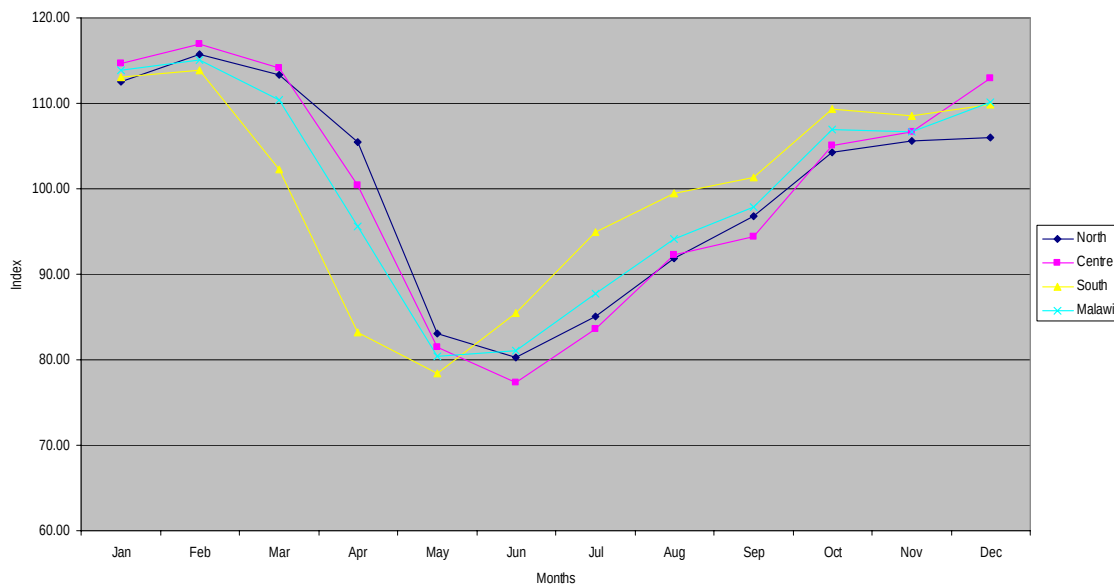


Figure 6: Maize seasonal price index by month, 1994 through 2005/2006 crop marketing years (2006=100)

Figure 6 depicts the seasonal pattern of maize prices across the country. Typical of agricultural commodities, all the regions indicate lowest maize prices between May and June, which happens to be the maize harvest period. These prices start increasing from July reaching the peak between December and March, which represents the lean period in terms of maize supply. An interesting result though is that of the Southern Region where

the prices on average become lower than those from Central and Northern Regions (as shown in Figure 6) after February until May probably because it usually receives early rains than the other two regions and supply from the Central Region Ng'ong'ola *et. al.* (1997) and informal cross-border trade with Mozambique (Whiteside, 1998). But afterwards, on average the prices become higher than the other two regions and the national average. This could be because as argued earlier, the South is always the region that is almost always heavily hit by maize shortages and therefore the prices on average are higher compared to the other two regions.

4.3.2. Trend Analysis

Trends in crop markets are gradual, long-term changes that can have a powerful influence on markets and which may significantly alter seasonal patterns. As suggested by Goodwin (1994), Goetz and Weber (1986), to analyse the effect of trend on a time series, the trend factor can be calculated simply by performing an OLS of the time series on a time dummy variable, which is incremented by 1 for each consecutive time period (month). The time variable is an independent variable, which is used as a surrogate for other variables, which may change by the same amount each period, or for variables such as technological change that may not be readily subject to measurement.

Table 2 depicts the results of regressing each price series on time variable to determine the influence of time trend on the price levels. In general, if the trend analysis suggests that time alone explains as much as 15 percent of the variation in the price series, the trend is of enough significance that it probably should not be ignored (Goodwin, 1994).

Table 2: Results of regressing price series on trend variable

Market	Real Price trend coefficient	t-statistic of linear trend	R-square of the trend equation
Chitipa	0.05759	5.034	0.138
Mzuzu	0.09341	8.883	0.339
Karonga	0.07412	6.403	0.208
Rumphi	0.131	11.032	0.443
Chimbiya	0.0999	7.178	0.249
Lizulu	0.09433	6.969	0.238
Mchinji	0.112	6.743	0.226
Mitundu	0.08497	6.083	0.192
Salima	0.112	6.567	0.217
Bangula	0.147	14.722	0.587
Luchenza	0.07495	4.928	0.133
Lunzu	0.117	6.999	0.240
Ntaja	0.08402	5.234	0.148

The results in the table above are consistent with the graphical presentation of the price series in Figures 3, 4 and 5. All trend coefficients are positive showing that prices have been increasing over the study period. Trend explains as much as 15% or more of the variability in price series except for Chitipa and Luchenza whose R-square were less than 15%. The time trend had more influence on the price levels for Bangula and Rumphi with R-square of 58.7% and 44.3%, respectively.

4.4. Market Integration: Correlation Coefficients

The first step in testing for market integration is usually an informal graphical inspection of the time series such as one shown in Figures 3, 4 and 5 which though inconclusive is depicting a pattern of cointegration or prices moving in tandem albeit weakly so. With exception of Bangula between January 1994 and July 1997, all the other markets are showing maize prices moving in tandem. Thus the maize prices are moving in unison in the same direction in spatially separated markets overtime.

4.4.1. Correlation Coefficients of Price Levels

As stated earlier on in Chapters 2 and 3, bivariate correlation coefficients of maize price levels were calculated. Past studies by several authors (Golleti and Babu, 1994; Golleti *et al.*, 1995; Behura and Pradham, 1998) have also used bivariate correlation coefficients of price series between different markets to test for market integration. Again, as outlined in the methodology the data set was divided into two sub-sets representing the two major policy eras when there was maize price band and after the price band had completely been removed. Tables 3 and 4 present the bivariate correlation coefficients among the price series of markets understudy calculated using the real maize prices for the two data sets.

Table 3: Correlation coefficients for maize price levels with price band

	Chitipa	Mzuzu	Karonga	Rumphi	Chimbiya	Lizulu	Mchinji	Mitundu	Salima	Bangula	Luchenza	Lunzu	Ntaja
Chitipa	1.000												
Mzuzu	0.797	1.000											
Karonga	0.709	0.674	1.000										
Rumphi	0.859	0.824	0.738	1.000									
Chimbiya	0.615	0.641	0.548	0.610	1.000								
Lizulu	0.774	0.761	0.658	0.763	0.723	1.000							
Mchinji	0.554	0.595	0.555	0.701	0.674	0.697	1.000						
Mitundu	0.833	0.708	0.634	0.694	0.611	0.781	0.518	1.000					
Salima	0.812	0.753	0.713	0.840	0.620	0.808	0.681	0.746	1.000				
Bangula	0.309	0.372	0.364	0.393	0.416	0.482	0.719	0.455	0.425	1.000			
Luchenza	0.523	0.569	0.484	0.461	0.474	0.516	0.461	0.429	0.474	0.257	1.000		
Lunzu	0.766	0.748	0.736	0.730	0.709	0.823	0.700	0.776	0.744	0.614	0.592	1.000	
Ntaja	0.519	0.552	0.553	0.506	0.508	0.460	0.393	0.434	0.537	0.331	0.485	0.615	1.000

Table 4: Correlation coefficients for maize price levels without price band

	Chitipa	Mzuzu	Karonga	Rumphi	Chimbiya	Lizulu	Mchinji	Mitundu	Salima	Bangula	Luchenza	Lunzu	Ntaja
Chitipa	1.000												
Mzuzu	0.844	1.000											
Karonga	0.819	0.765	1.000										
Rumphi	0.878	0.913	0.726	1.000									
Chimbiya	0.614	0.521	0.516	0.556	1.000								
Lizulu	0.664	0.632	0.549	0.636	0.862	1.000							
Mchinji	0.621	0.495	0.446	0.537	0.895	0.803	1.000						
Mitundu	0.623	0.565	0.520	0.591	0.884	0.908	0.818	1.000					
Salima	0.761	0.581	0.652	0.653	0.814	0.836	0.816	0.807	1.000				
Bangula	0.544	0.565	0.630	0.488	0.549	0.655	0.414	0.625	0.526	1.000			
Luchenza	0.640	0.738	0.643	0.696	0.716	0.800	0.636	0.762	0.692	0.738	1.000		
Lunzu	0.729	0.640	0.645	0.671	0.863	0.770	0.891	0.784	0.791	0.607	0.768	1.000	
Ntaja	0.675	0.623	0.506	0.631	0.858	0.870	0.842	0.864	0.807	0.569	0.808	0.835	1.000

As indicated earlier in Chapter 3, the strength of the relationship between two markets is portrayed by the size of the correlation coefficient; the larger the coefficient the stronger the relationship. The coefficients ranged from 0.414 for the Bangula-Mchinji link to 0.913 for the Mzuzu-Rumphi link, when there was no price band and 0.257 to 0.859 for Bangula-Luchenza and Chitipa-Rumphi links respectively when there was the price band policy. Interesting results to note however are the correlation coefficients between Ntaja and the central region markets (Chimbiya, Lizulu, Mchinji, Mitundu, and Salima) and that between Chitipa-Mitundu and Chitipa-Salima links which are separated by long distances but have high correlation coefficients of greater than 0.8. It can be argued that this could be a result of spurious correlation resulting from non-stationarity (Gujarati, 1995) of price series that are embedded in the price levels as a result of time trends and seasonality (see Table 2 and Figure 5). It could also be that the markets are linked by a third market, presumably Lilongwe or Mzuzu.

But in general and as expected, markets within regions are portraying high correlation coefficients within the Northern Region having bivariate correlation coefficients ranging from 0.726 to 0.913 for Karonga-Rumphi and Mzuzu-Rumphi links respectively without the price band. The Central Region markets have correlation coefficients of greater than 0.8 while those from the Southern Region recorded correlation coefficients ranging from 0.569 to 0.835 in the period without price band policy. The same scenario is also true for the period with the price band policy. The magnitude of the average values of the coefficients show that Lunzu had the strongest link with other markets with average values of 0.713 and 0.749 with and without the price band policies respectively. It is

followed by Lizulu in both scenarios. This could be because these two markets are located along the major trading corridor that links the whole country. This may imply that these markets are the most integrated while Bangula with average correlation coefficients of 0.428 and 0.576 during and after scrapping off of the price band policy respectively had the weakest links implying the least integrated.

Although not conclusive, it is also interesting to note that all coefficients with or without price band policy are positive meaning that the prices in all markets move in the same direction i.e. as prices increase in one market; they also increase in the other markets although in varying degrees. This could be a rough indicator of competitiveness and information and trade flows between spatially separated markets. Although an earlier study by Ng'ong'ola *et. al.* (1997) found that there was almost no maize trade between markets the Southern Region and markets in the Northern Region, it is likely that price signals are transmitted between markets in these two regions through Central Region markets which was found to be trading with markets in the two regions. Therefore, no wonder that some correlation coefficients between markets in the Southern Region and Northern Region are high.

Taking into consideration the aforementioned limitations of price level correlation coefficients, they are not a proof of market integration but rather rough indicators of integration and efficiency. Criticisms of this approach were earlier advanced by Blyn (1973), Timmer (1974) and Harris (1979). Recently, criticisms of this methodology were advanced by Ravallion (1986) and Delgado (1986) where they argued that testing of

market integration based on correlation coefficients of prices mask presence of other synchronous factors such as general price inflation, seasonality, time trend and population growth, etc. It is therefore important to use other measures of market integration. The next section looks at bivariate correlation coefficients of first price differences as a better measure of market integration.

4.4.2. Correlation Coefficients of Price Differences

Differencing is meant to remove stochastic trend, non-stationarity and other problems associated with time series data. It is therefore imperative that correlation coefficients of price differences are considered a better measure of market integration as earlier stated in Chapter 2. Tables 5 and 6 present bivariate correlation coefficients of maize price differences for markets under study.

Table 5: Correlation coefficients for maize price differences with price band

	Chitipa	Mzuzu	Karonga	Rumphi	Chimbiya	Lizulu	Mchinji	Mitundu	Salima	Bangula	Luchenza	Lunzu	Ntaja
Chitipa	1.000												
Mzuzu	0.286**	1.000											
Karonga	0.059	0.241*	1.000										
Rumphi	0.395**	0.419**	0.263**	1.000									
Chimbiya	0.286**	0.288**	0.120	0.156	1.000								
Lizulu	0.307**	0.202*	0.046	0.313**	0.381**	1.000							
Mchinji	0.158	-0.017	0.272**	0.306**	0.208*	0.466**	1.000						
Mitundu	0.443**	0.268**	0.371**	0.153	0.367**	0.288**	0.132	1.000					
Salima	0.195*	0.118	0.262**	0.338**	0.228*	0.404**	0.492**	0.192*	1.000				
Bangula	0.173	0.045	0.247*	0.024	0.126	0.089	0.116	0.401**	0.136	1.000			
Luchenza	0.141	-0.051	-0.025	0.067	0.133	0.321**	0.204*	0.113	0.206*	0.218*	1.000		
Lunzu	0.483**	0.195*	0.196*	0.182*	0.256**	0.368**	0.217*	0.581**	0.228*	0.378**	0.092	1.000	
Ntaja	0.142	0.008	0.031	0.005	0.082	0.055	0.101	0.027	0.152	-0.029	-0.010	0.161	1.000

**Correlation is significant at the 0.01 level (1-tailed).

* Correlation is significant at the 0.05 level (1-tailed).

Table 6: Correlation coefficients for maize price differences without price band

	Chitipa	Mzuzu	Karonga	Rumphi	Chimbiya	Lizulu	Mchinji	Mitundu	Salima	Bangula	Luchenza	Lunzu	Ntaja
Chitipa	1.000												
Mzuzu	0.622**	1.000											
Karonga	0.696**	0.381**	1.000										
Rumphi	0.659**	0.678**	0.270*	1.000									
Chimbiya	0.301**	0.169	0.279*	0.191	1.000								
Lizulu	0.244*	0.241*	0.074	0.132	0.605**	1.000							
Mchinji	0.413**	0.230*	0.187	0.268*	0.522**	0.624**	1.000						
Mitundu	0.197	0.144	-0.029	0.180	0.649**	0.677**	0.559**	1.000					
Salima	0.448**	0.115	0.464**	0.111	0.550**	0.396**	0.568**	0.479**	1.000				
Bangula	0.289**	0.072	0.284**	0.067	0.546**	0.441**	0.421**	0.606**	0.443**	1.000			
Luchenza	0.341**	0.404**	0.221*	0.380**	0.469**	0.424**	0.332**	0.517**	0.290**	0.444**	1.000		
Lunzu	0.573**	0.390**	0.480**	0.546**	0.444**	0.301**	0.502**	0.416**	0.393**	0.562**	0.560**	1.000	
Ntaja	0.398**	0.460**	0.212*	0.449**	0.538**	0.490**	0.488**	0.626**	0.463**	0.412**	0.690**	0.562**	1.000

**Correlation is significant at the 0.01 level (1-tailed).

* Correlation is significant at the 0.05 level (1-tailed).

Correlation coefficients of first maize price differences like those of price levels are high. But as expected, they were generally smaller than those of price levels. They range from 0.005 for Rumphi-Ntaja link to 0.492 for Mchinji-Salima link when there was the price band and -0.029 to 0.696 for Karonga-Mitundu and Chitipa-Karonga links respectively. 36% and 19% of the correlation coefficients were statistically significant at 1% and 5% levels of confidence respectively when there was the price band. The number of significantly correlated markets increased to 73% at 1% levels of confidence and dropped to 10% at 5% levels of confidence when the price band was removed. Only 17% of the correlation coefficients were not significant at 5% confidence level when the price band policy was removed. Negative correlation coefficients are indicating certain degree of segmentation between markets. Market segmentation can be a result of high transfer costs, poor infrastructure and lack of information flows between spatially separated markets all of which affects arbitrage activities of traders.

CHAPTER 5

5.0. MARKET INTEGRATION: COINTEGRATION ANALYSIS

As stated in Chapter 3, the criterion that was used to determine whether markets are integrated or not was based on the Engle and Granger (1987) cointegration approach. The approach states that two markets A and B are integrated if there is cointegration in either direction. More simply this means that a regression of price series for market A on price series for market B and vice versa yield stationary error terms. On the other hand, if there is no cointegration in at least one direction, the two markets are not integrated.

In this cointegration analysis, the first step was to perform the unit root test and determining the order of economic integration for each price series using the ADF test. Tables 7 and 8 below present the unit root test statistics for each price series separated into period when there was the price band and period after the price band was scrapped off, respectively. The appropriate lag length was chosen using the Akaike Information Criterion (AIC) by trading off parsimony against the reduction in sum of squares following Rapsomanikis *et. al.* (2006). The ADF test statistics presented in these tables correspond to the regressions that maximized the AIC. The number of lagged terms was also chosen to ensure that the error process in the estimating equation is residually uncorrelated using the Durbin Watson statistics' proximity to 2 as suggested by Pindyck and Rubinfeld, (1987) and Gujarati, (1995).

Table 7: Stationarity test results using ADF test for unit roots for period with maize price band policy

Market	Level	ADF Test statistics						Order of integration
		Without trend			With trend			
		Coefficient	t-statistic	No. of lags	Coefficient	t-statistic	No. of lags	
Bangula	PL	-0.1129	-1.5938	6	-0.3973	-2.8993	6	NI
	1st Diff	-1.1426	-6.5898	1	-1.1302	-6.5489	1	I(1)
Chimbiya	PL	-0.1637	-2.2095	4	-0.1733	-2.0512	4	NI
	1st Diff	-0.9509	-6.7488	1	-0.9572	-6.7271	1	I(1)
Chitipa	PL	-0.1937	-2.4664	5	-0.1955	-2.3916	5	NI
	1st Diff	-0.9344	-5.4220	2	-0.9366	-5.3873	2	I(1)
Karonga	PL	-0.2722	-2.7956	2	-0.2922	-2.8389	2	NI
	1st Diff	-1.4683	-7.5817	1	-1.4712	-7.5397	1	I(1)
Lizulu	PL	-0.2367	-2.2172	6	-0.2466	-2.0123	6	NI
	1st Diff	-1.2868	-6.2835	2	-1.2962	-6.2704	2	I(1)
Luchenza	PL	-0.2334	-2.3787	5	-0.2263	-2.1695	5	NI
	1st Diff	-1.3791	-5.6081	3	-1.3991	-5.6341	3	I(1)
Lunzu	PL	-0.1389	-2.1841	5	-0.1576	-2.1127	5	NI
	1st Diff	-0.8263	-5.6683	1	-0.8305	-5.6543	1	I(1)
Mchinji	PL	-0.0924	-1.4563	5	-0.1036	-1.0820	5	NI
	1st Diff	-1.3091	-7.4935	1	-1.3224	-7.5100	1	I(1)
Mitundu	PL	-0.2483	-2.1613	7	-0.2577	-2.0557	7	NI
	1st Diff	-0.9403	-6.9887	1	-0.9412	-6.9508	1	I(1)
Mzuzu	PL	-0.1821	-2.1203	5	-0.1967	-2.0990	5	NI
	1st Diff	-1.3745	-5.1571	3	-1.3966	-5.1712	3	I(1)
Ntaja	PL	-0.2142	-1.9291	6	-0.2316	-1.8069	6	NI
	1st Diff	-1.5923	-6.0240	2	-1.6012	-6.0069	2	I(1)
Rumphi	PL	-0.1659	-2.0878	5	-0.1958	-2.1518	5	NI
	1st Diff	-1.2313	-4.8019	3	-1.2407	-4.7871	3	I(1)
Salima	PL	-0.2304	-2.1413	6	-0.2580	-2.1292	6	NI
	1st Diff	-1.4420	-5.1532	3	-1.4478	-5.1332	3	I(1)

The MacKinnon critical values for rejection of hypothesis of a unit root without trend are -3.5164 and -2.8991 for $P \leq 0.01$ and $P \leq 0.05$ respectively and -4.0803 and -3.4681 for $P \leq 0.01$ and $P \leq 0.05$ with trend.

PL=Price level

1st Diff=First difference

Table 8: Stationarity test results using ADF test for unit roots for period without maize price band policy

Market	Level	ADF Test statistics						Order of integration
		Without trend			With trend			
		Coefficient	t-statistic	No. of lags	Coefficient	t-statistic	No. of lags	
Bangula	PL	-0.3162	-3.0877	6	-0.5068	-3.6431	6	I(0)
Chimbiya	PL	-0.2019	-2.7878	5	-0.1980	-2.7156	5	NI
	1st Diff	-1.0120	-4.2716	3	-1.0564	-4.3751	3	I(1)
Chitipa	PL	-0.2109	-2.3540	6	-0.2562	-2.4996	6	NI
	1st Diff	-0.8892	-6.5344	1	-0.8925	-6.4934	1	I(1)
Karonga	PL	-0.2971	-2.5680	4	-0.4495	-3.0960	4	NI
	1st Diff	-1.4772	-6.2384	2	-1.4804	-6.1913	2	I(1)
Lizulu	PL	-0.2271	-2.7724	6	-0.2272	-2.5546	6	NI
	1st Diff	-0.7495	-6.3199	0	-0.7544	-6.3206	0	I(1)
Luchenza	PL	-0.1561	-3.0861	4	-0.1814	-3.1749	4	I(0)
Lunzu	PL	-0.1832	-2.7778	6	-0.1820	-2.5526	6	NI
	1st Diff	-0.8767	-4.6798	2	-0.9003	-4.7208	2	I(1)
Mchinji	PL	-0.1124	-2.2273	3	-0.1185	-2.3417	3	NI
	1st Diff	-0.8274	-6.0983	1	-0.8434	-6.1547	1	I(1)
Mitundu	PL	-0.2255	-2.7056	4	-0.2232	-2.6481	4	NI
	1st Diff	-1.1519	-6.1043	2	-1.1587	-6.0919	2	I(1)
Mzuzu	PL	-0.2050	-2.4143	6	-0.3505	-2.9767	6	NI
	1st Diff	-0.9735	-7.9338	0	-0.9780	-7.8972	0	I(1)
Ntaja	PL	-0.1927	-2.6266	6	-0.1897	-2.5350	6	NI
	1st Diff	-0.8205	-4.9959	2	-0.8346	-5.0178	2	I(1)
Rumphi	PL	-0.2108	-2.7512	5	-0.3033	-3.0699	5	NI
	1st Diff	-1.0560	-4.4037	3	-1.0766	-4.4253	3	I(1)
Salima	PL	-0.2646	-2.7931	5	-0.2681	-2.7222	5	NI
	1st Diff	-1.0148	-5.0962	2	-1.0217	-5.0754	2	I(1)

The MacKinnon critical values for rejection of hypothesis of a unit root without trend are -3.5267 and -2.9035 for $P \leq 0.01$ and $P \leq 0.05$ respectively and 4.0948 and 4.4749 for $P \leq 0.01$ and $P \leq 0.05$ with trend.

PL=Price level

1st Diff=First difference

The results for both periods as depicted in Tables 7 and 8 show that the calculated t-statistics are less than the MacKinnon critical value at 1% and 5% levels of significance at price levels with or without the inclusion of the time trend variable. We therefore conclude that there is insufficient evidence to reject the null hypothesis of non-stationarity for all the price series except Bangula and Luchenza in the period after the price band was removed, both of which showed stationarity at price levels. They were $I(0)$ or just integrated. As expected, when the ADF test was applied to the differenced price series, the calculated t-statistics were larger than the MacKinnon critical values at 5% and 1% levels of significance in absolute value terms. Thus all series attained stationarity after first differencing and are said to be integrated of order one or just $I(1)$. This agrees with Pindyck and Rubinfeld (1981) who reported that most time series become stationary when they are differenced once or more times. This could be an indication that the markets are cointegrated. Although the earlier analysis showed that there was considerable time trend influence in each price series, this trend seemed not to have influence on the stationarity of the data. Since the price series are all $I(1)$ but Luchenza and Bangula (without price band), we proceed by testing the null hypothesis of non-cointegration following Engle and Granger (1987) procedure.

5.1. Cointegration Test Results

Tables 9 and 10 present ADF results for error terms from OLS regression of pairs of price series of the same order of integration by region.

Table 9: Cointegration coefficients for maize prices with price band by region

Market <i>i</i>	Market <i>j</i>	coefficient β_{ij}	t-statistic β_{ij}	coefficient β_{ji}	t-statistic β_{ji}
Northern region					
Chitipa	Karonga	-0.4112	-3.4193	-0.5735	-3.6938
	Mzuzu	-0.6710	-4.9176	-0.6244	-4.4030
	Rumphi	-0.5740	-4.4428	-0.5063	-3.3196
Karonga	Mzuzu	-0.6391	-4.8743	-0.5264	-4.6594
	Rumphi	-0.5560	-4.0874	-0.3524	-2.8162
Mzuzu	Rumphi	-0.5658	-4.6666	-0.5123	-4.2893
Central Region					
Chimbiya	Lizulu	-0.3742	-4.3849	-0.4253	-4.6841
	Mchinji	-0.4055	-4.0930	-0.2449	-2.7135
	Mitundu	-0.2937	-3.4032	-0.3893	-4.1441
	Salima	-0.3990	-3.9306	-0.4004	-3.8901
Lizulu	Mchinji	-0.3417	-4.0866	-0.1897	-2.4456
	Mitundu	-0.7012	-5.5074	-0.8638	-5.7545
	Salima	-0.7497	-5.8163	-0.5905	-3.4256
Mchinji	Mitundu	-0.1654	-2.1177	-0.3741	-4.3800
	Salima	-0.1803	-2.2454	-0.3667	-4.2699
Mitundu	Salima	-0.7665	-6.0670	-0.6977	-6.5932
Southern region					
Bangula	Luchenza	-0.1263	-2.0725	-0.2429	-2.8909
	Lunzu	-0.1716	-2.1862	-0.1643	-2.6531
	Ntaja	-0.1723	-2.4092	-0.2526	-2.3821
Luchenza	Lunzu	-0.4497	-4.4388	-0.3236	-3.5454
	Ntaja	-0.3984	-3.3162	0.3405	-2.8922
Lunzu	Ntaja	-0.2816	-3.2313	-0.4718	-3.3639

The MacKinnon critical values for rejection of hypothesis of a unit root are -3.5132, -2.8976, and -2.5858 for $P \leq 0.01$, $P \leq 0.05$ and $P \leq 0.1$ respectively. An integrated link between markets *i* and market *j* is one for which either of the t-statistic for coefficients β_{ij} or β_{ji} is above the MacKinnon critical values.

Table 10: Cointegration coefficients for maize prices without price band policy by region

Market i	Market j	coefficient β_{ij}	t-statistic β_{ij}	coefficient β_{ji}	t-statistic β_{ji}
Northern region					
Chitipa	Karonga	-0.4101	-3.8577	-0.4636	-3.7631
	Mzuzu	-0.4280	-2.9269	-0.3519	-2.6050
	Rumphi	-0.5400	-3.7373	-0.3256	-2.2207
Karonga	Mzuzu	-0.9113	-5.2593	-0.7028	-3.8614
	Rumphi	-0.7702	-3.7711	-0.6995	-4.6572
Mzuzu	Rumphi	0.6941	-4.3637	-0.6287	-4.4268
Central Region					
Chimbiya	Lizulu	-0.4774	-4.1331	-0.4523	-4.0231
	Mchinji	-0.5832	-3.4272	-0.4231	-2.8080
	Mitundu	-0.5453	-4.2923	-0.5427	-3.1092
	Salima	-0.4269	-3.3059	-0.5522	-4.1395
Lizulu	Mchinji	-0.2647	-3.0289	-0.1678	-2.0429
	Mitundu	-0.5466	-4.1540	-0.6151	-4.4970
	Salima	-0.5389	-4.0317	-0.6053	-4.3358
Mchinji	Mitundu	-0.2024	-1.8153	-0.4257	-3.3795
	Salima	-0.2045	-1.9830	-0.4023	-3.5574
Mitundu	Salima	-0.5139	-4.2223	-0.5440	-3.8828
Southern region					
Lunzu	Ntaja	-0.3700	-3.4359	-0.5934	-4.8622
†Bangula	Luchenza	-0.5161	-4.1795	-0.2750	-2.5532

The MacKinnon critical values for rejection of hypothesis of a unit root are -3.5328, -2.9062, and -2.5902 for $P \leq 0.01$, $P \leq 0.05$ and $P \leq 0.1$ respectively. An integrated link between markets i and market j is one for which either of the t-statistic for coefficients β_{ij} or β_{ji} is above the MacKinnon critical values.

† Bangula and Luchenza are $I(0)$. See Table 8.

Results from Tables 9 and 10 indicate that all links but Bangula-Ntaja link in the period with price band are cointegrated in at least one direction. The Northern Region markets are more cointegrated in both directions i.e. cointegration coefficients for residuals are significant when price series for maize market i is regressed on price series for maize

market j and vice versa except the link between Rumphu-Chitipa in the period without price band which is not significant (Table 10). The same is true for the Central Region where in both periods the cointegration coefficients are significant in at least one direction. It is interesting to note that in both periods Mchinji-Mitundu and Mchinji-Salima and Mchinji-Lizulu links cointegration coefficients are not significant despite that Mchinji is well connected with a good road. This is an indication that these markets are not well integrated with Mchinji. But, Mchinji may be integrated with the other markets (in at least one direction) through Lilongwe as argued by Rashid (2004) that two markets, say A and B can be integrated and their prices co-move in the long-run if they both supply to a major urban market, say C although there is no direct trade flow between A and B due to factors such as geographical locations and distance between these markets.

Combined with our knowledge of maize trade patterns, these results support for spatial integration in the maize markets within regions in Malawi. The same can be said of the Southern Region markets: Bangula, Luchenza and Ntaja which are showing a great deal of cointegration in either direction. These markets although connected by good roads, are far apart but they may be cointegrated probably through Blantyre and Zomba, which happen to be major urban areas and major maize consumption areas. Because of its proximity to Blantyre, it was expected that Lunzu market would be integrated with the rest of the markets. The results support this expectation. The same scenario was expected in the Central Region where, because of its closeness to Lilongwe City, Mitundu market was expected to be well integrated with the rest of the markets in Central Region, which is the case here. Because Chimbiya and Lizulu lie along the major road that connects

Blantyre and Lilongwe, which also happens to be a major trading route for many agricultural produce, these markets were expected to be integrated with the rest of the markets as the results have revealed.

However, when we compare the period when there was price band and when there was no price band policies, there seem not to be greater differences in terms of number of integrated markets. This could be a result of controlled liberalisation because of continued intervention of government through ADMARC in the maize. Because of its social role, ADMARC continues to play a significant role in dictating the movement of prices especially in rural markets where private sector participation is relatively lower than in the urban markets.

A significant implication of the cointegration approach is that, while individual price series may wander extensively, certain pairs should not diverge from one another in the long run. Another, implication of cointegration and representation is that cointegration between two variables implies the existence of causality (in the Granger sense as outlined in Chapter 3) between them in at least one direction (Gujarati, 1995). The definition of causality and its relevance in the context of market integration and price transmission warrants some discussion. Cointegration itself cannot be used to make inferences about the direction of causation between the variables and the causality tests are necessary. The next section presents the results of Granger causality tests between pairs of cointegrated maize markets.

5.2. Causality Test Results

As earlier stated, to determine whether there are any causal relationships in prices among cointegrated markets, Granger causality test was carried out following regression equations 6 and 7 in Chapter 3. Again, like the ADF tests, of importance in the causality test is the specification of lag length in the equation. Gujarati (1995) concedes that Granger causality test is very sensitive to the number of lags used in the analysis. He suggests that to have confidence in the results of the test, we should use more rather than fewer lags. The Akaike Information Criterion (AIC) was also used to determine the appropriate lag length to be included in the regression equations. Following Gujarati (1995), prices in market i are said to Granger cause prices in market j following F-distribution as earlier stated in Chapter 3.

It is important to note that although cointegration between two price series implies Granger causality in at least one direction, the opposite is not necessarily true as stated by Abdulai (2006). In this case, as noted in the earlier discussion about cointegration, lack of cointegration between the two trending price series may indicate that market integration is absent, as other factors such as transaction costs determine the movements of one of the price series. However Granger causality may exist, indicating that, although the two price series drift apart due to other factors such as non-stationary transaction costs, some price signals are passing through from one market to another. On the other hand, lack of Granger causality may not imply an absence of transmission, as price signals may be transmitted instantaneously under special circumstances, which are expected for a staple food commodity like maize as reported by Abdulai, (2006).

Table 11 presents results of the Granger causality tests. The direction of the arrow indicates direction of causality. Causality is bi-directional where arrows face both directions.

Table 11: Summary of pairwise Granger causality test results between maize markets by region

Market i	Market j	F_{ij} -statistic	P_{ij} -value	F_{ji} -statistic	P_{ji} -value	Direction of causation
Northern Region						
Chitipa	Karonga	8.99416	0.00000	2.96575	0.03436	→←
	Mzuzu	5.77654	0.00095	5.57645	0.00123	→←
	Rumphi	12.8256	0.00000	2.60267	0.05459	→←
Karonga	Mzuzu	4.80766	0.00326	4.00354	0.00910	→←
	Rumphi	5.54001	0.00129	5.09759	0.00226	→←
Mzuzu	Rumphi	2.99839	0.03295	4.40757	0.00543	→←
Central Region						
Chimbiya	Lizulu	2.84542	0.02634	6.54138	0.00001	→←
	Mchinji	7.13781	0.00000	3.62339	0.00766	→←
	Mitundu	3.66567	0.00716	9.23345	0.00000	→←
	Salima	7.99593	0.00000	0.60895	0.65685	→
Lizulu	Mchinji	2.83365	0.02683	1.65504	0.16389	→
	Mitundu	9.42071	0.00000	5.20003	0.00062	→←
	Salima	14.1609	0.00000	0.52621	0.71663	→
Mchinji	Mitundu	3.02715	0.01977	12.8226	0.00000	→←
	Salima	5.32249	0.00051	0.78127	0.53915	→
Mitundu	Salima	13.9635	0.00000	2.11870	0.08163	→←
Southern region						
Bangula	Luchenza	2.33229	0.05876	1.00450	0.40742	→
	Lunzu	9.6532	0.00000	0.81283	0.51898	→
	Ntaja	3.65183	0.00732	1.29839	0.27365	→
Luchenza	Lunzu	2.99074	0.02094	3.79330	0.00584	→←
	Ntaja	4.67853	0.00142	1.14214	0.33930	→
Lunzu	Ntaja	4.35197	0.00239	1.56725	0.18637	→

F_{ij} -statistic is F -statistic associated with the null hypothesis that maize prices in market i do not Granger cause maize prices in market j and P_{ij} is the probability associated with F_{ij} .

Results from Table 11 are consistent with earlier results from other measures of market integration. They show that there is no distinct central market in the Central and Northern regions. There are more of bi-directional causal relationships among markets in the

Central and Northern regions. Except for Chimbiya-Salima, Lizulu-Mchinji, Lizulu-Salima and Mchinji-Salima links, all the markets in the two regions are showing a bi-directional causal relationship. This entails that there is free flow of price information between maize markets in the two regions. It is not surprising though that no single market was singled out as a central market in terms of price information signals in the central region because of data limitations particularly because Lilongwe (which was expected to be the central market for the Central Region) was missed out in the analysis.

The causal relationships are a bit different from the Southern Region where all market links are indicating a unidirectional causation except for Lunzu-Luchenza link, which is showing bidirectional causation. However, Bangula looks to be central to all the other markets in the region. Considering that Bangula is distant from Blantyre and generally smaller market compared to Lunzu, this is a unique finding. This result sharply contrasts earlier studies by Golleti and Babu (1994) and Rosegrant and Mendoza (1994) both of which found central markets in major urban centers. This could be due to the fact that the Lower Shire area where Bangula is located is one of the frequently hit by floods and droughts hence experience maize shortages and prices rise faster than the other areas or it could just be a statistical artifact.

In all the regions with the unique exception of Bangula in the South, there is generally no unique central maize market as indicated by the directions of causality in the maize prices. Generally, it can also be argued that since ADMARC continues to operate across the country using the pan-territorial and sometimes pan-seasonal pricing policies,

(although to a smaller scale), it still plays a role in guiding the prices nationwide. This could also work to the elimination of maize central markets. As earlier indicated, due to lack of plausible data, Lilongwe, Blantyre and Zomba Markets were dropped from the analysis. In the absence of these markets, results show that there are no central markets for maize.

CHAPTER 6

6.0. CONCLUSIONS AND RECOMMENDATIONS

The study attempted to determine the extent of market integration as a measure of maize market efficiency in Malawi. In this study, 13 spatially distinct maize markets across Malawi were examined. Maize was modeled because of its significance to Malawi's food security. Time series maize price data spanning from January, 1994 to September, 2006 was used for analysis. It was hypothesised that maize markets in Malawi are not well integrated. The study looked at two periods with different maize price policy regimes.

The objectives of the study were to examine the extent of maize market integration in Malawi. The study examined the trend and seasonal variation, the long run relationships of maize price among spatially distinct markets and causal relationships between pairs of markets.

Decomposition of the price series revealed the existence of seasonality in the fluctuation of the maize prices. The results show that maize prices are lowest between May and July gradually rising thereafter, reaching the peak between December and March. This information, if relayed to the maize market participants can assist them in timing their maize sales and assist households properly manage their food production. The price series showed increasing trend overtime. This trend is likely to continue to rise as a result of external influence like the increased maize demand within the Southern Africa region especially Zimbabwe and the general increase in world food prices as more maize is now also being used in bio-fuels production in developed countries.

Results from the empirical analysis of the maize markets in Malawi using the simpler measures of market integration i.e bivariate correlation coefficients of maize prices and maize price first differences and the more sophisticated market integration measures using the cointegration technique indicate that within the three regions of Malawi, maize markets are integrated implying efficiency in price information transmission.

Cointegration results were consistent with correlation results with all markets within regions being integrated in at least one direction. In the period with price band policy all market links within the regions except Bangula-Ntaja were cointegrated at least in one direction. The Northern region markets showed greater integration in both directions than both the central and southern region markets. As expected, Mitundu and Lunzu were the most integrated with other markets in the central and southern regions owing to their closeness to Lilongwe City and Blantyre City, respectively. The causality test revealed that there was more of bidirectional causality implying free flow of price information between markets in the northern and central regions. In the Southern Region though there was more of unidirectional causation with unique result of Bangula causing Lunzu and Luchenza. These results show that maize markets are efficient.

The study further concludes that agricultural price policies may facilitate market integration thus improving market efficiency depending on the nature of the policy instrument employed and probably on the type of crop/commodity on which it is employed. However, there seemed to be no differences in terms of the number and extent of maize market integration between the periods with and without price band policies.

6.3. Recommendations

Based on the results from this study the following recommendations have been drawn:

- ✓ The study has demonstrated that spatially separated maize markets in Malawi are integrated, except in the Southern Region where price information flows were mostly unidirectional. Market information dissemination should seriously consider this limitation that other markets cannot transmit price information to others. It is recommended that government and NGOs should strengthen the current market information services especially in the Southern Region by expanding the market coverage of the MIS.
- ✓ Since the current MIS concentrates only on collection and dissemination of price information, an effort to collect and disseminate additional marketing decision information on crop production prospects, temporal and spatial maize flows, food import and export intentions, stock level, formal world market prices of different crops, and informal cross boarder trade with neighbouring countries all of which influence maize prices etc. to assist and guide agricultural market participants in proper marketing decisions. This study failed to analyze how all these elements impacted on maize prices in Malawi. The MIS should also consider collecting transportation costs between major markets which have great implications on pricing of agricultural commodities.

- ✓ Since maize prices have shown greater seasonal variation over the year in response to different supply levels, it is recommended that the rural masses be sensitized on management of their maize production. This can be done by intensifying agricultural diversification or initiating other income generating activities so that they do not sell all their maize at harvest. At national level, government should put measures for proper management of national surpluses to counteract the seasonal maize price variations. Again, the somewhat rising trend of the maize prices over the years can also act as an incentive for producers to increase their maize production.
- ✓ Market information systems should also consider collecting consistent data in major markets e.g. big cities like Lilongwe and Blantyre in both producing and consumption areas markets all of which are important in terms of price formation and hence market integration and efficiency.
- ✓ Since the current study focused only on retail maize prices, similar research should be conducted on the different components of the maize (and other agricultural commodities) marketing system- farmers, assemblers, transporters, warehousing, and other structural determinants of market integration etc., in order to expand our understanding of the entire maize (and other agricultural commodities) marketing system.

- ✓ One of the major limitations of the cointegration approach is its failure to incorporate transfer costs in the analysis, which have been found to greatly affect arbitrage activities of traders and market integration. Future research in the area of market integration should therefore employ approaches such as threshold cointegration or parity bound models (PBM) that take into consideration the specific conditions such as distances between markets, road infrastructure both of which have implications on transaction costs and arbitrage activities of market participants.

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