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ANALYSIS OF EFFECTIVENESS OF MODERN INFORMATION AND COMMUNICATION TECHNOLOGIES ON MAIZE MARKETING EFFICIENCY IN LILONGWE AND DEDZA DISTRICTS AND SELECTED MARKETS OF MALAWI

MSc. (AGRICULTURAL AND APPLIED ECONOMICS) THESIS

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JULY, 2011

ANALYSIS OF EFFECTIVENESS OF MODERN INFORMATION AND COMMUNICATION TECHNOLOGIES ON MAIZE MARKETING EFFICIENCY IN LILONGWE AND DEDZA DISTRICTS AND SELECTED MARKETS OF MALAWI

BY

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BSc. (Agric. Economic.) Malawi

A THESIS SUBMITTED TO THE FACULTY OF DEVELOPMENT STUDIES IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR WARD OF THE DEGREE OF MASTER OF SCIENCE IN AGRICULTURAL AND APPLIED ECONOMICS

UNIVERSITY OF MALAWI

BUNDA COLLEGE OF AGRICULTURE

JULY, 2011

DECLARATION

I hereby declare that the work done in this thesis is the result of my own work and effort. This thesis has never been submitted for any award and where other sources of information were used, they have been acknowledged appropriately.

NAME: SARAH EPHRIDAH TIONE

SIGNATURE: ______________________________

DATE: __________________________ (Day\ Month\ Year)

CERTIFICATE OF APPROVAL

We, the undersigned, certify that this thesis is a product of the student own work and effort and where other sources of information have been used, they were duly acknowledged. The thesis is acceptable in form and content and it has not been submitted for any award. Satisfactory knowledge of the field covered by the thesis was demonstrated by the candidate through oral presentation held on 13th June, 2011.

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DATE: __________________ (Day\Month\Year)

DEDICATION

This work goes out to my dear loving parents, Mr. and Mrs. Tione. Thank you for your moral, spiritual, financial and physical support. I also dedicate this work to my sisters, Grace and Winnie. Thanks for your support because I have seen the power of three in us.

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ABSTRACT

The Government of Malawi has been promoting initiatives like Malawi Agriculture Commodity Exchange (MACE) that aim at reducing information asymmetry among market players especially smallholder farmers. Using co-integration error correction models, the study assessed effectiveness of modern ICT based market interventions on improving maize marketing efficiency in Malawi. Considering that efficient markets are integrated markets when price difference is only a factor of transaction costs, TAR models assessed price transmission speed in pre – ICT and post – ICT periods. Using logit model, the study further identified socioeconomic factors influencing use of modern ICTs among smallholder farmers.

Of the sampled households, only 18 percent used modern ICTs because of high initial capital cost, illiteracy and lack of awareness on the modern ICTs. Based on the logit model results, the significant socioeconomic factors that highly influenced use of modern ICTs were physical asset wealth and gender of the household head. The spatial integration results show that markets in Malawi were integrating. The results of TAR models in pre – ICT and post – ICT periods show that ICT based market interventions have positively influenced market integration and price transmission. Thus, modern ICTs have contributed to the reduction of search transaction costs leading to improved marketing efficiency. Based on the results, the study recommends the need to increase awareness on ICT based market interventions to all gender groups and to improve market infrastructure in the country.

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LIST OF ACRONYMS

ACE	Agriculture Commodity Exchange
ADMARC	Agriculture Development and Marketing Corporation
ADF	Augmented Dickey Fuller
AIC	Akaike Information Criterion
ANOVA	Analysis of Variance
EPA	Extension Planning Area
AR	Autoregressive
ASWAp	Agricultural Sector Wide Approach
FAO	Food and Agriculture Organization
ICT	Information and communications technology
ICRISAT	International Crops Research Institute for Semi-Arid Tropics
IDEAA	Initiative for Development and Equity in African Agriculture
IFAD	International Fund for Agricultural Development
GoM	Government of Malawi
KACE	Kenya Agriculture Commodity Exchange
MACE	Malawi Agriculture Commodity Exchange
MGDS	Malawi Growth Development Strategy
MIS	Marketing Information System/Services
MIP	Market Information Points
MK	Malawi Kwacha

MoAFS	Ministry of Agriculture and Food Security
NASFAM	National Association of Smallholder Farmers in Malawi
NFRA	National Food Reserve Agency
OLS	Ordinary Least Square
SGR	Strategic Grain Reserves
SMS	Short Messaging Service
SPSS	Statistical Package for Social Scientist
TAR	Threshold Autoregressive
WFP	World Food Program

CHAPTER ONE

INTRODUCTION

1.1 General Information on Malawi

Malawi is a landlocked nation that shares its borders with Mozambique, the United Republic of Tanzania and Zambia (Figure 1). The country covers 118,484 square kilometers of which 24,000 square kilometers are accounted for by fresh water bodies including Lake Malawi and the Shire River in the Southern Region. Forests and woodlands occupy 40 percent of the total land area and consist chiefly of savannah-type grasses and shrubs on the infertile plateaus; and bamboo, acacia and yellowwood trees on the highlands (Government of Malawi (GoM) and World Food Programme (WFP), 2010). Malawi has an equatorial monsoonal climate with three seasons: a cool, dry season from May to August; a warm, dry season from September to November; and a rainy season from December to April. Annual rainfall ranges from 800 mm in the lowlands to 1,300 mm on the plateaus and 2,300 mm in the northern highlands (GoM and WFP, 2010).

The country is sub divided into three regions and 28 districts. There are 6 districts in the North, 9 districts in the Central and 13 districts in the Southern Region (Figure 1). All the three regions are characterized by plateaus, mountains, valleys, rivers and lakes. The National Statistical Office – NSO (2009) estimated that Malawi has a population of 13.1

million people out of which 49 percent are males and 51 percent are females. NSO (2009) further estimated that the country has a growth rate of 2.8 percent per annum.

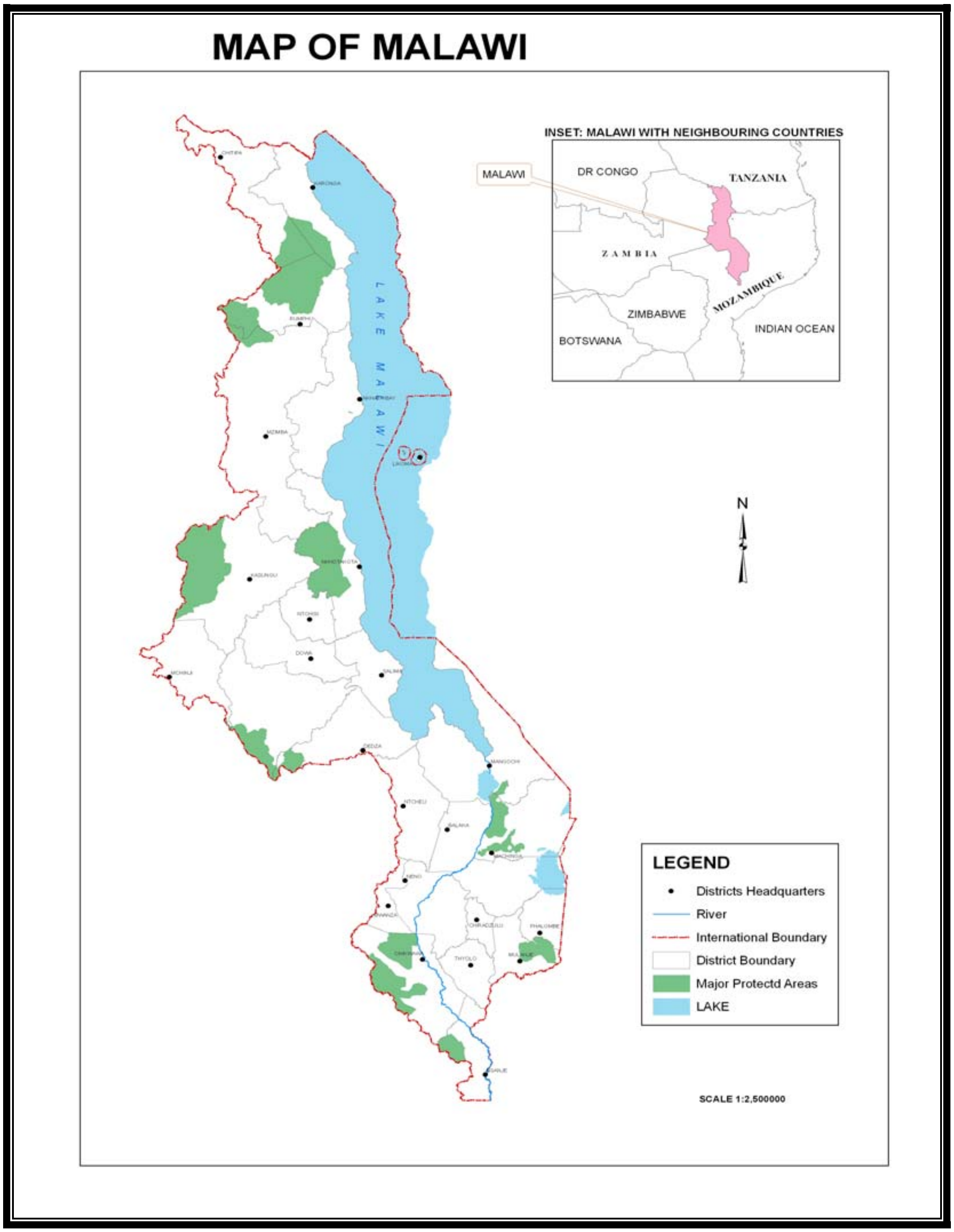

Figure 1: Map of Malawi showing the districts and Malawi on the African map

Among the regions, NSO (2009) estimated that the Southern Region has the highest population of 45 percent compared to 42 and 13 percent in the Central and Northern Regions, respectively. Based on the available land in the country, the population density was 139 people per square kilometer in 2008. The Southern Region has the highest density of 185 people per square kilometer followed by 154 and 63 people per square kilometer in the Central and Northern Regions, respectively (NSO, 2009).

1.2 Economy

Malawi is an agro-based economy where agriculture contributes at least 36 percent to the Gross Domestic Product (GDP) and provides 80 percent of employment. Services contribute about 46 percent and the industry sector accounts for 20 percent of the GDP. In the rural economy, agricultural sales account for over 63 percent of rural income (GOM, 2007). The main cash crops grown in the country are tobacco, sugarcane, tea, cotton and coffee. The food crops include maize, rice, sorghum, millet, potatoes, groundnuts and beans. As an agro-based economy, tobacco is the main cash crop that contributes 65 percent of export earnings followed by tea at 8 percent and sugar at 6 percent. Maize is the main staple food that is cultivated on almost 80 percent of the arable land (GOM, 2007).

The Ministry of Agriculture and Food Security (MoAFS) through its departments and district offices is responsible for the implementation of all agricultural related activities. Based on similar agro-ecological zones, the district offices are coordinated by eight Agricultural Development Divisions in the Country. The Ministry also collaborates with parastatals, the private sector and civil society in implementing its activities. Thus, the Agricultural Development and Marketing Corporation (ADMARC) and the National Food Reserve Agency (NFRA) are parastatals responsible for marketing and stocking of maize and other agricultural products in a liberalized economy, respectively. Despite problems of accessibility, input and output markets are established in all the districts in the country.

1.2.1 Agricultural sub - sectors

The agricultural sector is dual in nature, comprising estate and smallholder sub-sectors. The total cultivated land is estimated between 2.2 and 2.5 million hectares of which almost 90 percent is under small farms. The estate sub-sector comprises a much smaller number of large-scale farmers, producing almost entirely for the export market. The major crops grown under estate farming include tobacco, tea, sugar and coffee on leasehold or freehold land, (Food and Agricultural Organisation – FAO, 2003). The estate sub-sector contributes almost 30 percent to the agricultural GDP (GoM, 2007).

The smallholder sub-sector comprises a very large number of small-scale farmers growing mainly food crops for their own consumption and few cash crops such as coffee, tobacco, macadamia and cotton for the market. The smallholder sub-sector is based on customary land and about 84 percent of the national product comes from the smallholder sub-sector. The subsector contributes almost 70 per cent to agricultural GDP (GOM, 2007). This implies that smallholder farmers play an active role in the economic growth and poverty reduction efforts of Malawi. The major food crops grown by smallholders include maize, rice, sorghum, pulses and root crops.

Although the smallholder agricultural sub-sector plays a critical role in the economy, most smallholder farmers engage in subsistence and semi-subsistence agriculture characterized by low productivity, low marketable surplus and returns and low investments, a situation described as low equilibrium poverty trap (Barrett and Swallow, 2006; Barrett, 2008).Since there are few large scale estate farms and very large number of small – scale farms, the average land holding size is small among smallholder farmers. Almost 2.5 to 3 million smallholder farmers cultivate about 2.4 million hectares, with an average land holding size of 0.5 hectares per farmer (Babu and Sanyal, 2007). As a result of the small land holding size and use of low yielding varieties, about one-third of the population is perpetually unable to produce enough food to feed their families for a year. These smallholder farmers must seek other sources of income or depend on sales of other agricultural products to purchase food or maize (Babu and Sanyal, 2007).

In line with output markets, timely access to good quality inputs can help improve yield on the small land size among the smallholder farmers in Malawi. Barrett and Swallow (2006) noted that the analysis of poverty traps lies in understanding the nature of transitions or the absence of transitions which is vital in smallholder farmers' poverty transition. Efficient input markets can promote surplus production for markets resulting in farmers transiting from subsistence to commercial status. Therefore, efficient agricultural markets are critical to smallholder farmers and the rural poor in Malawi.

1.2.2 Malawi agricultural policy

As an agro-based economy, Malawi's policies are aligned to moving the country from a predominantly importing and consuming economy to a producing and exporting economy. The government's overarching medium term strategy (2006/07 to 2010/2011) to attain the Nation's Vision 2020 is the Malawi Growth Development Strategy (MGDS). The MGDS aims at creating wealth through sustainable economic growth and infrastructure development as a means of achieving poverty reduction through production and exports (GoM, 2005).

As a key sector in achieving the medium term development strategy, agricultural policy promotes agricultural productivity and sustainable management of land resources. This is to achieve national food sovereignty, increase incomes and ensure sustainable socio-economic growth. Prior to 2004, the country faced cycles of food insecurity as a result of policy changes, environmental and technological factors such as of local seeds and not improved hybrid seeds. With the implementation of universal input subsidy policy coupled with good weather conditions and technological factors, the country has been producing surplus maize and other food crops to attain food security. Although production has increased, marketing efficiency has lagged behind to promote commercial farming among smallholder farmers in the country (GoM, 2010a).

To enhance growth in the agricultural sector, the Agricultural Sector Wide Approach (ASWAp), a key priority investment plan, focuses on food security and risk management; commercial agriculture, agro-processing and market development and sustainable agricultural land and water management. The framework supports the development and dissemination of technologies and strengthening the institutional capacity of the agricultural sector. This aims at attaining the vision of a food secure nation with sustainable economic growth and development. On commercial agriculture, the framework focuses on promoting market oriented production among smallholder farmers (GoM, 2010b).

1.3 Maize Marketing

Historically, maize production in Malawi has been held as synonymous with food security since it is the dominant food staple (70 percent of the average Malawian diet consists of white maize) that plays a crucial role in food security and food markets (FAO, 2006). Although the majority of citizens grow and consume white maize almost exclusively, most rural Malawian households especially smallholder farmers are net purchasers of maize (Sahley *et. al*., 2005) which leaves them vulnerable to price fluctuations. Since most of these farmers are engaged in semi-subsistence agriculture, enhancing returns from agricultural production through improved access to markets can be vital in alleviating their poverty. In the short to long run, improved access to markets (either through market information or infrastructure development) can result in production of marketable surplus, higher revenues and savings in agriculture especially among the smallholder farmers (Barrett, 2008).

In Malawi, maize is traded throughout the country with three parallel marketing channels. These are ADMARC, Private traders and National Food Reserve Agency (NFRA). Figure 2 show the general maize trading flows in Malawi.

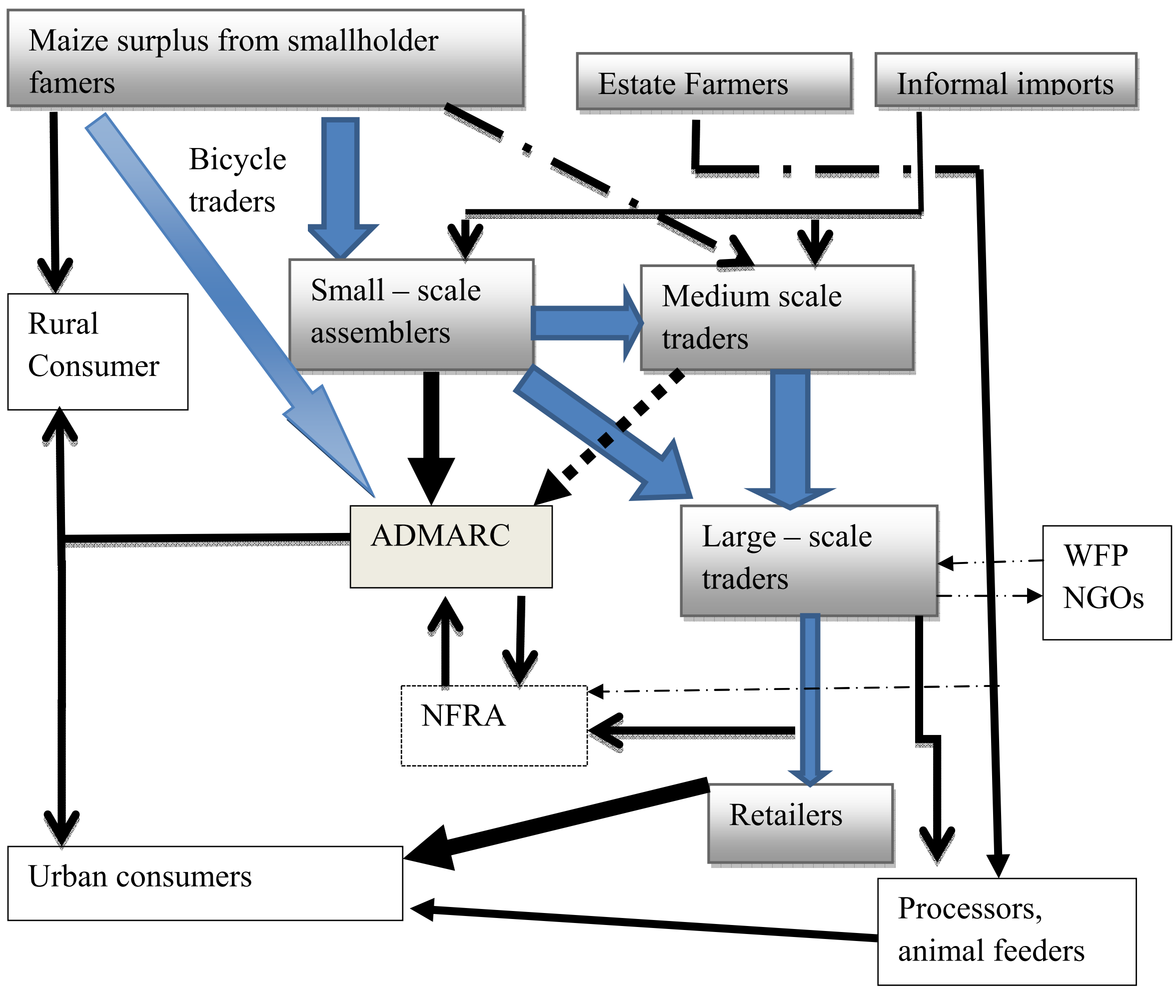

Figure 2: General maize flow in Malawi[1]

Note: The shaded boxes signify the main marketing channels in terms of volume. The thickness of the arrows signifies volume of maize flow.

[1] Source: Jayne *et. al.* (2008)

ADMARC is the main maize trading channel with close to 350 depots spreading throughout the country. ADMARC buys maize from farmers and traders, engages in storage and transport of maize to deficit areas or the resell of the maize to traders, miller and consumers. Through this channel, maize prices are set in consultation with the government as one way of ensuring food security in the country. Before liberalization, ADMARC was the sole buyer and seller of agricultural produce and inputs among the smallholder farmers. After market liberalization in 1987, ADMARC now operates in a competitive market with the private sector in maize pricing and trading volumes.

The second marketing channel is the private sector maize market. The private sector buys and sells maize at market determined prices based on regional supply and demand. This channel consists of small-scale assemblers, medium scale traders, large scale traders, processors or in general, commodity traders (Jayne *et. al*., 2008). The small-scale assemblers go to the villages to purchase grain after harvest. Such traders either construct makeshift shades or hang their scales on a pair of poles to purchase maize from farmers. In certain situations, such traders move from farmer to farmer in search of grain. Each small-scale trader is able to buy between 5-15MT from the farmers as they are constrained by their access to working capital, size of trucks for transportation and road quality. These traders rarely store maize but they sell off to medium and large scale traders (Jayne *et. al.,* 2008).

The Medium-scale traders usually trade 500-2000 MT of maize per year and are often found in major trading centres such as Chimbiya, Lunzu, Mitundu and Mchinji. Usually they are linked to small assemblers in the producing areas who act as their agents to buy maize from farmers. These traders buy maize from farmers and small scale traders until they have enough to fill a reasonably large truck or a mobile trader comes and offers an attractive price. The medium-scale traders sell to large traders and ADMARC. Since medium-scale traders communicate regularly with the larger traders they know the prevailing maize prices at national level. These traders are quite flexible in the geographic scope of their purchasing areas, often moving maize across districts from surplus to deficit areas. They also have good access to transport and storage facilities (Jayne *et. al*., 2008).

The large private traders get their maize from a variety of sources. In certain cases, the maize comes from medium scale traders and neighboring countries particularly Mozambique and Zambia. Sometimes the larger traders set up their own buying points in major producing areas to purchase maize directly from farmers. These traders tend to have a good network of traders either medium or small scale within Malawi and across the border. The good networks assist them in identifying available supplies and in bulking such supplies in economic lots for transportation to their warehouses. These large traders flourish because of their relatively high skills, know-how, connections, and access to relatively low-cost capital. Large traders usually buy maize to meet contract requirements of about 1,000MT from the National Food Reserve Agency (NFRA), World Food Program (WFP), Non-Governmental Organizations, processors and institutions. As large traders, they have warehousing facilities, either rented or owned in cities (Jayne *et. al*., 2008).

The third marketing channel is the National Food Reserve Agency (NFRA) a government parastatal that handles disaster relief and manages the Strategic Grain

Reserves (SGR) through buying and selling of maize. The maize is released in times of shortage. Despite NFRA not being a major maize marketing channel among smallholder farmers, its activities have the potential to influence prices and operational conditions of ADMARC and the private sector (Myers, 2008).

In all these marketing channels, there is need for effective price transmission among the spatially and temporary separated markets, since this is a necessary condition for the efficient operation of the markets. The integration of markets or the free flow of goods and price information over form, space and time leads to efficiency of markets. The absence of market integration, or the complete pass through of price changes from one market to another, has important implications on the economic welfare and policy. Therefore, in the long run, improvements in market information system should enhance the price transmission among spatially and temporary separated maize markets (Barrett, 2008).

1.4 Price, Market Information and Market Efficiency

Access to market information helps farmers decide 'what to produce', 'when to produce', 'what technologies to use for high quality products', 'when to sell' and 'at what price'. Information is vital in agriculture as it empowers farmers with bargaining power for better prices in the market. Information also brings stability in product supplies and prices in time and space thereby reducing transaction costs in input and output markets (Mukhebi *et. al.*, 2007). Mangstl (2008) noted that rural livelihoods would be greatly enhanced by efficient markets through enhanced access to agricultural markets, improved agricultural practices and better and timely information.

Price and market signals are key instruments that facilitate coordination involved in resource allocation. At the same time, price information helps market participants to make effective decisions on production and consumption (Abraham, 2007). McMillan (2002) indicated that, in well-functioning markets, prices serve to aggregate information dispersed among market participants. This means that in a marketing system, price information serves as a feedback mechanism that coordinates the actions of market participants. Therefore in this study market, efficiency in marketing is shown by the level of transaction cost indicated by the price differences in markets.

Stiglitz (1989) showed that imperfect information or absence of information impeded market entry and in extreme cases, markets ceased to exist resulting in market inefficiency. This has the effect of lowering farm gate prices in surplus areas, resulting in reduced incomes for farmers and raising consumer food prices in deficit areas. This leads to food insecurity for the poor in such areas (Mukhebi *et. al.*, 2007).

Shepherd (1997) indicated that market information can be particularly valuable where countries are changing over from a state-controlled marketing system to one of private enterprise, in that farmers and small traders are made more aware of market opportunities. By contributing to more efficient marketing, particularly improved spatial distribution, market information should be beneficial to consumers, farmers and traders.

Information on retail prices may also, under certain circumstances, assist consumers to bargain. Arua (2007) noted that information is the only way that the smallholder farmers can guard themselves against exploitation by traders, brokers, processors and middlemen. At the same time, information also helps to notify farmers of the quality and quantity demanded of their products in a market in order to capitalize on better prices.

1.5 Information and Communications Technology (ICT)

Information and Communications Technologies (ICTs) including broadcasting and internet are clusters or interrelated systems of technological innovations in the field of microelectronics computing and electronic communications (Preston, 2003). ICTs have proven revolutionary in nature as far as creation, distribution, dissemination and repackaging of information and sharing of knowledge is concerned (Britz, *et. al.,* 2006). Basically, ICTs are a means of passing information from one person to the other using some technology; be it written, electronic or verbal. The ICT tools include newspapers, radio, telephone, fax, cell phone and computers (e-mail and internet). With ICT, available information can be stored, processed and transmitted easily and quickly. Abraham (2007) noted that ICTs can help in improving information flow, reducing search cost and generally contributing to market efficiency.

In Malawi, the communications sector is liberalized. The liberalization in 1994 resulted in the introduction of more Frequency Modulation (FM) radio stations, television, mobile phone operators and the use of computers for internet and e-mail. This was a deliberate effort to allow the underdeveloped and excluded villages to have access to information including agricultural market information (GoM, 2006). Today the gap between those who can and cannot access ICT has been reduced as a result of, among others, the emergence of more FM radios, newspapers and cheap cell phones distributed by the mobile phone network providers; Zain Malawi, Malawi Telecommunications (a fixed phone operator) and the Telekom Networks Malawi (Initiative for Development and Equity in African Agriculture – IDEAA, 2008).

The liberalization in the communication sector initiated the development of a pro-poor ICT policy. The development of this ICT policy has opened up easy access to information. In the agricultural sector, the pro-poor ICT policy has given farmers an opportunity to access market information in a timely fashion. Before liberalization, market price dissemination was solely done by the Government of Malawi through the Ministry of Agriculture and Food Security. With liberalization and the pro-poor ICT policy, projects like IDEAA-Malawi Agriculture Commodity Exchange (MACE) and Agriculture Commodity Exchange (ACE) program by National Association of Smallholder Farmers in Malawi (NASFAM) have been developed to complement the work that the Ministry of Agriculture and Food Security is doing through the Agro-Economic Survey section in Planning Department. These initiatives disseminate information among farmers through modern ICTs including the FM radios, mobile telephone (SMS), internet or physical displays on blackboard in all Market Information Points (MIPs) and Market Information Centers (MICs) across the country. These initiatives aim at improving access to market and enhance marketing efficiency among smallholder farmers.

1.6 IDEAA MACE Project

The development of institutions and projects like the Malawi Agriculture Commodity Exchange (MACE) project under IDEAA that collaborates with the Ministry of Agriculture and Food Security on weekly price dissemination was expected to improve access to information among smallholder farmers. The mission of IDEAA is to improve farm gate prices so as to increase income and create wealth in the agricultural sector for the benefit of the resource poor farmers in Malawi. Thereby improving food security and reducing poverty.

MACE was established in 2004 as a project to respond to the challenges faced by smallholder farmers. MACE project aims at (1) facilitating linkage between sellers and buyers, exporters and importers of agricultural commodities, (2) empowering farmers with relevant and timely information and intelligence to enhance their bargaining power and competitiveness in the market place, (3) providing a transparent and competitive price discovery mechanism through the operation of the exchange trading floor; and harness and apply the power of ICT technologies as a strategic tool for rural value addition and empowerment. MACE is based on three principles: (1) implemented as a public/private sector initiative in order to ensure that the resource poor farmers get access to the service, (2) cost recovery mechanism based on gradual introduction for sustainability and (3) commodity neutral agriculture marketing information system (IDEAA, 2008).

The Marketing Information System (MIS) established by the MACE project has various components aimed at harnessing the power of ICT based market interventions. These include providing relevant and timely market information and intelligence targeted at smallholder farmers but also serving other market intermediaries. In the commodity markets, the project provides market outlets for the smallholder farmers. The MIS components include a central Hub at IDEAA main office in Lilongwe, Market Information Centers (MICs) and Market Information Points (MIPs), Short Messaging Service (SMS) from mobile phone service providers i.e. Telekom Networks Malawi and Zain Malawi (now Airtel), a website and a radio program.

This is a national and international level initiative to link farmers to markets. At smallholder level, IDEAA promotes the use of SMS through the mobile phones, radio and provides information through MICs and MIPs in all the regions and encourages the use of internet for those who can manage. The IDEAA project collaborates with the Ministry of Agriculture and Food Security (MoAFS) and other smallholder oriented development organizations like International Crops Research Institute for Semi-Arid Tropics (ICRISAT). IDEAA is there to help in disseminating the weekly retail prices collected by the MoAFS enumerators from 72 markets across the country.

In general, these ICT projects are aimed at (1) increasing the bargaining power of the smallholder farmer leading to better market prices, (2) avoiding exploitation from the private traders, (3) reducing the transaction cost of seeking market information and (4) reducing transportation cost in input and output markets. In the long run, these are expected to increase farm income, ensure food security and poverty alleviation among smallholder farmers.

1.7 Problem Statement

Agriculture plays a critical role both at macro and micro levels in Malawi. High productivity and access to efficient and better paying markets are important in enhancing the livelihood of the rural poor (Mukhebi *et. al.,* 2007) but agricultural markets do not work efficiently for smallholder farmers in Malawi (Goletti and Babu, 1994 and Jayne *et. al.,* 2008). In late 1980s and early 1990s Malawi, like most African countries, implemented major policy changes under the structural adjustment programs. Both the communication and agricultural sectors were liberalized. The liberalization especially of agricultural commodity markets was intended to facilitate the functioning and effectiveness of rural markets. The liberalization, was also intended to equip smallholder farmers with successful marketing instruments and the ability to obtain market intelligence (information) so as to make rational decisions regarding crops to produce and markets to sell the product (McCrystal, 2007).

The liberalization has however introduced a new marketing challenge, which is poor access to reliable and timely market information or asymmetry of market information especially among smallholder farmers. Since the lack of market information substantially increases transaction cost and reduces market efficiency (Barrett, 2008), in Malawi liberalization has led to poor access to timely and reliable markets as a result of information asymmetry where traders influence prices in local markets (Goletti and Babu, 1994 and Jayne e*t. al.,* 2008). This inefficiency in markets and poor access to market information have been the major contributors to the problems of poor access to markets (i.e. input and output prices and quality) and small volumes of high valued products offered by the individual smallholder farmers. With the marketing chain consisting of multiple middlemen, each taking a margin at every stage of the chain, price variations in space and time have often been large and unreliable leading to inefficient markets in Malawi (Goletti and Babu, 1994 and Jayne e*t. al.*, 2008).

1.8 Justification

The problem of access to market information is not new. In the early 1990s, Malawi through the Ministry of Agriculture and Food Security instituted an Agricultural Marketing and Estate Development project to collect and disseminate market information for the consumption of farmers and traders. Through the marketing section of the Planning Department in the Ministry, weekly price information was disseminated to the whole country through the radio and daily newspapers.

The impact of this initiative was limited because it relied on limited channels of information dissemination and it also had limited focus, that of price dissemination only. Apart from limited focus, the initiative had no built in cost recovery mechanisms and harnessing or development of the private sector to run the information system beyond donor funding. Consequently the information disseminated through the initiative had no tangible results. Learning from this initiative, recent developments in improving access to markets through dissemination of market information have been adopted.

In 2006, the government instituted the National ICT for Development policy, aimed at developing the ICT industry and sector; and promoting the development and use of modern ICTs in all sectors for the greatest impact in socioeconomic development. With this, institutions have been developed to link various stakeholders in several sectors using modern ICT interventions in the country. These institutions are promoting the use of quick and reliable modern ICT tools like mobile phone, internet and more FM radios in disseminating information.

The agricultural marketing sector in Malawi is one of the sectors that has actively promoted the use of these modern ICTs to enhance the dissemination of market information among farmers, traders, middlemen and all other market participants. The development of institutions like IDEAA in 2004, for smallholder farmers and other market players, was aimed at improving access to timely and reliable information using modern ICTs leading to accessing efficient markets. These institutions are also helping to link producers, middlemen and consumers in agricultural markets through modern ICTs. Among market participants, smallholder farmers are trained on how to access information using mobile phones, actively participate in radio phone-in programs and visit MIPs. Smallholder farmers are also linked with potential buyers using these modern ICTs. Although the institutions are promoting use of modern ICTs among smallholder farmers for quick and reliable market information, little is known on the extent of the initiatives in improving the efficiency of markets in Malawi.

Many studies *(see Golleti and Babu, 1994; Chirwa, 2000; Sopo, 2008, Katengeza, 2008)* have been done on market efficiency in Malawi. These studies have focused on spatial and inter-temporal linear co-integration of market prices, market value chains and price margins after liberalization. From the literature, there is little evidence on the factors that influence use of modern ICTs among smallholder farmer and how these modern ICTs have improved agricultural commodity market efficiency through timely information on commodity prices, market transparency and efficiency in spatially separated markets. At the same time, the challenges smallholder farmers are facing when using modern ICTs, is also not well documented.

Although linear co-integration approach has been applied widely to assess agricultural commodity market integration in Malawi, the methodology has been criticized as being unreliable if (1) the transaction cost are non-stationary (*see Barrett, 1996; Barrett and Li, 2002*) and (2) if there are reversals in trade flows across markets (Barrett and Li, 2002). Considering these challenges over the years, methodologies like threshold error correction models and parity bound models have been developed. These models capture transaction costs when assessing market efficiency but no published study has applied such methodologies on agricultural maize markets in Malawi. In addition, no published studies have been done in Malawi to investigate the effectiveness of ICTs considering the transaction cost in spatially separated maize markets.

Since linear co-integration methods fail to recognize the pivotal role played by transfer costs and the non-linearities implied by spatial arbitrage conditions, this study uses threshold autoregressive error correction model to examine the relationship between 9 regional markets in Malawi. The markets are Karonga in Karonga District, Rumphi in Rumphi District and Mzuzu in Mzuzu City in the north; Lilongwe in Lilongwe District, Mitundu in Lilongwe District and Lizulu in Dedza District in the central; and Lunzu in Blantyre District, Luncheza in Thyolo District and Bangula in Nsanje District in the Southern Region (Figure 1). The choice of these markets was based on availability of market data. The study will also identify the socioeconomic factors that affect the use of ICT based market interventions and the challenges encountered when using them.

1.9 Objectives of the Study

1.9.1 Main objective

To analyze the effectiveness of ICT based market interventions on maize marketing efficiency in Lilongwe and Dedza District and some selected markets of Malawi.

1.9.2 Specific objectives

1. To determine socioeconomic factors that influence the use of ICT based market interventions among smallholder farmers.
2. To identify the challenges associated with using ICT based market information services among smallholder farmers.
3. To analyze the spatial co-integration effect of ICT based market interventions on maize markets in Malawi.

1.10 Hypotheses

1. Socioeconomic factors (such as education, age, extension visits, access to credit and distance to market place) do not influence use of ICT based market interventions.
2. The use of ICT based market interventions has not improved maize marketing efficiency in Malawi.

1.11 Organisation of the Thesis

The rest of the thesis is organized as follows. Chapter two presents literature on the overview of effect of ICT in different markets. The review focused on effects of ICT interventions on market transparency and efficiency. It also presented a general review of the theoretical background to the methodology used in studying market integration. The chapter further reviewed literature on adoption of new interventions in the agricultural sector.

Chapter three presents the theoretical and empirical approaches. This highlights the conceptual framework on transaction costs and market participation. It further describes the theoretical and empirical background to the methodology used in the project and associated econometric models.

Chapter four presented data sources and description. This includes description of study area, sampling framework and data collection procedures used. Chapter five gives the descriptive statistics of household characteristics. Based on the socioeconomic factors used in this project, this chapter described the factors that influence use of different ICTs in Lilongwe and Dedza Districts and the aggregate sample. The chapter further gave the reasons for not using ICTs based market interventions.

Chapter six presents the results of the logit model applied to analyse the socioeconomic factors that influence use of modern ICTs based market interventions. The chapter also presented descriptive statistical results of the challenges encountered when using modern ICTs. The logit identified the socioeconomic factors that significantly influence use of modern ICTs. The associated challenges assessed the problems smallholder farmers encounter when using such modern ICTs.

Chapter seven gives the results of the co-integration models on monthly price data from the nine markets in Malawi. Spatial co-integration and price transmission of the markets is assessed using the linear autoregressive and threshold error correction autoregressive models before and after the promotion of modern ICTs among smallholder farmers. The threshold error correction autoregressive model considers transfer cost in maize marketing compared to the standard autoregressive model. Chapter eight presents the summary of the findings, conclusion and provides recommendations for the study.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter reviews some literature on use of ICT in marketing, market integration, efficiency and price transmission. Special focus is on spatial market integration and ICT use in agricultural sector. The subsequent sections in this chapter put into perspective market information and participation, market performance and integration. Further sections review literature on spatial market integration and price transmission. Socioeconomic and environmental factors of smallholder farmers that influence use of modern ICTs are also discussed in the chapter.

2.2 Market Information and Participation

Market participation is necessary for structural transformation from subsistence agriculture to an economy based on specialization, exchange and technological innovation. The transition from low productivity or semi – subsistence agriculture to high productivity and commercialized agriculture has been the core of agricultural transformation in many economies (Barrett, 2008). Being an agro-based economy, Malawi needs active market participation of all market players, particularly smallholder farmers if structural transformation is to materialize. To achieve this transformation, markets need to operate efficiently for all participants. All semi-subsistence smallholder farmers must have access to better paying, low transaction cost and well-connected markets. This implies that market efficiency should ensure that market prices are right in all markets and at all times i.e. prices are only differentiated by transaction cost between or among markets.

Riston (1997) indicated that problems of agricultural commodity markets originate from market structure and efficiency which are exhibited through market power, excessive price margins and poor price signals. To stimulate competition and to enhance smallholder market participation, Barrett (2008) recommended formation of smallholder organization so as to reduce cost of inter-market commerce, and to improve poorer households' access to improved technologies and productive assets. Williamson (1985) observed that farmer organisations can facilitate vertical and horizontal coordination in a market. Instead of having spot market, well organized farmer groups have bargaining power to enter forward sales contracts.

Aker (2008) noted that improved access to information by traders in Niger reduced search costs resulting in less price volatility and price spread between trade–linked markets. Jensen (2007) and Abraham (2007) observed that improved availability of information to Indian fishermen reduced price dispersion and wastes. Abraham (2007) further explained that mobile phones assisted boat owners to know exactly when their boats will come and this helped them to have extra time to be productive in other business ventures.

Aker (2008) and Jensen (2007) also indicated that access to information is pareto improving and is a near perfect adherence to the law of one price or market arbitrage.

All these studies agree with Anderson *et.al.* (1998) that increased availability of information improves the process of price discovery by reducing the search, negotiations and policing costs thereby improving market efficiency in an economy.

Shepherd (1997) indicated that lack of information is an entry barrier to both production and trade. Where farmers have access to information, shifts in cropping patterns to higher value produce and to marketing of produce have been noted. In the area of trade, individuals find it difficult to begin trading without information. Mukhebi e*t. al.* (2007) studied the Kenya Agriculture Commodity Exchange (KACE)-Market Information Linkage System (MILS), which is similar in its activities to IDEAA –MACE project, and indicated that the proportion of farmers and traders whose incomes and bargaining positions had improved was very high (75% farmers and 60% commodity traders). Furthermore, the study concluded that during the years in which the KACE MILS was operational, market integration improved for maize and beans.

Mehta and Kalra (2006) observed that ICT kiosks in rural areas are important in improving the profit or market margin of producers who shoulder the relative risk of producing in the value chain. Although middlemen are vital in compensating for infrastructure bottlenecks through physical transmission of products, the challenge arises when they are involved in the flow of price related information in the value chain. With such monopoly power, middlemen tend to offer lower prices to the producer and higher prices to the consumers thereby creating marketing inefficiencies. Thus ICT kiosks in rural areas can assist in information flows thereby mitigating the market inefficiencies.

Despite the value of information, different human, environmental and technological factors influence the decision to source and use information. Taragola and Van Lierde (2009) noted that age and education, are related to a decision-maker's ability to create value from the information gathered. Asfaw and Admassie (2004) also noted that with education, people understand instructions better. They further indicated that the education level of the household head has a positive and significant impact on the adoption of modern technologies. Although education is important Schnitkey *et. al.* (1992) further argued that age is related to farming experience, and that farmers with more experience should have less demand for external information since they rely more on extension services than younger farmers.

Aker (2008) observed that cell phones have a more positive impact on search costs of a distant market with slightly poor road condition as opposed to distant market with good road condition. Sun and Wang (2005) further indicated that through information and communication technologies, enterprises in rural areas can get access to markets in key markets and metropolitan areas. At the same time, they also help in accessing higher quality/ lower cost business services through electronic delivery.

2.3 Market Performance and Integration

Economic growth entails continued transformation of the economy through linkages among sectors of the local economy. Markets are a key to this process because if they operate efficiently they help coordinate decisions of both producers and consumers in a manner that leads to (a) efficient use of resources, (b) availability of and access to new technologies and (c) efficient combination of outputs within and across all sectors (Goletti *et. al.*, 1994).

The main function of markets is to signal the relative scarcity of goods and resources, guide decisions of economic agents and ensure the mobility of commodities over time and across space (Ravallion, 1986). The cost associated with the temporal and spatial transfer of commodities is the extent to which prices generated through the market process reflect the relative scarcity of goods. Thus the quality of price signals transmitted across markets is the key determinant of market performance (Rapsomanikis *et. al.,* 2006).

Structural and institutional deficiencies of various types often weaken the performance of markets, as reflected in high distribution costs, distorted market prices, and inadequate price transmission. The induced inefficiencies in the market process can have significant implications for long term growth, equity and other economic policy objectives (Goletti *et. al.*, 1994).

Market performance is mainly related to the function of arbitrage[2]. Spatial arbitrage equalizes supply and demand at different market places until price differences are reduced to the level of transaction costs. The higher the level of transaction costs between markets, the smaller the probability that exchange will take place between them. Links between markets thus become more likely as transaction costs decrease (Shepherd, 1997).

Abdulai (2006) noted that the performance and success of markets after reforms in developing countries depends, to a larger extent, on the strength of price signals transmitted between markets. In order to transmit intended incentives of reforms to beneficiaries, integration of markets is essential. Shiferaw *et. al*. (2006) observed that increased participation in markets can result in increased household commercialization which in turn increases adoption of better techniques of production.

The approach of using market integration[3] to measure market efficiency is based on the concept that an efficient commodity market will establish prices that are interrelated spatially by transaction and transfer costs and inter-temporary by storage costs (Demeke and Sinke, 1995). If markets are integrated, there will be low spatial and inter-temporal variation in prices leading to commodity market efficiency especially in high

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[2] Arbitrage is the process of exchange of commodities with the objective of taking advantage of price differences between locations that exceed transaction costs.

[3] Market integration can be viewed in terms of: (1) vertical integration – stages in marketing and processing; (2) spatial integration – to spatially distinct markets, and (3) inter-temporal integration – to arbitrage across periods (Barrett and Li, 2002).

competitive markets. The experience from Kenya Agriculture Commodity Exchange (KACE) showed that market linkage mechanisms enable farmers to actually sell their produce or purchase needed inputs on time and at competitive prices. This is another key plunk in making markets work better for the poor farmer (Mukhebi e*t. al.*, 2007).

Market integration, among spatially and inter-temporally separated markets, has been particularly significant in predicting the impacts of price changes in producing areas/markets and food deficit areas/markets. Rapsomanikis *et. al*. (2006) indicated that markets that are isolated may convey inaccurate price information that might distort producer-marketing decisions and contribute to inefficient product movements. The incomplete price transmission arising due either to trade policy or other policies, or due to transaction costs such as poor transport and communication infrastructure, results in a reduction in price information available to economic agents and consequently may lead to decisions that contribute to inefficient outcomes (Rapsomanikis *et. al*., 2006).

Empirically, applied econometric analysis using price data have been used to analyse spatial market integration and price transmission. Earlier studies on market integration relied on static and dynamic correlations between pairs of markets or regression based analysis (Abdulai, 2006). Considering the non stationarity of prices, the correlation models gave way to co-integration models (Goodwin and Piggott, 2001). These models indicated the need for market prices to co-move together in the short run and long run.

Despite the advances made in co-integration analysis, empirically, the co-integration models used in these analyses implicitly assume that the tendency to move toward equilibrium is always present. However, movement toward equilibrium may not occur in every period (Nathan and Fomby, 1997). In particular, the presence of fixed costs of adjustment may prevent economic agents from adjusting continuously. Recent studies have developed threshold autoregressive and parity bound models (Goodwin and Piggott, 2001 and Abdulai, 2006). Such models recognize that deviations must exceed a certain threshold before provoking equilibrating price adjustments which result in market integration (Goodwin and Piggott, 2001). Only when the deviation from the equilibrium surpasses a critical threshold do benefits of adjustment exceed the costs, and economic agents act to move the system back towards equilibrium. Mostly, the considered transaction costs are transportation and search costs.

The challenge of threshold and parity bound models is the assumption of constant transaction costs or a neutral band over a period of time (Abdulai, 2006). Van Campenhout (2007) indicated that using such static models, one would observe a high frequency of inefficient arbitrage leading to a conclusion of poor market integration. To curb the challenge, threshold models of dynamic economic equilibrium are therefore more appropriate when examining price relationships between distant markets (Nathan and Fomby, 1997). Although dynamic models are appropriate, their econometric application is limited when using market price data only without actual transaction data, (Van Campenhout 2007). Therefore, recent studies have mostly applied neutral band or ‘in and out’ threshold co-integration models while others have extended the models by factoring in time trend variable.

Sephton (2003) extended the neutral band threshold co-integration by Goodwin and Piggott (2001) using a multivariate approach to test for more than one threshold effect and nonlinear co-integration. Further to that, to effectively assess market efficiency Barrett (1996) indicated the need to also consider both price and trade flows when analysing market integration and price analysis.

2.4 A Review of Spatial Market Integration and Price Transmission Studies

Following the advances in spatial market integration, several studies have been done on market integration in spatially separated markets. Ravallion (1986) applied the dynamic error correction method of analyzing long run and short run market integration in Bangladesh rice market. From the model (Autoregressive Distributed Lag Model), price series for each local market were permitted to have their own autoregressive structure and a dynamic relationship with prices in trading markets. The analysis results suggest significant departures from both short run and long run market integration as opposed to the static error correction model. This was attributed to transport cost since the analysis was done between a central market and relatively remote area markets, with poor road condition. Mphatso (2007) also applied Autoregressive Distributed Lag Model on spatially separated cassava markets in Malawi. The results indicated presence of market integration but markets were not perfectly efficient in transmitting price information across the markets.

Getnet *et. al.* (2005) also used the Autoregressive Distributed Lag Model to analyse the effect of government policies in spatial market integration. The study focused on market integration of local supply producer prices and central market wholesale prices for white teff in Ethiopia. To effectively assess market integration, the model regressors included wholesale price in central market, quantity of rainfall around the supply (producer) market and price of commercial fertilizer. From the results, the existence of nonspurious long run relationship between wholesale and producer prices was confirmed. Using the stated error correction model of market integration, it was concluded that wholesale price in central market is the major short run and long run determinant of producer price in local supply market. Considering the post – liberalization period, it was concluded that government interventions that affect central wholesale market prices can effectively influence the producer prices and overall market performance.

The analysis by the Grain Marketing Research Project (1997) also concluded that cereal price spreads for major regional markets have generally declined after liberalization in Ethiopia. It further indicated that grain prices in one market are transmitted to other markets more rapidly. This was revealed by the increase in prices for surplus producing areas and a decrease in prices in deficit regions, i.e. adherence to market arbitrage.

Goletti and Babu (1994) employed linear co-integration econometric technique to examine the impact of market liberalization on integration of maize markets in Malawi. Their findings indicated that almost all maize markets studied are co-integrated in the long run and that the number of co-integrated markets increased after liberalization. It was also concluded that liberalization enhanced market integration but the rate of price transmission was low. Chirwa (2000) concurred with the result using rice markets in Malawi. Using a linear co-integration model, the study concluded that rice markets are more integrated after full liberalization of markets.

Sopo (2008) used bivariate correlation coefficients and linear co-integration to investigate maize price transmission across regional markets and co-integration of spatially separated maize markets in Malawi. The study focused on market integration after government policy to strengthen Market Information System (MIS) in the agricultural sector in period with and without price band. It was concluded that spatially separated markets are linearly co-integrated in the long-run as a result of market information availability or improvements in market information flow within the regions.

Motamed *et. al.* (2008) analyzed trade linkage between maize prices in United States and Mexico following North American Free Trade Agreement (NAFTA). Using linear co-integration analysis and error correction model, it was observed that prices between United States and Mexico do not share a common long run relationship. Rather Mexico prices are determined by local conditions in the regions. Such an analysis was to assist policy makers to develop complementary free trade policies, so as to reduce transportation and transfer cost from surplus to deficit areas within Mexico.

Abdulai (2000) noted that major maize markets in Ghana are well integrated based on threshold co-integration model. The asymmetric threshold error correction model revealed that wholesale maize prices in local markets of Ghana respond more swiftly to increases than decreases in central market prices. Thus, viewed in relation to their long-run levels, shifts in marketing margins are corrected more rapidly when there is an increase than a decrease in prices.

Goodwin and Piggott (2001) utilized neutral band threshold autoregressive and co-integration models to analyse daily price linkages among four corn and soybean markets in North Carolina. The results indicated the presence of thresholds and strong support for market integration. Using nonlinear impulse response functions to investigate dynamic patterns of adjustments to shocks, the threshold model suggested much faster adjustments in response to deviations from equilibrium than standard co-integration models. To extend the analysis, Sephton (2003) multivariate analysis agreed with the neutral band threshold analysis done by Goodwin and Piggott (2001) but indicated that transaction costs may create nonlinearities in relationship between commodity prices among spatially distributed markets.

Uchezeba (2005) compared the Standard autoregressive (AR) and threshold autoregressive (TAR) error correction models to determine whether transaction costs have significant effect in measuring market integration. The results showed that there are larger adjustment coefficients in the TAR model than AR model. This was an indication that price adjustments are faster in threshold autoregressive TAR models than in AR models. With these results, Uchezeba (2005) noted that there is strong market integration in the apple markets in South Africa.

Van Campenhout (2007) compared the standard linear autoregressive (AR) and threshold autoregressive (TAR) error correction models on weekly maize prices for seven markets in Tanzania. Using a bivariate analysis between one major supply market and other six markets, the analysis compared the price adjustment changes with and without transaction costs between AR and TAR models. The TAR model was also compared with and without time trend variable. The results of AR indicated that price adjustment, estimated as half-life, ranged between 3.9 to 22 weeks. After factoring in transaction costs, the TAR model indicated that the price adjustment was faster and the half-life was reduced to between 4 and 11 weeks. Despite the quick price adjustment, distance and road condition affected the half-life adjustment period. The TAR that factored the time trend indicated gradual reduction in transaction costs over time. This resulted in estimated half-life of 1 to 5 weeks.

Balcombe e*t. al.* (2007) used threshold error correction model to test the presence and form of threshold behavior in price transmission. Using the Bayesian approach, the study compared a single equilibrium threshold autoregressive model (Eq – TAR) and a band threshold autoregressive model (Band – TAR) on wheat, maize and soybean prices from United States, Argentina and Brazil. From the results, both the standard co-integration and threshold co-integration models indicated that causality flowed from Argentina and United States towards Brazil. Three out of the five studied markets exhibited existence of threshold effect in transmission of commodity prices. There was a unanimous support for Band – TAR in markets that exhibited threshold effect.

Baulch *et. al.* (2007) examined spatial market integration between and within paddy markets in north and south of Vietnam using error correction models from Ravallion's that allows for transfer cost. Data on transfer cost consisted of loading and unloading cost, freight costs and *ad valorem* trade taxes collected from a survey of traders in the regions. A sequential testing strategy was used to test for market integration, the number of thresholds, long-run integration, informational efficiency and Law of one price.

Baulch *et. al.* (2007) results indicated neither threshold effect nor evidence of market integration between the regional markets but there was slight threshold effect and market integration within regional markets. The no threshold effect between the regions implied a linear relationship but the estimated speed of price adjustment was small (0.41). These implied slow price transmission and sufficiently high transfer cost for the two regions to engage in trade. The study results indicated the need for specific regional policies against overall national policies (Baulch *et. al.,* 2007).

Meyer (2002) extended the threshold co-integration model to a threshold vector error correction model (TVECM). The two – threshold vector error correction model was used as opposed to equilibrium neutral threshold model. The results suggested that market were integrated in pork prices between Germany and the Netherlands. Further, there was a significant effect of transaction costs and that ignoring these effects would have caused biased results.

Barrett and Li (2002) used maximum likelihood estimation of a mixture of distributed model incorporating price, transfer cost, and trade flow data in pacific soybean meal markets. This was applied to differentiate between market integration and competitive market equilibrium. The application was done to derive intuitive measures of inter-market tradability, competitive market equilibrium, perfect integration, segmentation equilibrium and segmented disequilibrium. The results suggested prevailing competitive equilibrium and tradability in the pacific soybean meal markets although trade flows were intermittent at monthly frequency in most markets.

2.5 Summary

From the reviewed literature, market players are able to make rational and informed decisions when they can easily access market information. To assess spatial market integration and use of ICT in agricultural marketing, several studies have used different methodologies. The review indicated significant market integration in most agricultural markets but price transmission or price adjustment is sufficiently calculated when transaction costs are incorporated in the model. The review also indicated that different socioeconomic, environmental and technological factors affect smallholder decision to use new technologies. These include gender, age, education and geographical distribution in terms of road networks.

CHAPTER THREE

THEORETICAL AND EMPIRICAL APPROACHES

3.1 Introduction

The purpose of this chapter is to introduce the modeling techniques used to achieve the outlined objectives. The chapter will give the theoretical framework in the first section. The second and third sections will provide the conceptual, analytical and empirical frameworks aimed at addressing the co-integration and price transmission analysis and socioeconomic factors influencing use of modern ICTs, respectively. The fourth section will focus on assessing the challenges encountered by smallholder farmers.

3.2 Theoretical Framework

The problem of smallholder access to efficient markets can be assessed using market integration or co-integration transaction cost models. High transaction costs make markets for inputs and outputs fail for smallholder farmers and they can impede efficient functioning of markets by retarding the flow of price information. These transaction costs can be fixed or variable. Fixed transaction costs are the set up costs incurred in completing the exchange process. Such costs include costs of putting up capital facilities such as investing in infrastructure and information services (e.g. roads and telecommunication) and public and private institutions like the formal and informal associations (Larson, 2006).

On the other hand, variable transaction costs depend on the number or volume of transactions. Examples include fees for transportation and costs associated with quality inspection. Therefore, the greater the volume transacted and the more frequent the transactions the higher the variable transaction cost of trade (Williamson, 1985).

Market integration deals with linkages among markets that include trends and/or integrated seasonal components. Related to integration is the co-integration concept. Co-integration is a property of two or more variables which have shown to be integrated. Since they are 'tied together' in some sense, a long-run equilibrium will exist. When two price series are co-integrated it follows that the markets are integrated in the long run (Alexander and Wyeth, 1994). This applies the 'Law of One Price'. The theory postulates that, given prices for a commodity in two spatially separated markets P_{it} and P_{jt} at all points in time, the price differences should be the transfer cost for moving the commodity from market *i* to market *j* (Rapsomanikis *et. al*., 2006). This can be presented as

$$P_{it} = P_{jt} + c \tag{1}$$

where: c is the marginal transfer cost

If this relationship between two prices holds, the market is integrated. However this extreme case is unlikely to occur especially in the short run. On the other hand, if the joint distribution of two prices were found to be completely independent, then it implies no market integration and no price transmission leading to market segmentation

(Ravallion, 1986). These two extreme conditions are called the strong form of 'Law of One Price' which is not the case in reality. The weak form of the spatial arbitrage ensures that prices of a commodity will differ by an amount that is at most equal to the transfer cost and it can be presented as

$$P_{i,t} - P_{j,t} < c \qquad (2)$$

This condition represents an equilibrium condition that observed prices may diverge from the relationship in equation *(1)* but the spatial arbitrage will cause the difference between the two prices to move towards the transfer cost. The spatial arbitrage condition implies that co-integration test indicates market integration.

If two spatially separated price series are co-integrated, there is a tendency for them to co-move in the long run according to the linear relationship in (*2)*. In short run the prices may drift apart, as shocks in one market may not be instantaneously transmitted to other markets but the arbitration opportunities ensure that these divergences from the underlying long-run (equilibrium) relationship are transitory and not permanent (Rapsomanikis *et. al*., 2006).

Central to market integration or co-movement of prices are transfer or transaction costs, comprising transportation, storage and processing charges plus a modest allowance for trader's normal profit (Van Campenhout, 2007). The transaction costs determine the 'parity bound' within which the prices of a commodity in two markets can vary independently of one another. If markets are integrated, the price differential or spread between markets cannot exceed transfer costs. The arbitrage activities of traders, who ship a commodity between low and high price locations, will raise price in some markets whilst lowering them in others. This is possible until price differentials equal transfer costs and all opportunities for earning excess trading profits have been exhausted (Baulch, 1997).

Using theory from New Institutional Economics, market efficiency and transaction cost can be looked at in three different areas: (1) the transaction cost and market linkage, (2) transaction cost and performance of spatially and temporally separated markets and (3) transaction cost and market participation. Transaction cost economics argues that difficulties in economic exchange between two partners arise because of three exchange related problems namely, asymmetric information, bounded rationality and opportunism. These problems can cause one of the partners to behave opportunistically leading to inefficient markets (Kirsten and Karaan, 2005). Thus, this study focused on theory of transaction cost and market participation in nine spatially separated markets.

3.2.1 Transaction cost and market participation in spatially separated markets

The effect of transaction cost at the micro and meso levels can be understood by looking at simple stylized models relating the household and two market prices. Following Minot (1999), Larson (2006) and Barrett (2008) it can be argued that transaction cost at the micro level causes a wedge between the exogenous market price (P^{cm}) and the household shadow price (p^{ch}) for crop C, where C = 1,2,………N.

Consequently, for transaction cost (t^c), a household faces a market price from crop *C* given by

$$p^{ch} = p^{cm} - t^c(QN^c, K, Z, IS) \quad (3)$$

where transaction cost depends on:

- QN^c Net sales volumes[4] of crop *C;*
- K A vector of household asset endowment for instance human, financial, physical and social capital;
- Z Quasi-fixed factors (Z) such as state of infrastructure development e.g. roads and other natural capital; and
- IS A vector of ICT based and other market information services. It also includes public and/or private extension information services on marketing strategies.

The household's net market position is thus determined by equation below:

$$p^{ch^*} = p^{cm} - t^c(QN^c, K, Z, IS) \text{ If the household chooses to participate in a market} \quad (4)$$

$$p^{ch^*} = p^a \quad \text{If the household is autarkic} \quad (5)$$

Equation (4) indicates that the household faces a market price that is different from its shadow price by the amount of transaction cost. Equation (5) says that there exists an

[4] The dependence of transaction cost on net sales volume occurs where there are fixed transaction costs. Such costs may arise where some fixed assets are needed to complete the transaction.

autarkic shadow price (p^a) that equates household demand to household supply and for which the household is self-sufficient hence subsistence oriented (Minot, 1999).

Using similar formulation, efficiency in spatially separated markets can be assessed. Assuming that p^{cb} is the boarder price (i.e. price at boarder of two spatially separated geographic markets) then the effects of inter-village/regional cost of commerce (t^c) in each local market on household price can be presented mathematically as

$p^{chm} = p^{cb} - t^c(Q, Z, IS)$ If a household is involved in inter-village/regional market, or selling outside farm gate (6)

$p^{chm} = p^{am}$ If household is autarkic (7)

where:

- P^{chm} Household inter-market shadow price;
- P^{am} Autarkic market shadow price; and
- Q Volume traded or the quantity of the product exported outside their regional market.

Therefore, the volume traded (Q), state of infrastructure (Z), and the vector of market information – related public and private services (IS) condition the costs of inter-village or regional commerce. The price at farm gate or market within village / region will be higher in an importing market than the border price between the villages / regions but lower in exporting market by the amount of the transaction cost. If a household is autarkic, it implies that the household either sales at farm gate only or is involved in local markets only (otherwise, they do not cross borders in their transactions) and only incurs transaction cost of participating in a local market. Efficient performance of spatially separated markets requires that prices in the two markets differ exactly by the amount of transfer cost. Therefore, higher transaction cost can prevent trade between or among regions.

3.3 Conceptual Framework

Transaction costs can affect efficiency of both input and output markets (Figure 3).

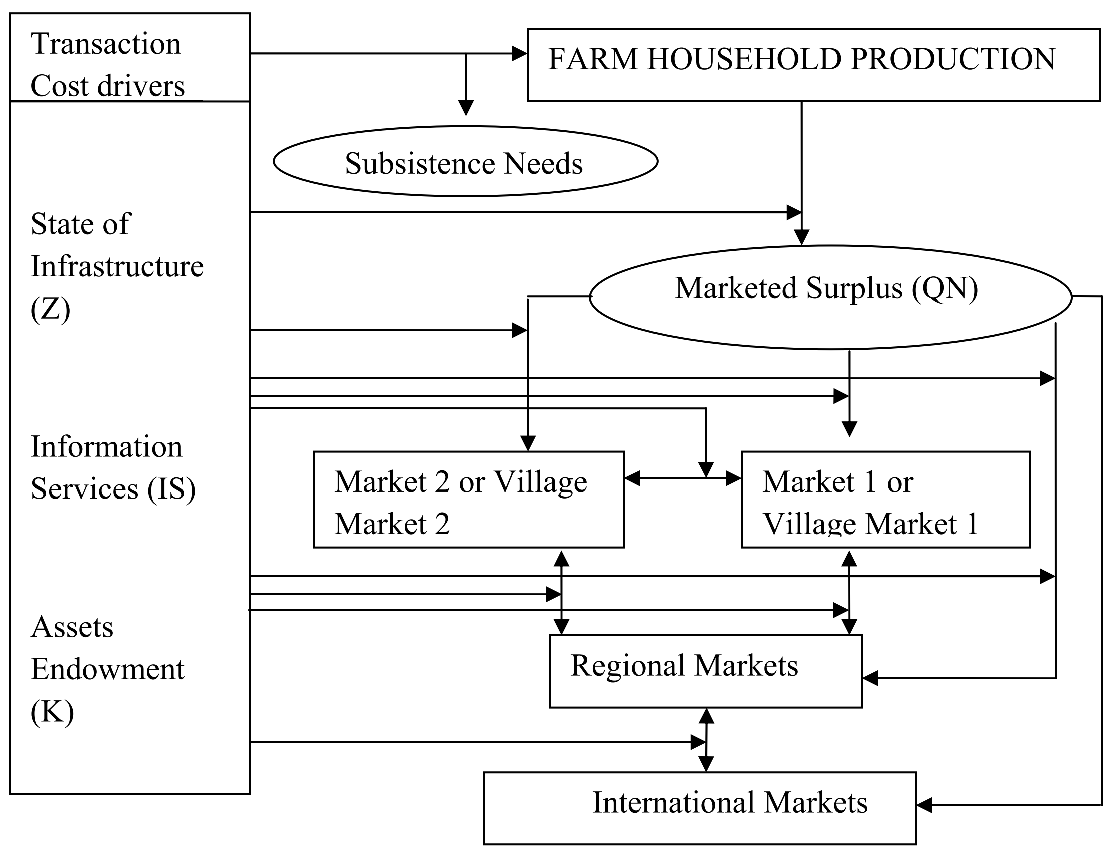

Figure 3: The effect of transaction cost on market participation[5]

[5] Sourced from electronic Agricultural Research Network working paper (eARN)

In input markets, production level transaction costs relating to input market access increase input cost. The high production level transaction cost depresses the household shadow price and causes some households to produce only what is enough for household subsistence needs. Such households stay out of the market or they are autarkic. However, other households overcome the production level transaction costs and commercialize. These participate in market through sales of surplus production to village, inter-village and regional markets.

In the output markets, households have to overcome transaction cost barriers in doing so. This trade can occur between village markets (market 1 and market 2) or between village and regional markets and between regional markets (e.g. between central and southern regions of Malawi) or between regional and international markets. Such trade will also be constrained by transaction costs arising from the various policies, socioeconomic and other environmental factors that condition transaction costs as indicated in Figure 3.

Therefore equations (4) and (6) are important in explaining the importance of ICT based market interventions in linking farmers to markets. The changes in the vector IS will affect the price that accrues to the household or earned through inter-village or regional trade by changing the transaction costs. Thus, it affects the incentive to participate in the output market after overcoming the productive input level transaction cost. It is important to note that the increase in IS (that is investment in communication network, private and public market information services on marketing strategies) enhances access to market information through; 1) reducing transaction costs facing the household through reduced search, negotiations and policing costs, 2) increasing price earned by the household from market participation (p^{ch*}) and 3) increasing the reigning price in spatially separated markets linked through trade (p^{chm}).

In both cases, reduction in transaction cost enhances the likelihood of participation in the market due to increased market margin. Thus for a given quantity QN or Q, the good state of IS reduces the (t^c), increases the margin earned by the farmers and promotes incentives to participate in the market even though market access is not uniform across households (Omamo, 1998; Renkow *et. al.*, 2004).

3.4 Models for ICT Based Market Interventions, Spatial Co-Integration and Socioeconomic Variables

3.4.1 Spatial co-integration econometric modeling

To analyse the spatial price integration and price transmission, error correction models were used. Co-integration analysis tools and both linear and threshold price transmission tools were applied to assess the effect of ICT in price integration by comparing the threshold models to the standard linear model in pre and post ICT periods. Before assessing price transmission, long-run co-integration and Granger causality test were applied to the whole sample to determine the co-integrating market and the direction of causality for the whole period. This assisted in determining the long-run co-integrating markets before price transmission was assessed in pre and post ICT periods.

3.4.1.1 Unit root test

The Augmented Dickey – Fuller (ADF) test was used to check for statistical properties for price stationarity, as a unit root test (Gujarati, 2004). This was based on the following;

$$P_t = \rho P_{t-1} + e_t \tag{8}$$

where P_t is the price at time t

P_{t-1} is the lagged price of P_t

e_t is the white noise error term at t

Therefore, an individual price series is said to be non-stationary if the null hypothesis $\rho = 1$ is not rejected. Theoretically, subtracting P_{t-1} on both sides of equation *(8)* will result in

$$P_t - P_{t-1} = \rho P_{t-1} - P_{t-1} + e_t \tag{9}$$

$$= (\rho - 1)P_{t-1} + e_t \tag{10}$$

Equation (10) can be re-written as

$$\Delta P_t = \delta P_{t-1} + e_t \tag{11}$$

where $\delta = (\rho - 1)$

Δ is the first difference operator or (1-L) [6]

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[6] L is the lag operator. If *P =1* then $P_t - P_{t-1} = e_t$. Using the Lag operator *L* the equation can be presented as $LP_t = P_{t-1}$, $L^2P_t = P_{t-2}$, ………. , $L^nP_t = P_{t-n}$. Simply the equation can be written as $(1-L)P_t = e_t$, if (1-L) = 0 one obtains L = 1, thus a unit root (Gujarati, 2004).

Therefore the null hypothesis can be $\delta = 0$. If $\delta = 0$ then $\rho = 1$ that is a unit root or price series are non-stationary. From equation (11), if $\delta = 0$ then $\Delta P_t = (P_t - P_{t-1}) = e_t$. Since e_t is a white noise error term which is stationary, the first difference of the price series are stationary. It implies that the price series are stationary when we fail to accept the null hypothesis of $\delta = 0$ or $\rho = 1$. Based on equation *(8)*, as ρ approaches zero the price series are non-stationary and integrated of order one I(1) or higher order, i.e. I(d). On the other hand, when price series are stationary, they are integrated of order zero I(0).

To determine appropriate lag length, Akaike Information Criterion (AIC) was used. This was done to reduce the sum of squares and to ensure that the error process in estimating equation is residually uncorrelated (Gujarati, 2004). Considering the significant influence of trend factors in price series, the analysis included trend analysis in stationarity test. Trend analysis is an OLS analysis where time is the independent variable that increases with 1 in each period. The time variable takes care of periodic changes in several factors like technological changes.

3.4.1.2 Long-run bivariate co – integration

To assess the long run market integration, Johansen vector error correction test was used. This assessed integration of bivariate price series between markets. The Johansen vector error correction tests for co-integration among stationary price series was used to determine the number of co-integrating vectors. Through a maximum likelihood ratio, the analysis used the eigenvalues and trace statistics. Extending equation *(11)*, the analysis equation can be presented as;

$$\Delta P_t = \alpha + \delta P_{t-1} + \sum_{t=1}^{k-1} \phi \Delta P_{t-1} + e_t \qquad (12)$$

where

δ and ϕ are *n* x *n* matrices of coefficients; and

k is lag length

Since P_{t-1} is I (1), but ΔP_t and ΔP_{t-i} variables are I (0), equation (12) will balance only when δP_{t-i} is I(0), i.e. $\delta P_{t-1} \sim I(0)$. The δ matrix is the one to convey information about the long-run relationship among variables in P_t. Therefore, the hypothesis of co-integration, was based on the reduced rank of δ. This is given as $H(r): \delta = \chi\theta$, where *r* is the rank of δ that determines how many linear combinations of P_t are stationary, χ and θ are *n* x *r* matrices of full rank. Thus if *r = 0,* it implies no linear combination of P_t is stationary against a null hypothesis that *r = n* where variables are stationary with linear combinations in level, (Ghosh, 2003 and Katengeza, 2008). Using the maximum eigenvalues ($\lambda_{\max}$) and trace statistic, the null hypothesis of *r* co-integrating vectors can be presented as follows:

$$H_0 : \lambda_i = 0 \qquad i = r + 1 \ldots\ldots\ldots, n \qquad (13)$$

The $\lambda_{\max}$ is given as

$$\lambda_{\max} = -T \log(1 - \hat{\lambda}_{r+1}) \qquad r = 0, 1, 2, \ldots\ldots\ldots, n-1 \qquad (14)$$

where T is the sample size and

$(1-\hat{\lambda}_{r+1})$ is the maximum eigenvalue estimate.

The trace statistic is computed as

$$\lambda_{trace} = -T\sum_{i=r+1}^{n}\log(1-\hat{\lambda}_i) \qquad r = 0, 1, 2, \ldots\ldots, n\text{-}1 \tag{15}$$

The analysis test the null hypothesis of *r* co-integrating vectors against the alternative of *r + 1* (Uchezuba, 2005). To assess bivariate co-integration, the null hypothesis is that there is at least one co-integrating vector (*r* = 1) against the alternative that there is no co-integrating vector (*r* = 0).

3.4.1.3 Granger causality test

After determining the bivariate co-integrating markets, the causal relationship between co-integrating maize price series was assessed using Granger Causality test. This is a measure of price predictability. That is, price movements in one market can be used to forecast price changes in other markets. Gujarati (2004) indicated that a price series P_{it} is said to granger cause another price series P_{jt} if the current and the lagged price of P_{it} improve the prediction of P_{jt}. This was tested using a Wald test. By extending equation *(12)*, the pair-wise causal relationship can be presented as

$$\begin{bmatrix}\Delta P_{it}\\ \Delta P_{jt}\end{bmatrix} = \begin{bmatrix}\alpha_i\\ \alpha_j\end{bmatrix} + \sum_{l=1}^{k-1}\begin{bmatrix}\phi_{l,11} & \phi_{l,12}\\ \phi_{l,21} & \phi_{l,22}\end{bmatrix}\begin{bmatrix}\Delta P_{it-l}\\ \Delta P_{jt-l}\end{bmatrix} + \begin{bmatrix}\beta_i\\ \beta_j\end{bmatrix}\begin{bmatrix}\delta_i & \delta_j\end{bmatrix}\begin{bmatrix}P_{it-k}\\ P_{jt-k}\end{bmatrix} + \begin{bmatrix}\varepsilon_{it}\\ \varepsilon_{jt}\end{bmatrix} \tag{16}$$

The granger causality can be tested at three different levels i.e. unidirectional, bidirectional and independent price series. Unidirectional implies that shocks in market P_{it} cause prices in market P_{jt} but there is no reverse effect. This tests the null hypothesis that coefficient δ_{it} is statistically different from zero ($\delta_{it} \neq 0$) against δ_{jt} is not statistically different from zero ($\delta_{ij} = 0$). The opposite is that shocks in market P_{jt} cause prices in market P_{it} with no reverse effect. Bidirectional causal effect is when shocks are transmitted both ways between markets. The null hypothesis is that, all coefficients ($\delta_{it}, \delta_{jt}, \beta_i, \beta_j, \alpha_j$ and $\alpha_i \neq 0$) are statistically different from zero. When the markets are not causing each other, there is independent causality. This tests the null hypothesis that, all coefficients ($\delta_{it}, \delta_{jt}, \beta_1, \beta_2, \alpha_j$ and $\alpha_i \neq 0$) are statistically different from zero.

3.4.1.4 Spatial price transmission

From the conceptual framework and the 'Law of One Price', enhancing information services aim at improving price adjustment between markets. Based on the estimated co-integrating vectors between markets, autoregressive error correction method was used to estimate price transmission adjustment factors. Van Campenhout (2007) indicated that it is uncommon to observe trade flow reversal for agricultural commodities that are both major staple and cash crop with high volume of trade. Thus, the model assumed symmetric price transmission while trade flow in the markets was determined by the granger causality test discussed in Section 3.3.1.2.3. Spatial price transmission was estimated using both linear autoregressive (AR) and threshold autoregressive (TAR) error correction models. These were applied to compare models that consider transaction costs against liner models in assessing market efficiency

<u>Standard linear autoregressive (AR) error correction model</u>

The standard linear autoregressive error correction model can be expressed as follows.

$$P_{it} = \beta P_{jt} + \eta_t \qquad (17)$$

where

P_{it}	is the retail price at time *t* and at location *i* of a given quantity;
P_{jt}	is the retail price at time *t* and at location *j* of a given quantity;
β	is parameters to be estimated; and
η_t	is the error terms, $iid \sim N(0,\sigma)$.

The error term η_t is used to define the error correction model since integration of P_{it} and P_{jt} depends on behavior of η_t That is, η_t is referred to as the deviation between prices in two different markets. When $\beta = 1$, the deviation η_t becomes non stationary leading to no integration between the price series. Thus, co-integration depends on the autoregressive behavior of the deviation *(*η_t*)* (Uchezuba, 2005).

The estimation of price adjustment is based on how the deviation ($\eta_t = P_{it} - P_{jt}$) at time *t* corresponds to price difference in the previous period, as presented in equation (18).

$$\Delta\eta_t = \rho\eta_{t-1} + \omega_t \qquad (18)$$

where:

$\eta_t = P_{it} - P_{jt}$	is the price spread between markets at period *t*;
Δ	is the first difference operator and
$\Delta\eta_t$	is difference in price spreads $\eta_t - \eta_{t-1}$
ρ	is the coefficient

ω_t is zero mean serially uncorrelated error term.

Linear autoregressive error correction was used to assess price transmission between maize market prices in pre and post ICT periods. Using equation (*18)*, the estimated ρ shows the adjustment parameter on lagged price difference. It indicates the extent to which price differences in the previous period are 'corrected' back to equilibrium price. The model was applied in both pre and post ICT periods.

Threshold autoregressive (TAR) error correction model

The applied standard linear autoregressive error correction method is known to be restrictive for investigating spatial maize price transmission. The method fails to allow for a zone of trade inactivity or the 'parity bound' when price spreads fall below a threshold that reflects transfer cost between markets. Thus if markets are integrated, the price differential or spread between markets cannot exceed the transfer cost (Alexander and Wyeth, 1994). To analyze symmetrical price adjustment further, the study used threshold autoregressive (TAR) error correction model. This was compared with the standard AR model in pre and post ICT periods.

Assuming η_t from equation *(17)* follows a threshold autoregressive behavior, spatial price transmission in long-run equilibrium under competitive behavior is given as follows (Myers, 2008):

$$\left|P_{it} - P_{jt}\right| < c \qquad \text{If q = 0 (Regime 1)} \qquad (19)$$

$$P_{it} - P_{jt} = c \qquad \text{If q > 0 (Regime 2)} \qquad (20)$$

$$P_{it} - P_{jt} = -c \qquad \text{If q < 0 (Regime 3)} \qquad (21)$$

where:

P_{it}	is the price in market *i* at time *t* ;
P_{jt}	is the price in market *j* at time *t* ;
q	is the quantity of commodity traded between the markets in two way direction;
If q > 0	amount of commodity traded is from market *i* to *j*;
If q < 0	amount of commodity traded is from market *j* to *i,* and
c	Is the marginal transfer cost and it is assumed symmetric irrespective of the direction of trade flow.

The first regime occurs when there is no trade between markets hence the absolute value of the price spread should be less than transfer cost. The second regime implies that if trade flows from *i* to *j*, then the price in *j* market should be to equal the price in *i* plus transfer cost. The third regime indicates that if trade flows from *j* to *i*, then the price in *i* market should be equal to the price in *j* plus the transfer cost (Myers, 2008).

To test these regimes, threshold autoregressive error correction model was used. This model can allow for the deviations from the efficiency conditions to occur. Following Myers (2008) the threshold autoregressive error correction model can be presented as

$$\Delta\eta_t = \alpha + \beta_0\eta_{t-1} + \sum_{k=1}^{K}\beta_k\Delta\eta_{t-k} + \varepsilon_t \qquad \text{If } |\eta_t| \le c_t \text{ (Regime 1)} \qquad (22)$$

$$\Delta(\eta_t - c_t) = \alpha(\eta_{t-1} - c_{t-1}) + \sum_{k=1}^{K}\alpha_k\Delta(\eta_{t-k} - c_{t-k}) + \varepsilon_t \qquad \text{If } \eta_t > c_t \text{ (Regime 2)} \qquad (23)$$

$$\Delta(\eta_t + c_t) = \alpha(\eta_{t-1} + c_{t-1}) + \sum_{k=1}^{K}\alpha_k\Delta(\eta_{t-k} - c_{t-k}) + \varepsilon_t \qquad \text{If } \eta_t < -c_t \text{ (Regime 3)} \qquad (25)$$

where:

$\eta_t = P_{it} - P_{jt}$	is the price spread between markets at period *t*;
Δ	is the first difference operator $\Delta\eta_t = \eta_t - \eta_{t-1}$;
c_t	is the long run transfer cost at *t* ; and
ε_t	zero mean serially uncorrelated error term.

There is a non-linearity at the threshold which allows the price spread to display different behavior inside versus outside a ‘parity bound’ defined by long transfer costs. To evaluate the effectiveness of spatial price transmission the primary interest is in regime 1, the size of the parity bound and regime 2, the behavior of price spreads when they are outside the bounds. In particular, if the spreads deviate from the parity bound, the point is to know how long it takes for them to return to the bound.

Threshold error correction model can be straightforward if price spread and transfer cost data are observable. However, the used data does not have transfer costs as separate data hence an auxiliary model for long run transfer costs c_t, which captures trends and variations over time can be used. Thus the long run transfer cost threshold can be presented as:

$$c_t = \delta_0 + (\delta_1 - \delta_0)\frac{t}{(T-1)} + \delta_2 p_{it} \qquad (25)$$

where:

t	is the time index t = 0,1,2,……, T-1; and
T	is the total number of price observations.
P_{it}	is the price in market I at time t

Note: If $\delta_2 = 0$ then δ_0 is the long run transfer cost at the beginning of the sample and δ_1 is long run transfer cost at the end of the sample, after allowing for a linear time trend.

The price variable of market i (p_{it}) is included to allow for the fact that some marginal transfer costs[7] may vary with the price of the product.

This model may not capture all the short run movements in transfer cost but should capture long run changes and trends. That is, if the estimate of the threshold long run transfer cost c_t from the model is a reasonable estimate of actual average transfer cost between the markets, then the results suggest long run efficient, competitive inter-regional trade activity between the markets.

To evaluate effectively the spatial price transmission, the focus is on regimes 1 and 2. In regime 1 (the price spread is inside the parity bound), trade flow should be zero (Myers,

[7] Particularly costs related to revenue rather than volume, such as credit costs or volume discounts

2008). This implies that movements in the price spread follow an arbitrary stochastic process that depends on autarky supply and demand conditions in the two markets and not transfer cost. It might be expected that $\alpha \approx \beta_0 \approx 0$, which would imply that price spread inside the parity bound follows a random walk without drift (i.e. price spread changes randomly inside the parity bound).

For regimes 2 and 3 (outside the parity bound) price transmission is not fully efficient because there should be incentive to increase trade flow until the price spread returns to the parity bound. This means that for effective spatial price transmission we cannot have $\alpha \geq 0$ (because then η_t and c_t would be unrelated in the long run and there would be no tendency for spatial price spreads to return to the parity bound). This sufficient condition for ineffective spatial price transmission (i.e. $\alpha \geq 0$) is testable (Myers, 2008).

Thus if $\alpha < 0$ there is a long run equilibrium relationship between η_t and c_t, and the size of α determines the spread of adjustment of the price spread back to the parity bound. Furthermore, when $\alpha = -1$ and $\delta_k = 0$ for k = 1,2, ……,K it would imply immediate adjustment although price spread never moves systematically outside the parity bound. For values of α between 0 and -1, the closer α is to 0 the slower the adjustment and the closer to -1 the faster the adjustment. If the adjustment is fast, it implies more effective spatial price transmission.

Although the value of α gives the rate of price adjustment it does not show the value of adjustment. Therefore, a measure that helps interpret the spread of adjustment of price spreads back to the parity bound in regimes 2 and 3 is referred to as the half-life (h).

$$h = \ln(0.5) / \ln(\alpha - 1) \tag{28}$$

The half-life is the time it takes for trade to increase and drive the price spread half way back to the parity bound, when there is a supply or demand shock that raises price spread above the parity bound. This assumes there is no other shock within the period of adjustment. If the half-life is shorter, it implies more effective price transmission (Myers, 2008).

3.4.2 Logit model

To identify socioeconomic factors that influence use of ICT based market interventions, a Logit model was used. This choice was based on the fact that the smallholder farmer can choose to access information through modern ICTs or non-modern ICTs. The focused modern ICTs are SMS from mobile phone, Radio and MIPs of IDEAA-MACE project. The non-modern ICTs refer to the ordinary way of getting market information from traders, middlemen, friends, relatives and government extension officers. Although the two major distinct groups are modern and non-modern ICTs, other farmers combine both tools. Despite other farmers combining both tools, the study considered the main source of information of the farmers in the logit model, i.e. modern and non-modern ICTs.

Assuming that the smallholder farmer that is participating in a market has utility U_j for two alternative ICT technologies (j = modern ICT or non-modern ICT). Let U_j be a function of attributes of alternatives. The smallholder farmer will tend to choose the technology that maximizes his/her utility. Let $U_j = V_j + \varepsilon_j$, where V_j is a function of the socioeconomic characteristics and ε_j is a stochastic error term. Assuming ε_j is independently and identically distributed *(iid)* with extreme-value distribution (Greene, 2003 and Guajarati, 2004) then the probability (P_j) that alternative *j* will be chosen is given in equation 26.

$$p_j = \frac{1}{1+e^{-y_j}} \qquad = \qquad p_j = \frac{e^{y_j}}{1+e^{y_j}} \tag{26}$$

Assuming the cumulative distribution function is logistic, the *y* in *(26)* can be estimated as:

$$Y_{ji}^{*} = \beta' V_i + \varepsilon_i^i \tag{27}$$

Where

Y_{ji}^{*}	Is the modern ICT based market intervention *(j)* used by household *i*.
V_i	Is a vector of factors that condition the use of modern ICT –based market intervention like the socioeconomic variables
β	Is the vector of coefficients
ε	Stochastic Disturbance term

Y_{ji}^{*} is an underlying latent variable whose observable counterpart Y_{ji} is defined as;

$Y_{ji} = 1$ if $Y_{ji}^{*} > 0$ that is household *i* use ICT –Based Market Intervention *J*

$Y_{ji} = 0$ if otherwise

The technique for estimating equation *(27)* (the probability choice that maximizes utility) is to estimate the parameter β (Maddala, 2002). Assuming logistic distribution, the study used the logit model to identify the socioeconomic variables that determines the use of either modern ICTs or non-modern ICTs. Considering that some modern ICTs like MIPs were offered in limited places and that IDEAA –MACE was promoting farmer associations, the challenge of estimating a logit with treated and non-treated groups that are of similar characteristics was controlled by applying propensity score matching technique. This was to control for selection bias[8] and finite data (Chen and Zeiser, 2008).

The propensity score is the probability of receiving treatment conditional on vector of observed variables. The idea is to compare individuals who, based on observables, have a very similar probability but one of them received treatment as opposed to the other (Jumbe, 2009). It is given as

$$p(x) = pr[D = 1 \mid X = x] \qquad (27)$$

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[8] Potential bias from treatment selection conditional on observed variables, due to the effects of unobserved variables, controlled with selection into treatment.

where

P(x)	Propensity scores
D = 1	Treatment group
X|*x*	Covariates of household characteristics

Thus, among those with the same predicted probability of treatment (27), those who get treated and not treated differ only on their error term in the propensity score equation. But this error term is approximately independent of the X's. The treatment assignment *D* is independent of *Y*, given the strata created by X's (Chen and Zeiser, 2008).

3.4.2.1 Model variables

The socio economic factors included in logit model are discussed below and Table 3.1 gives the summary of the variables discussed:

Education

Education plays a significant role in farming activities such as adoption of agricultural technologies (Edriss, 2003). Among smallholder farmers, agriculture instructions are easily understood when farmers are educated than when they are not. Asfaw and Admassie (2004) noted that in Ethiopia education of the household head is critical to household decisions since most decisions are made by the household head.

Education is taken to be formal education provided by the Government of Malawi. In the model, the variable was entered as continuous variable representing the number of years in school. Asfaw and Admassie (2004) indicated that education has a positive and significant impact on the adoption of modern technologies thus it is hypothesized that education will be positive and significant.

Gender of household head

Gender can be referred to as the socially constructed relations between women and men in a particular society. These relations and the roles that women and men may assume are culturally and institutionally embedded. Whereas biological sex (being male or female) is not easily altered, gender as a social identity changes over time (historically) and space (geographically). As a result, gender roles of men or women in one society may differ from another society.

In Malawian agricultural sector, women provide at least 70% of the labor force (GoM, 2010b). They also actively participate in agricultural production and food processing, food provision and marketing at farm gate. While men are also active in agriculture, they are mainly focused on cash crops and inter-village or regional marketing (Tellegan, 1997). In a baseline study for IDEAA –MACE, Phiri (2006) observed that more than 60% of the farmers involved in trade in all markets were men except for a few areas such as Liwonde market where 60% were females. This distribution is important when understanding ICTs accessibility to gender groups. In this study, gender will be entered as a dummy, female = 1 and male = 0. Generally, it is hypothesized that male-headed households are more likely to get information about new technologies and take risky businesses than female-headed households (Asfaw and Admassie, 2004). Thus the variable will have a negative sign in the model representing female headed households.

Age of the household head

Age is usually taken as a proxy for experience and is expected to have a positive impact on adoption. It is hypothesized that age is positively related to adoption decisions although the expected sign on age is an empirical question. It may be that older farmers have more experience in cultivation and marketing and are better able to compare the characteristics of modern technology than younger farmers. However, it could also be that older farmers are more risk averse than younger farmers and have a lesser likelihood of adopting new technologies (Adesina and Baidu-Forson, 1995).

With this dilemma, Asfaw and Admassie (2004) argued that there is a certain threshold of age beyond which the ability of farmers to take risk and adopt innovations decreases. This means that young farmers are more likely to face the risks associated with innovations (uncertainty in yield and unfamiliarity in technology) and to adopt them than their old counterparts. Therefore, the age variable was hypothesized to have a positive sign and its square a negative sign. In the model, age of the household head was entered as a continuous variable in years.

Farm size

Farm size is one of the factors that influence the adoption decision of improved modern technologies since it is taken as a proxy of business size. Langyintuo and Mekuria (2005) noted that improved technologies require economies of size to ensure profitability in a business. As smallholder farmers, the surplus production for marketing is greatly influenced by the size of the farm. Thus the farm size influences the decision to use improved market information sources for a profitable business. Taragora and Van Lierde (2009) indicated that farm size was positively related to attitudes towards and use of information sources. Therefore, it is hypothesized that farm size is positively related to use of modern information tools. In the model, farm size is entered as a continuous variable in hectares.

Distance to the market

Transaction costs are a function of infrastructure development and transport cost. Referring to the theory of transaction cost and market participation, farmers will only make decision on where to market their products based on the transaction cost of moving the product from production point to market. Since transaction costs are a function of transport cost, the distance to the exchange place or market area and the condition of the road will determine the decision to participate in marketing. Transport cost as a function of distance to the exchange point depends on state of roads and the mode of transport (Dijkstra *et. al.*, 2001). As such, distance to the market place in kilometers (Km) and condition of the road were used.

The involvement in village, inter-village and regional markets (based on distance to the exchange place) can influence use of ICT based market interventions by the farmer. The variable was used because knowledge of distant to the exchange point (as a proxy for transport cost) improves knowledge on transaction cost and use of ICTs. With such information on distance to trading market and condition of the road, farmers can make rational marketing decisions. Thus, distance and the condition of the road are hypothesized to be positive (Jensen, 2007 and Makhura *et. al.,* 2001). The distance variable was entered as a continuous variable in Kms while the condition of the road was categorized into 0 = not accessible in some seasons and 1 = all season accessible road.

Frequency of visit by public and private extension worker[9]

Access to extension services is important because it enhances adoption of new technologies and ensures high levels of crop productivity. Government extension sections and the private sector provide extension services and information to smallholder farmers geographically dispersed all over Malawi. Extension workers are meant to help farmers with production, grading and marketing information. Therefore the frequency and the information provided by the public and private extension workers through basic extension methods can influence farmer use of modern ICT based market interventions.

The major extension service provider is the Ministry of Agriculture and Food Security. Thus the model will help to determine how the public and private extension services influence use of modern ICT tools. It is hypothesized that access to extension is positively related to adoption of new technologies since it exposes farmers to new information (Adesina and Baidu-Forson, 1995). From the IDEAA –MACE baseline

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[9] This excludes the extension services provided through ICT based market interventions.

survey the majority of the respondents (70%) indicated that they had access to basic extension services (Phiri, 2006). In this model, both access and frequency of extension visits were used.

To capture the differences in access to extension, a dummy variable was used where 0 = no access and 1= access to extension services. Furthermore, the extent of contacting an extension worker was categorized into once a week, once a month, three times a month and once a year visits. Frequency of extension visit is hypothesized to be negative. Herath and Takeya (2003) indicated that higher visitations rate by extension personnel exposes farmers to more information. Thus, farmers might rely more on extension officers to provide production and marketing information than to use modern ICTs. Although it is hypothesized that higher frequencies positively affect adoption of technologies (Herath and Takeya, 2003), high frequencies can negatively affect use of modern ICTs for sourcing market information.

Availability of formal and informal credit

Access to ICT digital devices can be considered as a long-term investment. As a result availability and access to credit by smallholder farmer can determine extent of use of these ICT based market interventions. Credit can influence the number of farmers who can access information timely and easily through the ICT – based market interventions. Market information is of no use to farmers if they fail to overcome the production transaction cost. Thus, credit helps farmers to move from subsistence to commercialization and influences the use of modern ICT tools in marketing. In this study, credit is measured as a dichotomous variable, 1 if any member of the household had accessed to any form of credit and 0 if otherwise. Following Asfaw and Admassie (2004), the variable is hypothesized to positively affect adoption of technologies.

Household wealth

Household wealth is one of the measures of socioeconomic status in terms of physical assets and it can be used as a proxy of household income or expenditure. Although income or expenditure is mostly applied in socioeconomic analysis, the difficulties in accounting issues and seasonality easily affect income (McKenzie, 2003). Further, income and expenditure are endogenous to current household decisions while asset wealth is exogenous since it reflects the cumulative outcome from past experiences and choices. Thus household wealth is used in this study.

To measure household wealth, Principle Component Analysis (PCA), a method of Filmer and Pritchett (2001) and Vyas and Kumaranayake (2006) is used. This tool is used to identify and classify asset poor households by generating an asset wealth index based on physical assets and housing characteristics. This was done to avoid reducing the degrees of freedom if all the physical asset wealth variables are included in the model. With PCA, the asset variables are weighted to generate one index which is entered in the models as a single variable.

The key to a good index is the inclusion of variables that capture the inequalities among households. In the model, the physical asset variables that are considered for constructing the index are having an ox-cart, bicycle, radio, mobile phone, tv, cattle and goats. The household characteristics included were roof and floor types. Except for cattle and goats that were entered as continuous variables, all the other variables were entered as dummy variables in the wealth index. Since the wealth index provides wealth categories, it is hypothesized that poor wealth index negatively affects the use of modern ICTs.

Associations and farmer groups

Smallholder farmers usually have low quantities of output surplus because of small and fragmented pieces of land. As a result of low market supply, most farmers are not able to influence or bargain for prices in a market (Barrett, 2008). One of the ways of improving smallholder market participation is the use of associations or farmer groups. These assist in improving the bargaining power of farmers through increased output supply. At the same time, they allow increasing returns to scale in acquiring inputs (Adesina and Chianu, 2002). Therefore, it is hypothesized that farmers in an association are eager to access market information for their produce. Thus, the variable should positively influence the use of modern ICT. This variable is entered as a dummy, where 1 is membership to an association and 0 is otherwise.

Based on the described variables, Table 3.1 presents a summary of the variable name, meaning, type of measure and the expected sign in the model.

Table 3.1: Description of variables specified in the logit model

Variable Name	Variable meaning	Type of measure	Expected sign
Education	Education level of the household head	Number of school years completed	+
Age	Age of the household head	Number of years	+
Age squared	Squaring the age variable to assess decision of older farmers to use modern ICT	Number of years	–
Female	Gender of household head	Dummy variable (0 = male and 1 = female)	+
Farm size	Total size of the farm cultivated	Number of hectares	+
Distance to the market	Distance to the main trading centre	In kilometers	+
All season road	Good road condition that is accessible all year round by motor vehicle	Dummy variable (0 = not accessible in other season and 1 = all season accessible road)	+
Physical asset wealth	Whether the household is poor or not	Dummy variable (0 = Non-poor and 1 = poor)	
Access to extension services	Whether public or private extension officers visit the farm or not	Dummy variable (0 = No access and 1 = access)	+
Frequency of extension farm visit	How often the extension officer visited the farm	Categorized into two variables of 1 = once a week (0 = No access and 1 = access), 2 =once a month (0 = No access and 1 = access),	–
Membership to associations	Whether household head is member to an association	Dummy variable (0 = No, and 1 = Yes)	+
Access to credit	Whether households have access to formal and informal credit	Dummy variable (0 = No access and 1 = access)	+
EPA	Location variable for the household	Categorized into four variables of 1 = Mitundu (0 = No and 1 = yes), 2 = Lobi (0 = No and 1 = yes), 3 = Linthipe (0 = No and 1 = yes) 4 = Mpingu (0 = No and 1 = yes).	?

3.5 Summary

The purpose of the chapter was to introduce the modeling techniques used to achieve the outlined objectives. The chapter has outlined the conceptual framework; the co-integration and price transmission modeling tools; the socioeconomic logit model influencing used of ICT based market information.

Socioeconomic factors influencing the use of modern ICTs include farmer characteristics like age and gender of household head; and household characteristics like farm size and membership to an association, access to credit and household asset wealth. Both the linear autoregressive and threshold autoregressive error correction model price transmission techniques were outlined to assess spatial integration of maize markets in Malawi.

CHAPTER FOUR

DATA SOURCES AND DESCRIPTION

4.1 Introduction

The chapter will focus on methodology that was applied to gather time series market price for selected markets in and socioeconomic cross-sectional data from the smallholder farmers in Lilongwe and Dedza districts of Malawi. Since the methodologies explained in chapter three used both time series and cross-sectional data; and qualitative and quantitative methods, the chapter describes the data sources and collection methods. The emphasis is on study area, sampling techniques, data type and sources, data collection and data processing.

4.2 Study Area

To assess the socioeconomic factors influencing use of ICT based market interventions in accessing market information, the primary data was collected from Lilongwe and Dedza Districts in the Central Region. These areas were purposively targeted because they are some of the areas that IDEAA-MACE is working in and have well established MIPs. The emphasis on these areas was to target smallholder maize farmers who have access to ICT based market interventions and participate in markets. The focused modern ICTs were radio, SMS through mobile phone and information displayed at an MIP set by IDEAA - MACE in the district. For a rural smallholder farmer in Lilongwe and Dedza, these are the main modern ICTs that they can easily access.

Lilongwe is the Capital City of Malawi in the Central Region of the country, located between the latitudes 13 30' and 14 45' South, and longitudes 33 15' and 33 30' East (Figure 4). It has total land area of 6,159 km^2 representing 6.5% of total land in Malawi. The district has average annual rainfall of between 800 to 1000mm and mean annual temperature of about 20 to 22.5 degrees celsius. The main food crops grown are maize, cassava, sweet potato, beans, groundnuts, soybean and cowpeas. The cash crops mainly grown are tobacco, cotton and paprika (Lilongwe District Assembly, 2006).

As a suitable area for agriculture, most of the land in Lilongwe is used for crop, livestock and fisheries as the main economic activities. Of the total land, 429,435 ha is arable land under smallholder farmers with an average of 1.22ha per farmer and 11,525 ha is under estate farming shared among 25 estates in the district. On agriculture land use, 57 percent of the arable land is used for growing food crops while only 8 percent is used for cash crops. As a main staple food, 39 percent of the 57 percent arable land is used for maize production. These agricultural activities depend on both rain-fed and irrigation farming (Lilongwe District Assembly, 2006).

Lilongwe District has 19 Extension Planning Areas (EPAs) and 228 sections covering 350, 6633 farm families with a total population of 1.3 million people. As of 2006, the district had 147 market points owned by private institutions, ADMARC and the District Assembly (Lilongwe District Assembly, 2006).

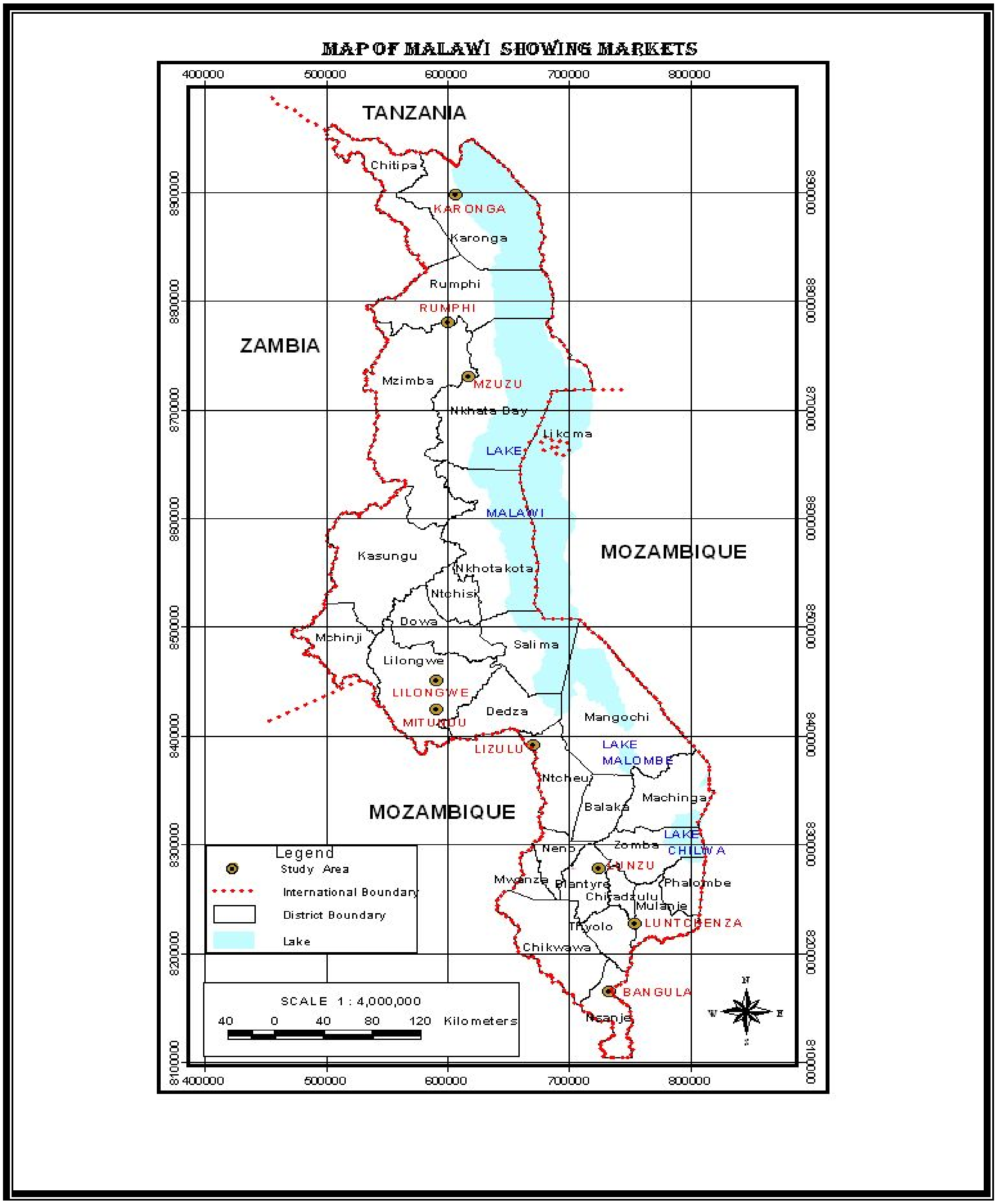

Figure 4: Map of Malawi showing case study markets

Dedza District is one of the nine districts in the Central Region and is a well-established township in the country (Figure 4). It is located about 86 km south of Lilongwe. The district total land area is 3,624 square km which is 4% of the total surface land in Malawi. The topography in the district includes the plains, highlands and an escarpment. The altitude of the highlands varies from 1000 to 2200m above sea level while the district average temperature varies between 7.5 and 12.5 Degrees Celsius (Dedza District Assembly, 2007).

The total arable land available in Dedza is 357,862 hectares of which only 57.7 percent is highly suitable for agriculture. Of the total arable land, 63 percent is under smallholder famers, 2 percent is for commercial or estate farming and 24 percent is total wetland area. Under agriculture, the main crops grown are maize, tobacco, legumes and tuber crops (especially Irish Potatoes). These crops are grown under both rain fed and irrigation farming in the district (Dedza District Assembly, 2007).

The district extension system uses the well-established government extension system. To effectively manage the extension, the district is demarcated into 10 Extension Planning Areas (EPAs) and 169 smaller sections, serving 174,068 farm families. The districts markets are managed by ADMARC, District and Town Council and private traders. Considering the topography of the districts, some smallholder farmers do not easily access ADMARC and districts markets. Such areas are mostly served by the private traders (Dedza District Assembly, 2007).

To assess market efficiency, the study sourced secondary data on prices from Ministry of Agriculture and Food Security for the selected nine markets in all the three regions of Malawi. Specifically the markets were Karonga, Rumphi and Mzuzu in the Northern; Mitundu, Lilongwe and Lizulu in the Central; and Lunzu, Luncheza and Bangula in the Southern Regions, respectively (Figure 4). These markets were chosen because they are the main maize trading markets in the regions. In addition, based on data requirements, these markets had available data for pre and post ICT intervention periods.

Geographically, Mitundu market is in Lilongwe District while Lizulu market is located in Dedza District. Lunzu market is in Blantyre District, Luncheza market is in Thyolo district and Bangula market is in Nsanje District. These markets were selected in each region to assess their integration before and after the ICT market interventions in 2004.

4.3 Data Type, Sources and Collection

Data was collected and sourced at three levels involving smallholder farmers, implementers of ICT interventions at MIP and weekly maize prices. A semi – structure questionnaire was used to collect the cross sectional data from the smallholder farmers based on the data needs. The questionnaire was pre-tested and administered in all the selected areas.

In-depth interviews with key informants were conducted at Mitundu and Lobi EPA MIPs. Since IDEAA works hand in hand with the Ministry of Agriculture and Food Security, the key informants were also consulted to assess the challenges encountered in the price data collection and dissemination of such information through modern ICTs. Considering that ICT based market interventions cover the whole Malawi and target all available markets through radio and SMS, the study sourced and used time series data for the selected markets in the three regions to analyze spatial market integration in Malawi.

Cross sectional data was collected from smallholder farmers in Dedza District (Chimbiya and Lobi EPAs) and Lilongwe District (Mpingu and Mitundu EPAs). These famers were targeted because of their proximity to MIPs and their participation in markets. Such farmers also use radio programs and phone – SMS initiatives to market their products. The primary data focused on awareness and use of ICT based market technologies provided, access to informal and formal financial services, educational levels, markets access, and challenges encountered when using and providing the ICT based market interventions and other socioeconomic variable of household head.

On market efficiency and spatial integration, monthly nominal maize retail prices for the nine markets (Karonga, Rumphi Mzuzu, Mitundu, Lilongwe Lizulu, Lunzu, Luncheza and Bangula) was sourced from MoAFS and IDEAA offices. In the sample, the urban markets are Mzuzu, Lilongwe and Lunzu. Monthly retail price data was available from January 1992 to December 2009. Where there were data gaps, extrapolation method was used. Considering that nominal prices do not consider inflation, Food Consumer Price Index (CPI year 2000 = 100) was used to deflate nominal prices using splicing method (See Appendix 1). Food CPI was used because maize has a weight of 60 percent in the index. The CPI data was source from National Statistical Office and Reserve Bank of Malawi.

4.4 Sampling and Sample Size

To collect the primary data from the smallholder farmers, multi-stage sampling was applied. Based on the sampling formula for population greater than 10, 000 the total sample size was 340 smallholder farmers (see Appendix 2). 170 farmers were selected from each district and 85 farmers were randomly selected from each section. The sampling was done at district, EPA, section, village and household levels.

In each district, two EPAs were purposively selected because of their proximity to main trading centres. Between the two EPAs, one EPA was selected because of the MIP in the area while the other EPA had no MIP. The EPAs without MIP were selected based on maize and other produce marketing activities within a trading centre. This was deliberately done to assess the use of ICT even in areas where IDEAA is reaching out through radio and mobile phone-SMS use only. Lobi and Mitundu EPAs have MIP in their area while Chimbiya and Mpingu have no MIP in their area but have well established maize market points in the region. From the selected EPAs, a section was also purposively selected based on its proximity to an MIP and targeted promotions by IDEAA-MACE on modern ICT use.

At the village level, Proportional Probability Sampling (PPS) was used to select six villages in each section of roughly 10 or more villages based on established government statistics in all districts. To further sample the households, simple random sampling based on random tables was employed to populations within the villages. At the household level, the household head or the spouse was selected for interviews. Since any farmer was capable of accessing the outlined ICT tools, the sample was drawn from the whole village population.

4.5 Data Processing

The collected data was entered, cleaned and analyzed using SPSS and STATA packages. Qualitative and quantitative data were entered in Excel and SPSS for easy transfer to other analysis packages like STATA. For the primary data, descriptive statistics and logit model analyses were done in STATA and SPSS.

The real monthly price time series data was entered and cleaned in Excel. The real price data was analyzed in SPSS and STATA. Co-integration and price transmission analysis was applied to real price time series data to assess effect of modern ICTs in improving spatial market integration.

4.6 Summary

The chapter discussed the study area, sampling, data collection and data processing for both the cross-sectional and time series data. The discussion on study area and sampling techniques described the multi-stage sampling that was used. It further discussed the geographical and socioeconomic factors of the districts where the data was collected.

The chapter also outlined the price data used for co-integration and price transmission analysis. The analyses used Excel, SPSS and STATA as analytical packages.

CHAPTER FIVE

SMALLHOLDER FARMER SOCIOECONOMIC CHARACTERISTICS

5.1 Introduction

This chapter presents descriptive statistics for socioeconomic factors from sampled farmers in Lilongwe and Dedza Districts. The socioeconomic analysis assists in understanding farmers' characteristics within ICT categories of modern, non-modern and combination of both modern and non-modern.

Subsequent sections in the chapter statistically compare farmer characteristics by district based on differences in using ICTs to access market information. The comparison was done on smallholder farmers with the same probability of using modern ICTs generated using propensity score technique. The socioeconomic variables include gender, age, marital status and education level of household head; access to extension services, market and credit; membership to an association, annual income and physical asset wealth. Since most of the variables presented are used in logit model in Chapter six, Table 5.22 presents the summary statistics for the variables used in the model. The chapter further presents reasons for not using modern ICTs among smallholder farmers.

5.2 Distribution of ICT among the Sampled Smallholder Farmers by EPA

Smallholder access to market information was mainly through modern or non-modern ICTs as discussed in Section 3.4.2.5. Although there are two major distinct ICT categories of modern and non-modern ICTs, some farmers used both modern and non-modern ICTs. Thus, the farmer characteristics were described based on three categories of modern ICT (MI) farmers, non-modern ICT (NMI) farmers and both ICT (BI) farmers. Table 5.1 shows that the total number of observations that was used in this study is 318 smallholder farmers from the sampled 340. Other observations were dropped after running the propensity score technique. From the table, 51 percent were from Lilongwe District while 49 percent were in Dedza District. Within the districts, 13 percent and 24 percent of the respondents in Lilongwe and Dedza, respectively, were modern ICT farmers. Of the sampled farmers, 22 percent and 26 percent in Lilongwe and Dedza, respectively, were combing both modern and non-modern ICTs.

Table 5. 1: Distribution of smallholder farmers by ICT category in districts

District	% Modern ICTs (MI)	% Non- modern ICTs (NMI)	% Both ICTs (BI)	% Total
Lilongwe	13.0	65.2	21.7	**100**
Dedza	23.6	51.0	25.5	**100**
Total	**18.2**	**58.2**	**23.6**	**100**

Source: Smallholder Household Survey in Lilongwe and Dedza Districts – March 2010
Note: n = 318

5.3 Farmer Characteristics

5.3.1 Gender of the household head

Of the total sampled households, Table 5.2 shows that 19 percent were female headed households. In Lilongwe, 11 percent of the households were female headed compared to 27 percent in Dedza District. The representation reflects the Integrated Household

Survey 2 (IHS 2) for Malawi, where 22 percent of the households in the country were female-headed (NSO, 2005). Among the MI farmers, no female headed household was observed in Lilongwe but at least 8 percent were observed in Dedza (Table 5.2). This is because most female headed households accessed marketing information through NMI. As indicated by Adesina and Chianu (2002), female farmers are less likely to use new technologies.

Table 5. 2: Gender group distribution within ICT categories

Gender	District								All			
	Lilongwe				**Dedza**							
	MI %	NMI %	BI %	**Total %**	MI %	NMI %	BI %	**Total %**	MI %	NMI %	BI %	**Total %**
Male	100	83.8	97.1	**88.8**	91.9	61.2	80.0	**73.2**	94.8	74.3	87.7	**81.1**
Female	0.0	16.2	2.9	**11.2**	8.1	38.8	20.0	**26.8**	5.2	25.7	12.3	**18.9**
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**
P-values	*0.082*	*0.005*	*0.078*		*0.003*	*0.001*	*0.267*		*0.003*	*0.000*	*0.0825*	

Source: Smallholder Household Survey in Lilongwe and Dedza Districts – March 2010

The *P-values* test significant differences in gender when ICT category equal to 1 and 0 otherwise

Note: Chi-Square values

Lilongwe = 7.739 *(P = 0.021)*
Dedza = 13.371 *(P = 0.001)*
Total Sample = 14.795 *(P = 0.001)*

Key:

MI = Modern ICTs
NMI = Non -modern ICTs
BI = Both ICTs

That is because male headed households are more likely to get information about new technologies and take risky business because of gender imbalances in terms of access to assets, education and support services compared to female farmers (Asfaw and Admassie, 2004). The chi-square shows that the variations within gender, in each ICT category, were significant at 1 and 5 percent for Dedza and Lilongwe Districts, respectively.

5.3.2 Age of the household head

The overall average age of the household head for the sample was 45 years. The mean age for Lilongwe was 43 years and 48 years for Dedza (Table 5.3). Comparing within the three ICT categories in the sample, the mean age of the household head in MI category was 43 years for Lilongwe and 44 years for Dedza. Highest mean age of 49 years was observed in Dedza within NMI farmer and BI farmer categories as presented in Table 5.3. To test for significant differences in mean ages between ICT categories in each district, F-test was used.

The F-test results for Lilongwe and Dedza district revealed that the mean ages in all ICT categories are not significantly different. Overall, the mean age of household head was not significant among the ICT categories (Table 5.3).

Table 5. 3: Mean age and education of household head

Household head characteristic	**District**								**All**			
	Lilongwe				**Dedza**							
	MI	NMI	BI	**Total**	MI	NMI	BI	**Total**	MI	NMI	BI	**Total**
Number of farmers (N0)	21	105	35	**161**	37	80	40	**157**	58	185	75	**318**
Average age of household head in years	43.05	44.39	38.71	**42.98**	43.73	48.75	48.92	**47.51**	43.48	46.27	44.95	**45.22**
	(2.59)	(1.59)	(1.98)	**(1.18)**	(1.98)	(1.66)	(2.12)	**(1.11)**	(1.56)	(1.16)	(1.57)	**(0.82)**
F - test		**0.1526**				**0.1679**				**0.3099**		
Average education of household head in years	3.67	4.02	5.54*	**4.30**	5.27	3.59*	4.95	**4.33**	4.69	3.83*	5.23	**4.32**
	(0.65)	(0.33)	(0.74)	**(0.29)**	(0.73)	(0.37)	(0.61)	**(0.30)**	(0.53)	(0.25)	(0.47)	**(0.21)**
F - test		**0.067***				**0.101***				**0.068***		

Source: Smallholder Household Survey in Lilongwe and Dedza Districts – March 2010

Note: The figures in parentheses are standard errors

* = significantly different from the rest of the groups at 10% level

To further understand the age distribution, Table 5.4 indicates that the distribution of farmers in each age category.

Table 5. 4: Age distribution by ICT category

Age range (years)	**District**								**All**			
	Lilongwe				**Dedza**							
	MI %	NMI %	BI %	**Total %**	MI %	NMI %	BI %	**Total %**	MI %	NMI %	BI %	**Total %**
20 - 30	9.5	22.9	28.6	**22.4**	16.2	7.5	7.5	**9.6**	13.8	16.2	17.3	**16.0**
31 – 40	42.9	32.4	34.3	**34.2**	29.7	28.8	17.5	**26.1**	34.5	30.8	25.3	**30.2**
41 – 50	28.6	15.2	11.4	**16.1**	13.5	25.0	30.0	**23.6**	19.0	19.5	21.3	**19.8**
51 – 60	9.5	6.7	22.9	**10.6**	35.1	15.0	27.5	**22.9**	25.9	10.3	25.3	**16.7**
60 - 70	4.8	14.3	2.9	**10.6**	5.4	15.0	12.5	**12.1**	5.2	14.6	8.0	**11.3**
≥ 71	4.8	8.6	0.0	**6.2**	0.0	8.8	5.0	**5.7**	1.7	8.6	2.7	**6.0**
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Source: Smallholder Household Survey in Lilongwe and Dedza Districts – March 2010

Note: Chi-Square values

Lilongwe = 19.013 *(P = 0.040)*
Dedza = 16.465 *(P = 0.087)*
Total Sample = 21.975 *(P = 0.015)*

Key:

MI = Modern ICTs
NMI = Non -modern ICTs
BI = Both ICTs

From the table, 30 percent of the sampled households were of ages between 31 and 40. Despite the differences in age distribution, chi-square shows that there were significant variations among ICT categories within each district. For instance, 72 percent of MI farmers in Lilongwe were of ages between 31 to 50 years while only 48 percent of NMI farmers were observed within the same age group.

5.3.4 Education of the household head

About 75 and 73 percent of the farmers in Lilongwe and Dedza Districts, respectively, had formal education in all ICT categories. Table 5.3 showed that the overall mean education level for two districts and the total sample was 4 years in school.

To compare the ICT means among the categories in Lilongwe (Table 5.3), F-test showed that the mean education levels in the ICT categories were significantly different at 10 percent. For Dedza District, the F-test showed that the mean education levels were also significantly different at 10 percent. To compare individual means, a t-test was used. For Lilongwe district, t-test showed that the mean education level for BI farmers (6 years) was significantly higher than the other ICT categories at 10 percent. For Dedza District, t-test showed that the mean education level for NMI farmers (4 years) was significantly lower than the other ICT categories also at 10 percent. To further understand education distribution, Table 5.5 presents distribution of farmers by different education groups against the ICTs categories.

The table shows that in both districts, over 60 percent of the farmers in all ICT categories had only formal primary education. Relating to IHS 2 (2005), 56 percent of the rural population had only primary education while 31 percent had no formal education in Malawi. Although most of the respondents had primary education, there were variations within ICT categories in the sample. For Lilongwe District, the chi-square shows that there were significant differences in education distribution within the

ICT categories at 10 percent. Contrary to Lilongwe, Dedza District showed no significant differences in variations of education distribution (Table 5.5).

Table 5. 5: Education level within ICTs categories

Education	District								All			
	Lilongwe				Dedza							
	MI %	NMI %	BI %	**Total %**	MI %	NMI %	BI %	**Total %**	MI %	NMI %	BI %	**Total %**
No formal education	23.8	26.7	20.0	**24.8**	27.0	30.0	20.0	**26.8**	25.9	28.3	19.2	**25.8**
Standard 1-5	42.9	41.9	25.7	**38.5**	21.6	37.5	30.0	**31.8**	29.3	40.1	27.4	**35.2**
Standard 6 - 8	28.6	25.7	34.3	**28.0**	35.1	26.2	32.5	**29.9**	32.8	25.7	34.2	**28.9**
Secondary	4.8	4.8	5.7	**5.0**	13.5	5.0	17.5	**10.2**	10.3	4.8	12.3	**7.5**
Tertiary	0.0	1.0	11.4	**3.1**	2.7	0.0	0.0	**0.6**	1.7	0.5	5.5	**1.9**
Adult literacy	0.0	0.0	2.9	**0.6**	0.0	1.2	0.0	**0.6**	0.0	0.5	1.4	**0.6**
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Source: Smallholder Household Survey in Lilongwe and Dedza Districts – March 2010

Note: Chi-Square values
Lilongwe = 16.755 *(P = 0.080)*
Dedza = 12.662 *(P = 0.242)*
Total Sample = 19.024 *(P = 0.040)*

Key:
MI = Modern ICTs
NMI = Non -modern ICTs
BI = Both ICTs

5.4 Household Characteristics

5.4.1 Household size

Table 5.6 show that the overall mean household size for Lilongwe and Dedza Districts was approximately 5 persons per household. From the table, the mean household size under the category of MI farmers was 5 persons for Lilongwe and 4 persons for Dedza District while mean household size for NMI farmers was 4 persons in both Lilongwe and Dedza. Looking at Malawi Census Report (NSO, 2009), the overall mean household size for Lilongwe rural was 5 while for Dedza rural was 4 persons per household. Overall mean household size from total sample was 5 persons. However, F-test and t-test results indicate no significant difference in the mean household size between ICT categories in all sample groups.

Table 5. 6: Smallholder farmers by some household characteristics

Household Characteristic	District								All			
	Lilongwe				Dedza							
	MI	NMI	BI	**Total**	MI	NMI	BI	**Total**	MI	NMI	BI	**Total**
Number of households (N0)	21	105	35	**161**	37	80	40	**157**	58	185	75	**318**
Average household size	5.38 (0.41)	4.81 (0.20)	5.43 (0.33)	**5.02 (0.16)**	4.35 (0.32)	4.73 (0.22)	5.10 (0.35)	**4.73 (0.16)**	4.72 (0.26)	4.78 (0.144)	5.25 (0.25)	**4.88 (0. .11)**
F – Test		**0.189**				**0.665**				**0.175**		
Average farm size in hectares	1.72* (0.19)	1.32 (0.08)	1.15 (0.14)	**1.33 (0.07)**	1.15 (0.08)	1.26 (0.09)	1.07 (0.11)	**1.19 (0.06)**	1.36 (0.94)	1.30 (0.59)	1.11 (0.88)	**1.26 (0.04)**
F – Test		**0.048**				**0.332**				**0.125**		
Average annual income of household in MK	75,700 (9704)	72,100 (13102)	167,000* (56635)	**93, 300 (15232)**	122,000 (21528)	83,800* (10104)	153,000 (32945)	**111,000 (11235)**	105,255 (14,401)	77,155* (8,614)	159,910 (31,519)	**101,800 (9,496)**
F – Test		**0.036**				**0.032**				**0.002**		
Mean distance to main market in Km	4.96 (0.80)	4.61 (0.31)	4.00 (0.58)	**4.52 (0.26)**	3.84* (1.22)	1.04 (0.13)	1.28 (0.18)	**1.76 (0.31)**	4.25** (0.829)	3.04 (0.225)	2.59 (0.332)	**3.16 (0.22)**
F – Test		**0.523**				**0.001**				**0.036**		

Source: Smallholder Household Survey in Lilongwe and Dedza Districts – March 2010

Note: Chi-Square values

The figures in parentheses are standard errors

* = significantly different from the rest at 10% level

** = significantly different from the rest at 5% level

Key:

MI = Modern ICTs

NMI = Non -modern ICTs

BI = Both ICTs

5.4.2 Farm size

Table 5.6 indicates that the mean farm size for the sample was 1.26 hectares (ha) but for Lilongwe and Dedza, the mean farm sizes were 1.33 and 1.19 ha, respectively. The averages for MI farmers, NMI farmers and BI farmers were 1.72, 1.32 and 1.15 ha for Lilongwe and 1.15, 1.26 and 1.07 ha for Dedza, respectively. As indicated in Section 1.2.1, many smallholder farmers have small landholdings on customary land. To compare the means in the district, both the f-test and t-test were used. From the results presented in Table 5.6, f-test shows that there were significance differences in farm size of farmers in Lilongwe district but not Dedza district. To further assess the significant differences, a *p-value* of less than 0.1 in the t-test showed that the mean farm size of MI farmers was significantly higher than mean farm size of NMI farmers and BI farmers in Lilongwe.

5.4.3 Household income and income sources

The overall average annual income of the sampled households was MK101, 800[10]. For farmers in Lilongwe and Dedza, their mean annual income was MK 93,300 and MK111,000, respectively as presented in Table 5.6. This is the annual income that farmers got from all income sources. To compare means within ICT categories in each district, both f-test and t-test were used. The f-test in Table 5.6 showed that there were significant differences in the mean annual income at 10 percent level of significance in

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[10] Mk = Malawi Kwacha. At the time of research, US$1.00 was equivalent to MK 152.00.

all districts. For Lilongwe district, the mean annual income in BI farmers was significantly higher than the means in MI farmers and NMI farmers at 10 percent based on the estimated t-test. For Dedza district, the mean annual income for NMI farmers was significantly lower than the other ICT categories using the t-test. From the overall sample, the mean annual income of NMI farmers was significantly lower than the other ICT categories based on the t-test.

Farmers can access income from different sources including agricultural sales, seasonal and permanent employment or small businesses. The seasonal employment entails on-farm *(ganyu)* and off-farm income generating activities that are done within a short period of time in a year. Permanent employment is the hired on-farm and off-farm income generating activity that runs continuously all year round for more than a year. Thus, Table 5.7 shows distribution of multiple responses on sources of income. The table indicates that the major source of income was agricultural sales. In both districts, at least 90 percent had agricultural sales as the major source of income. Specific to Lilongwe, 100 percent of MI farmers relied on agricultural sales but other MI farmers supplemented it with seasonal (24 percent) and permanent (9.5 percent) employment. This was also the case in Dedza although many MI farmers supplemented agricultural sales with small businesses.

Table 5.7 shows that almost 80 percent of the smallholder farmers in each ICT category sourced their annual income from agricultural sales because the targeted respondents were smallholder farmers who sell surplus produce after harvest. This income was supplemented by small businesses like selling home-made scones *(mandasi)*, buying and selling firewood and charcoal, running a kiosk, and brewing beer; and seasonal or permanent employment.

Table 5. 7: Distribution of income sources by ICT category

Income Source	District								All			
	Lilongwe				Dedza							
	MI %	NMI %	BI %	**Total %**	MI %	NMI %	BI %	**Total %**	MI %	NMI %	BI %	**Total %**
Agriculture	100	85.7	100	**90.7**	94.6	93.8	90.0	**93.0**	96.6	89.3	94.5	**91.8**
Permanent employment	9.5	6.7	8.6	**7.5**	5.4	5.0	2.5	**4.5**	6.9	5.9	5.5	**6.0**
Small Business	0.6	21.1	8.7	**30.4**	40.5	30.0	35.0	**33.8**	27.6	32.1	35.6	**32.1**
Seasonal employment	23.8	30.5	11.4	**25.5**	8.1	27.5	27.5	**22.9**	13.8	29.4	19.2	**24.2**
Other sources of income	9.5	4.8	5.7	**5.6**	10.8	11.2	17.5	**12.7**	10.3	7.5	12.3	**9.1**
Total	13.0	65.2	21.7	**100**	23.6	51.0	25.5	**100**	18.2	58.2	23.6	**100**

Source: Smallholder Household Survey in Lilongwe and Dedza Districts – March 2010

Note: The percentages within the ICT category are not adding up to 100 percent because of multiple responses.
Other sources of income included retirement fees, remittances and ox-cart services

Key:

MI = Modern ICTs
NMI = Non -modern ICTs
BI = Both ICTs

In the sample, the annual income distribution ranged from MK 2000 to MK2 million (Table 5.8). Among the respondents, 52 percent in Lilongwe and 40 percent in Dedza earned annual income between MK10,000 and MK50,000. In both districts, 26 percent earned between MK50,000 and MK100,000 annually. Only less than 2 percent of the respondents in both districts earned an annual income of over MK500,000 (Table 5.8). From the total sample, the income distribution is similar to district income distribution.

Table 5. 8: Annual income distribution by ICT category

	District											
	Lilongwe				Dedza				All			
Annual Income	MI %	NMI %	BI %	**Total %**	MI %	NMI %	BI %	**Total %**	MI %	NMI %	BI %	**Total %**
200 to 10000	0.0	4.8	0.0	**3.1**	2.7	6.2	7.5	**5.7**	1.7	5.3	4.1	**4.4**
10000.1 to 50000	52.4	57.1	37.1	**52.2**	40.5	47.5	25.0	**40.1**	44.8	52.4	31.5	**46.2**
50000.1 to 100000	19.0	27.6	28.6	**26.7**	24.3	23.8	30.0	**25.5**	22.4	26.7	27.4	**26.1**
100000.1 to 500000	28.6	8.6	31.4	**16.1**	32.4	22.5	32.5	**27.4**	31.0	14.4	32.9	**21.7**
500000.1 to 1000000	0.0	1.9	0.0	**1.2**	0.0	0.0	5.0	**1.3**	0.0	1.1	2.7	**1.3**
≥ 1000000.1	0.0	0.0	2.9	**0.6**	0	0	0	**0**	0.0	0.0	1.4	**0.3**
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Source: Smallholder Household Survey in Lilongwe and Dedza Districts – March 2010

Note: Chi-Square values

Lilongwe = 20.686 *(P = 0.023)*
Dedza = 11.922 *(P = 0.155)*
Total Sample = 23.197 *(P = 0.010)*

Key:

MI = Modern ICTs
NMI = Non -modern ICTs
BI = Both ICTs

Within the ICT categories in Lilongwe District, there were significant variations in income distribution at 5 percent. However, Chi-square for Dedza District shows that there were no significant differences in income distribution among the ICT categories.

5.4.4 Household wealth

As presented in Chapter 3, Section 3.4.2.3.1, annual income and expenditure can be endogenous to current production decisions while household asset reflects wealth accumulation over time. The Principle Component Analysis (PCA) explained in Chapter 3 was used to calculate household wealth index. PCA uses the asset factor score as weight for an asset variable in the wealth index.

Table 5. 9: Estimated factor scores in principle component analysis (PCA)

Physical Assets	**District**						**All**		
	Lilongwe			**Dedza**					
	Mean	Standard Error	**Factor Score**	Mean	Standard Error	**Factor Score**	Mean	Standard Error	**Factor Score**
Oxcart (1 = Yes)	0.05	0.017	**0.280**	0.08	0.021	**0.328**	0.06	0.2432	**0.3216**
Bicycle (1 = Yes)	0.63	0.038	**0.361**	0.52	0.040	**0.329**	0.58	0.4946	**0.2868**
Radio (1 = Yes)	0.51	0.040	**0.362**	0.59	0.039	**0.289**	0.55	0.4982	**0.2891**
Mobile phone (1 = Yes)	0.26	0.035	**0.252**	0.42	0.040	**0.336**	0.34	0.4743	**0.3129**
TV (1 = Yes)	0.00	0.000	**0.000**	0.10	0.024	**0.356**	0.05	0.2189	**0.3561**
Number of cattle	0.01	0.012	**0.299**	0.69	0.178	**0.309**	0.35	1.6023	**0.3262**
Number of goats	1.46	0.206	**0.356**	1.45	0.192	**0.153**	1.45	2.5098	**0.1804**
Thatched roof	0.86	0.028	**-0.460**	0.62	0.039	**-0.409**	0.74	0.440	**-0.430**
Mud floor	0.92	0.022	**-0.413**	0.79	0.033	**-0.418**	0.86	0.352	**-0.427**
Cumulative First Principle Component (PCA)			**0.275**			**0.353**			**0.3186**

Source: Smallholder Household Survey in Lilongwe and Dedza Districts – March 2010

The factor score can be positive or negative. A negative factor score shows a negative contribution to the wealth index while a positive factor score shows positive contribution to the wealth index (Filmer and Pritchett, 2001 and Vyas and Kumaranayake, 2006).

Table 5.9 shows that thatched roof and mud floor reduced the wealth index while other assets increase the wealth index. Following McKenzie (2003), household economic status is measured by the first principal component from the PCA analysis. Thus for this study, the first cumulative principal component for Lilongwe and Dedza explained 27 percent and 35 percent, respectively, of the total variance in the asset variables used. For the total sample, the first principal component explained 32 percent. As indicated by McKenzie (2003) and Chibwana (2010), the observed variances are good since acceptable first principal component can be as low as 12 percent.

To compute the household socioeconomic wealth index, the factor scores reported in Table 5.9 were weighted against the household's relevant physical holding assets to generate a socioeconomic score. This follows the approach by Filmer and Pritchett (2001), where the resulting socioeconomic score has a mean of zero and standard deviation equal to one. This score classifies the bottom two quintiles of the wealth distribution index as asset – poor households and zero otherwise. Based on the two bottom quintiles generated, Table 5.10 shows asset holding for poor and non-poor households.

Table 5. 10: Household asset ownership by wealth category

Physical Assets	**District**								**All**			
	Lilongwe				**Dedza**							
	Poor		**Non-poor**		**Poor**		**Non-poor**		**Poor**		**Non-poor**	
	Mean	Standard Error	Mean	Standard Error	Mean	Standard Error	Mean	Standard Error	Mean	Standard Error	Mean	Standard Error
Oxcart (1 = Yes)	0.000	0.000	0.425**	0.040	0.000	0.000	0.434***	0.041	0.0000	0.0000	0.4295***	0.4958
Bicycle (1 = Yes)	0.176	0.038	0.797***	0.053	0.122	0.036	0.707***	0.053	0.1630	0.3704	0.7313***	0.4449
Radio (1 = Yes)	0.098	0.032	0.722***	0.051	0.129	0.035	0.797***	0.051	0.1086	0.3120	0.7622***	0.4272
Mobile phone (1 = Yes)	0.143	0.055	0.496***	0.046	0.030	0.021	0.670***	0.050	0.0833	0.2777	0.5667***	0.4967
TV (1 = Yes)	0.000	0.000	0.000	0.000	0.000	0.000	0.447***	0.042	0.0000	0.0000	0.4238***	0.4950
Number of cattle	0.000	0.000	0.021	0.021	0.095	0.058	1.085***	0.288	0.0000	0.0000	0.5789***	2.0422
Number of goats	0.353	0.146	2.208***	0.310	0.730	0.186	1.925***	0.284	0.5937	1.4658	2.0316***	2.8783
Thatched roof (1= Yes)	0.471	0.043***	0.000	0.000	0.598***	0.050	0.083	0.036	0.5319***	0.5000	0.0361	0.1878
Mud floor (1= Yes)	0.439	0.041***	0.000	0.000	0.500***	0.045	0.030	0.030	0.4705***	0.5001	0.000	0.000

Source: Smallholder Household Survey in Lilongwe and Dedza Districts – March 2010

Note: *** = significantly different from the rest of the groups at 1% level
** = significantly different from the rest of the groups at 5% level

Table 5.10 showed that for Dedza, all the physical values considered in the wealth index are significantly different between the poor and non-poor households. For Lilongwe District, almost all the physical assets were significantly different except for cattle and the unobserved TV variable. In both districts, physical assets and household characteristics were significantly different between the poor and non-poor households.

To further understand the wealth distribution among the ICT categories in the districts, results are presented in Table 5.11. It was observed that 55 percent in Lilongwe and 65 percent in Dedza were non-poor households. Overall, 40 percent of the respondents were non-poor.

Table 5. 11: Wealth distribution within ICT category

Wealth	District								All			
	Lilongwe				Dedza							
	MI %	NMI %	BI %	**Total %**	MI %	NMI %	BI %	**Total %**	MI %	NMI %	BI %	**Total %**
Poor	9.52	60.95	20.00	**45.34**	13.51	46.25	32.50	**35.03**	87.9	45.4	73.3	**59.7**
Non-Poor	90.48	39.05	80.00	**54.66**	86.49	53.75	67.50	**64.97**	12.1	54.6	26.7	**40.3**
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**
P-values	*0.000*	*0.000*	*0.000*		*0.002*	*0.003*	*0.706*		*0.000*	*0.000*	*0.006*	

Source: Smallholder Household Survey in Lilongwe and Dedza Districts – March 2010

The *P-values* test significant differences in wealth when ICT category equal to 1 and 0 otherwise

Note: Chi-Square values

Lilongwe = 30.265 *(P = 0.008)*
Dedza = 12.064 *(P = 0.002)*
Total Sample = 40.7352 9 *(P = 0.000)*

Key:

MI = Modern ICTs
NMI = Non -modern ICTs
BI = Both ICTs

Of the MI farmers, 91 percent in Lilongwe and 87 percent in Dedza District were non-poor. For NMI farmers, 60 percent and 46 percent in Lilongwe and Dedza, respectively, were poor in physical assets. With the p-value of less than 0.05, the results show that there were significant differences between the poor and non-poor farmers expect for farmers who were using both ICTs in Dedza district. This concurs with Barrett (2008) who showed that there is a strong association between household asset holdings and household level market participation, where wealthier households are more likely to sell at a market than other households. Thus non-poor household were mostly observed in MI category while poor households were observed in NMI category.

5.4.5 Access to credit

Agricultural production in Malawi is predominantly rain fed. It is also the main source of income for most smallholder farmers. Access to credit is vital in acquiring capital assets but capital is usually a constraint in agriculture (Barrett, 2008). In Malawi, access to credit among smallholder farmers can either be formal or informal. The formal sources of credit include commercial banks and micro-finance organisation while the informal sources include credit from friends, relatives, other village members and 100 percent interest credit called *Katapila*.

Table 5.12 shows that 93 percent in Lilongwe and 71 percent in Dedza had no access to credit. Within the MI farmer category in Lilongwe, all the respondents had no access to credit but at least 32 percent in Dedza accessed credit. In all the three ICT categories for Lilongwe and Dedza, almost 93 percent of the respondents did not have access to credit.

Despite the differences in access, the chi-square for the districts shows no significant difference between those who accessed credit and did not access any credit among ICT categories except for overall sample. Using the t-test, the p-values indicate that significant differences were in NMI and BI farmers.

Table 5. 12: Smallholder access to credit by ICT category

Access to credit	District								All			
	Lilongwe				Dedza							
	MI %	NMI %	BI %	**Total %**	MI %	NMI %	BI %	**Total %**	MI %	NMI %	BI %	**Total %**
No	100	93.33	85.71	**92.55**	67.57	76.25	62.50	**70.70**	79.3	85.9	73.3	**81.8**
Yes	0.00	6.67	14.29	**7.45**	32.43	23.75	37.50	**29.30**	20.7	14.1	26.7	**18.2**
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**
P-values	*0.165*	*0.605*	*0.083*		*0.635*	*0.121*	*0.189*		*0.594*	*0.023*	*0.031*	

Source: Smallholder Household Survey in Lilongwe and Dedza Districts – March 2010

The *P-values* test significant differences in access to credit when ICT category equal to 1 and 0 otherwise

Note: Chi-Square values

Lilongwe = 4.154 *(P = 0.125)*
Dedza = 2.663 *(P = 0.264)*
Total Sample = 5.978 *(P = 0.05)*

Key:

MI = Modern ICTs
NMI = Non -modern ICTs
BI = Both ICTs

To understand the main reason for not getting any credit, Table 5.13 shows that at least 40 percent of those who did not access credit mainly attributed it to lack of opportunities for getting credit. Twenty four percent in Lilongwe and 36 percent in Dedza indicated fear of losing household assets once they fail to repay the loan as the main reason for not getting credit.

Table 5. 13: Main reason for not getting credit

Main reason for not getting credit	District								All			
	Lilongwe				Dedza							
	MI %	NMI %	BI %	**Total %**	MI %	NMI %	BI %	**Total %**	MI %	NMI %	BI %	**Total %**
Less opportunities of getting loans	47.6	48.0	43.3	**47.0**	44.0	42.6	40.0	**42.3**	45.7	45.9	41.8	**45.0**
Fear of losing household assets	23.8	26.5	16.7	**24.2**	28.0	41.0	32.0	**36.0**	26.1	32.1	23.6	**29.2**
No collateral	0.0	12.2	3.3	**8.7**	8.0	11.5	4.0	**9.0**	4.3	11.9	3.6	**8.8**
High Interest rates	19.0	8.2	13.3	**10.7**	4.0	0.0	8.0	**2.7**	10.9	5.0	10.9	**7.3**
Not Interested in getting a loan	4.8	1.0	10.0	**3.4**	16.0	4.9	16.0	**9.9**	10.9	2.5	12.7	**6.2**
Have enough finances, no need for a loan	4.8	4.1	13.3	**6.0**	0.0	0.0	0.0	**0.0**	2.2	2.5	7.3	**3.5**
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Source: Smallholder Household Survey in Lilongwe and Dedza Districts – March 2010

Note: Chi-Square values

Lilongwe = 16.384 *(P = 0.089)*
Dedza = 9.963 *(P = 0.267)*
Total Sample = 25.598 *(P = 0.02)*

Key:

MI = Modern ICTs
NMI = Non -modern ICTs
BI = Both ICTs

Other bottlenecks in getting credit included no collateral and high interest rates especially in the informal credit system. This agrees with Mehta and Kalra (2006) who indicated that in the absence of formal institutions, farmers resort to informal sector which is characterized by monopolistic practices and exorbitant interest rates.

Table 5.13 showed that 6 percent of the respondents in Lilongwe indicated that they did not need any credit because they have enough finances. The chi-square for Lilongwe indicated that there were significant variations within the ICT categories at 10 percent. For Dedza Districts, the variations were not significant.

5.4.6 Associations or farmer groups

Smallholder cooperatives or associations help in improving the bargaining power of producers. From the sample, Table 5.14 shows that only 9 percent of the respondents in Lilongwe and 32 percent of the respondents in Dedza were members of associations.

Table 5. 14: Smallholder membership to an association by ICT category

Member to an association	District								All			
	Lilongwe				Dedza							
	MI %	NMI %	BI %	**Total %**	MI %	NMI %	BI %	**Total %**	MI %	NMI %	BI %	**Total %**
No	90.48	93.33	82.86	**90.68**	51.35	80.00	57.50	**67.52**	65.5	87.6	69.3	**79.2**
Yes	9.52	6.67	17.14	**9.32**	48.65	20.00	42.50	**32.48**	34.5	12.4	30.7	**20.8**
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**
P-values	*0.972*	*0.115*	*0.073*		*0.016*	*0.001*	*0.119*		*0.004*	*0.000*	*0.015*	

Source: Smallholder Household Survey in Lilongwe and Dedza Districts – March 2010

The *P-values* test significant differences in access to membership to an association when ICT category equal to 1 and 0 otherwise

Note: Chi-Square values

Lilongwe = 3.411 *(P = 0.182)*
Dedza = 11.923 *(P = 0.003)*
Total Sample = 18.917 *(P = 0.000)*

Key:

MI = Modern ICTs
NMI = Non -modern ICTs
BI = Both ICTs

From the Table, more MI farmers (49 percent) and BI farmers (43 percent) were members of an association in Dedza compared to only 10 percent MI farmers and 17 percent BI farmers in Lilongwe. Chi-square indicates that there were significant differences within ICTs categories for association membership at 1 percent in Dedza but no significant differences were observed in Lilongwe. Overall, 21 of the respondents were members to associations in each ICT category. The p-values for the t-test show the significant differences of members and non-members in each ICT category. Thus, significant differences in Dedza district and the total sample were observed in all ICT categories at 10 percent level of significance.

5.4.7 Access to extension services

Extension is one of the channels where new information flows to smallholder farmers. Extension farm visits help in bridging the information gap thereby complementing information from other sources (Adesina and Baidu-Forson, 1995). Table 5.15 shows that 81 percent in Lilongwe and 67 percent in Dedza had access to extension services.

At least 72 percent MI farmers and BI farmers had access to extension services in both districts. This shows that the sampled respondents received information through extension services in the districts. The chi-square was significant for Lilongwe at 5 percent and not for Dedza District. From the table, the p-values compare the significant differences in percentages between ICT categories. For Lilongwe district, the significant differences in accessing extension were observed in NMI and BI categories while there were no significant differences in Dedza district. From the overall sample, significant differences in accessing extension were observed in NMI category at 5 percent level of significance (Table 5.15).

Table 5. 15: Smallholder access to extension services

Access to extension services	District								All			
	Lilongwe				Dedza							
	MI %	NMI %	BI %	**Total %**	MI %	NMI %	BI %	**Total %**	MI %	NMI %	BI %	**Total %**
No	14.29	23.81	5.71	**18.63**	27.03	38.75	27.50	**33.12**	22.4	30.3	17.3	**25.8**
Yes	85.71	76.19	94.29	**81.37**	72.97	61.25	72.50	**66.88**	77.6	69.7	82.7	**74.2**
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**
P-values	*0.586*	*0.021*	*0.027*		*0.371*	*0.128*	*0.385*		0.518	0.031	0.056	

Source: Smallholder Household Survey in Lilongwe and Dedza Districts – March 2010

The *P-values* test significant differences in access to extension services when ICT category equal to 1 and 0 otherwise

Note: Chi-Square values
Lilongwe = 5.970 *(P = 0.051)*
Dedza = 2.335 *(P = 0.311)*
Total Sample = 5.089 *(P = 0.079)*

Key:
MI = Modern ICTs
NMI = Non -modern ICTs
BI = Both ICTs

Despite the general understanding that at least 72 percent had access to extension, Table 5.16 shows that farmers mainly received agricultural production and marketing information from Government. The findings shows that between 87 and 91 percent received the agricultural production extension information from government officers in Lilongwe and Dedza districts, respectively. Only 3 percent were contacted by NGOs in Dedza district. The results agree with Chamdimba (2007), who observed that almost 72 percent of the respondents in Zomba had extension contacts in agricultural production and that extension was important in adopting new technologies in agro-forestry.

Table 5. 16: Type of extension information accessed

Access to extension services	District								All			
	Lilongwe				Dedza							
	MI %	NMI %	BI %	**Total %**	MI %	NMI %	BI %	**Total %**	MI %	NMI %	BI %	**Total %**
Agriculture production and marketing information from Government	88.9	86.2	87.9	**87.0**	88.9	93.9	86.2	**90.5**	88.9	89.1	87.1	**88.6**
Agriculture production and marketing information from NGOs	0.0	0.0	0.0	**0.0**	3.7	0.0	6.9	**2.9**	0.0	1.6	0.0	**0.8**
Forest management from Government	0.0	1.2	0.0	**0.8**	0.0	2.0	0.0	**1.0**	26.7	25.6	35.5	**28.4**
Public health from Government	33.3	28.8	42.4	**32.8**	22.2	20.4	27.6	**22.9**	2.2	0.0	3.2	**1.3**

Source: Smallholder Household Survey in Lilongwe and Dedza Districts – March 2010
Note: The percentages within the ICT category are not adding up to 100 percent because it is a multiple response.

Key: MI = Modern ICTs NMI = Non -modern ICTs BI= Both ICTs

Table 5.17 further indicates that 59 percent and 61 percent of the respondents who accessed extension in Lilongwe and Dedza, respectively, had a once in a month contact with an extension officer. This was the trend in all the ICT categories in the districts. About 26 and 33 percent were contacted once in a week in Lilongwe and Dedza. However, there are no significant differences in extension contact among the ICT categories in both districts based on the chi-square test.

Table 5. 17: Frequency of extension visit by ICT category

Access to extension services	District								All			
	Lilongwe				Dedza							
	MI %	NMI %	BI %	**Total %**	MI %	NMI %	BI %	**Total %**	MI %	NMI %	BI %	**Total %**
Once a week	16.7	26.2	30.3	**26.0**	37.0	30.6	34.5	**33.3**	28.9	29.0	30.0	**29.2**
Once a Month	61.1	58.8	57.6	**58.8**	63.0	63.3	55.2	**61.0**	62.2	59.5	58.3	**59.7**
Thrice a Month	11.1	10.0	6.1	**9.2**	0.0	0.0	0.0	**0.0**	4.4	6.1	3.3	**5.1**
Once a Year	11.1	5.0	6.1	**6.1**	0.0	6.1	10.3	**5.7**	4.4	5.3	8.3	**5.9**
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Source: Smallholder Household Survey in Lilongwe and Dedza districts – March 2010

Note: Chi-Square values

Lilongwe = 2.247 *(P = 0.896)*
Dedza = 3.097 *(P = 0.542)*
Total Sample = 14.499 *(P = 0.883)*

Key:

MI = Modern ICTs
NMI = Non -modern ICTs
BI = Both ICTs

5.4.8 Market access

Agricultural markets are critical to smallholder farmers in the two districts. In all the four EPAs where the study was conducted, there was one main trading center (Mitundu, Chimbiya, Mpingu or Lobi) but due to distance to the center, other study villages had local markets within their proximity. Local markets were small and offered minimal buying and selling options. The private traders were seasonal or permanent traders who established a market point to target sales of some products such as maize and tobacco. Since one of the pillars of IDEAA is to source markets for smallholder farmers, some farmers indicated that they depended on IDEAA tenders to market their produce.

One of the factors that determine market selection is distance to the market that defines transportation and other transaction costs (Barrett, 2008). Thus Table 5.6 showed the mean travel distance in km within ICT categories for the two districts and the total sample. Overall sample mean travel distance was 3.16 km. For Lilongwe and Dedza, the mean distance was 4.52 km and 1.76 km, respectively. To compare the means within ICT categories, both f-test and t-test were used. For Lilongwe district, there were no significant differences in mean distance to the market with a p-value of 0.523 in f-test. For Dedza District, the p-value of 0.001 in f-test showed that there were significant differences in mean distance to the market. Using the t-test, MI farmers traveled longer distances with a mean of 3.84 km and standard error of 1.22 than NMI farmers (1.04 km) or BI farmers (1.28 km). In the overall sample, the f-test showed significant differences in mean distance to the market. Further, the mean distance for MI farmers was significantly higher that the over categories.

Thus, mean distance for MI farmers was significantly higher than the other ICT categories at 10 percent. This implies that MI farmers were travelling long distance to market their produce based on acquired information. Acquiring information was the key to selling at a given market. This is in line with Jensen (2007) where fishermen in India were able to sell their catch in distance areas using information obtained via mobile phones. Further, Table 5.18 indicates that 80 percent of the respondents in all districts had an all season accessible road. That is, farmers were able use the road at all time to transport their produce to market places.

Table 5. 18: Number of distribution of respondents by condition of the road

Road condition	Lilongwe				Dedza				All			
	MI %	NMI %	Both %	**Total %**	MI %	NMI %	Both %	**Total %**	MI %	NMI %	Both %	**Total %**
All season car accessible	85.71	76.19	82.86	**78.88**	81.01	80.00	85.00	**81.43**	82.76	77.83	84.5	**80.19**
Seasonal car accessible dirt road	0.00	2.86	2.86	**2.48**	59.46	48.75	62.50	**54.78**	6.90	3.78	2.67	**4.09**
Partially seasonal car accessible dirt road	14.29	17.14	14.29	**16.15**	10.81	5.00	2.50	**5.73**	10.34	15.68	12.00	**13.84**
Non accessible by car	0.00	3.18	0.00	**2.48**	8.11	14.00	12.50	**12.73**	0.00	1.70	1.33	**1.88**
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Source: Smallholder Household Survey in Lilongwe and Dedza districts – March 2010

Note: Chi-Square values

Lilongwe = 4.436 *(P = 0.926)*
Dedza = 6.5687 *(P = 0.542)*
Total Sample = 6.489 *(P = 0.773)*

Key:

MI = Modern ICTs
NMI = Non -modern ICTs
BI = Both ICTs

Table 5.19 shows that the distribution of places where farmers were marketing their products. The table indicates that 48 percent of the farmers in Lilongwe and 63 percent of farmer in Dedza marketed their produce at the main trading center. This is so because it was within their proximity and there were more traders in these markets.

Table 5. 19: Smallholder access to markets by ICT category

Market Point	District								All			
	Lilongwe				Dedza							
	MI %	NMI %	BI %	**Total %**	MI %	NMI %	BI %	**Total %**	MI %	NMI %	BI %	**Total %**
Main trading centre	52.4	42.7	60.0	**48.3**	62.2	60.3	69.2	**63.0**	58.6	50.9	65.3	**55.9**
Private trader	23.8	37.1	31.4	**33.8**	8.1	35.9	28.2	**27.3**	13.8	37.3	27.8	**30.4**
ADMARC	23.8	16.9	20.0	**18.6**	10.8	15.4	15.4	**14.3**	15.5	16.0	18.1	**16.4**
Local market	9.5	13.5	8.6	**11.7**	13.5	10.3	17.9	**13.0**	12.1	11.8	13.9	**12.37**
Farm-gate	14.3	34.8	14.3	**26.9**	8.1	15.4	5.1	**11.0**	10.3	25.4	9.7	**18.7**
Action floors	14.3	9.0	17.1	**11.7**	10.8	1.3	7.7	**5.2**	12.1	5.3	12.5	**8.36**
IDEAA – MACE MIP	0.0	0.0	0.0	**0.0**	27.0	1.3	5.1	**8.4**	17.2	0.6	2.8	**4.35**

Source: Smallholder Household Survey in Lilongwe and Dedza Districts – March 2010

Note: The percentages within the ICT category are not adding up to 100 percent because of multiple responses.

In Lilongwe, no farmer had marketed their products at IDEAA MACE point while in Dedza, at least 8.4 percent sold through IDEAA – MACE point. Farmers in Lilongwe preferred other traditional markets than to rely on IDEAA. For NMI farmers in Lilongwe, 37 percent marketed through private traders while 35 percent marketed at farm-gate.

5.5 Statistics of Socioeconomic Variables

Based on the smallholder farmer characteristics, Table 5.20 gives summary statistic of variables used in the logit model. The statistic is provided for modern ICT (MI) farmers and non-modern ICT (NMI) farmers in Lilongwe, Dedza and the aggregate sample.

Table 5.20 shows that mean variables that were significantly different in Lilongwe District were gender and education of household head, access to extension and household wealth. For Dedza District, significant mean differences were observed in gender and education of household head, access to extension and credit, household wealth, membership to associations and distance to the main market. For the aggregate sample, the significant variables were similar to those observed in Lilongwe and Dedza plus one being a resident of Lobi and Mitundu EPAs.

Table 5. 20: Summary statistics of variables in logit model

Variable Name	Lilongwe			Dedza			All		
	MI	NMI		MI	NMI		MI	NMI	
	Mean	Mean	p-values	Mean	Mean	P-values	Mean	Mean	P-values
Age	40.78 (1.61)	44.09 (1.58)	0.186	46.03 (1.48)	48.90 (1.64)	0.197	43.84 (1.11)	46.16 (1.15)	0.165
Age squared	1800.48 (142.09)	2207.22 (160.68)	0.103*	2282.05 (141.48)	2607.22 (170.59)	0.147	2082.02 (103.37)	2379.56 (117.91)	0.074*
Female	0.02 (0.02)	0.16 (0.04)	0.007***	0.13 (0.04)	0.40 (0.05)	0.000***	0.08 (0.02)	0.26 (0.03)	0.000***
Education	5.00 (0.54)	4.00 (0.33)	0.084*	5.16 (0.47)	3.56 (0.37)	0.008***	5.09 (0.35)	3.78 (0.25)	0.008***
Farm size	3.28 (0.30)	3.30 (0.20)	0.966	2.76 (0.17)	3.10 (0.21)	0.205	2.98 (0.16)	3.22 (0.14)	0.274
Distance to the market	4.49 (0.48)	4.54 (0.31)	0.920	2.52 (0.62)	1.04 (0.12)	0.017**	3.33 (0.42)	3.04 (0.22)	0.498
All season road	0.83 (0.05)	0.75 (0.04)	0.221	0.61 (0.06)	0.49 (0.06)	0.163	0.70 (0.04)	0.63 (0.04)	0.254
Access to extension services	0.91 (0.04)	0.77 (0.04)	0.030**	0.73 (0.05)	0.60 (0.05)	0.080*	0.80 (0.03)	0.70 (0.03)	0.026
Once a week access to extension services	0.20 (0.06)	0.21 (0.04)	0.870	0.26 (0.05)	0.19 (0.04)	0.244	0.24 (0.04)	0.20 (0.04)	0.441
Once a month access to extension services	0.56 (0.07)	0.44 (0.05)	0.165	0.43 (0.06)	0.38 (0.05)	0.515	0.48 (0 .04)	0.41 (0.03)	0.220

Table 5.20: Continues

Access to credit	0.09 (0.04)	0.07 (0.02)	0.538	0.35 (0.06)	0.23 (0.05)	0.098*	0.24 (0.04)	0.14 (0.03)	0.014**
Membership to an association	0.12 (0.05)	0.07 (0.03)	0.261	0.44 (0.06)	0.21 (0.05)	0.001***	0.32 (0.04)	0.13 (0.02)	0.000***
Physical asset wealth	0.15 (0.05)	0.53 (0.05)	0.000***	0.25 (0.05)	0.54 (0.06)	0.000***	0.20 (0.04)	0.54 (0.04)	0.000***
Lobi EPA	-	-	-	0.54 (0.06)	0.41 (0.06)	0.135	0.32 (0.04)	0.18 (0.03)	0.005***
Linthipe EPA	-	-	-	0.46 (0.06)	0.58 (0.06)	0.135	0.27 (0.04)	0.25 (0.03)	0.701
Mitundu EPA	0.44 (0.07)	0.50 (0.05)	0.473	-	-	-	0.18 (0.03)	0.29 (0.03)	0.036**
Mpingu EPA	0.55 (0.07)	0.50 (0.05)	0.473	-	-	-	0.23 (0.04)	0.28 (0.03)	0.308

Source: Smallholder Household Survey in Lilongwe and Dedza Districts – March 2010

Note: The figures in parenthesis are Standard Errors

The p-values are for modern ICT = 1 and 0 for non-modern ICT

* = significant at 10 percent

** = significant at 5 percent

*** = significant at 1 percent

5.6 Reasons for Not Using Modern ICTs

One of the reasons for introducing modern ICTs was to make agricultural market information accessible to farmers and to address the problem of information asymmetry. The modern initiatives were introduced to farmers but 65.2 and 51.0 percent (see Table 5.1) of the respondents in Lilongwe and Dedza, respectively, did not use the technologies.

Table 5. 21: Reasons for not using modern ICTs

Reasons for not using modern ICTs	**District**		**All Sample**
	Lilongwe	**Dedza**	
	%	**%**	
Expensive to access	24.7	56.8	38.7
No knowledge on how to use the tools	30.6	27.2	21.5
Not needed	38.1	0.0	21.5
Lack of interest	25.8	23.5	27.4
Not aware of the ICTs tools	14.3	27.2	19.9
Its importance not known	2.9	4.9	3.8
No access to ICTs like MIP to visit	0.0	8.6	16.2
Not reliable when produce are available	0.0	2.5	1.1
Transport cost to send produce to better and far markets and low volumes of trade	2.9	9.8	6.4

Source: Smallholder Household Survey in Lilongwe and Dedza Districts – March 2010
Note: The percentages within the district are not adding up to 100 percent because of multiple responses.

The results in Table 5.21 show that 25 percent of smallholder farmers in Lilongwe and 57 percent in Dedza, found modern ICTs expensive. This is due to the initial procurement cost of the tool (phone or radio) and the cost of accessing information and managing the tool (i.e. airtime cost and battery cost). About 38 percent of the respondents in Lilongwe said they do not need the modern ICTs to source market information.

Thirty one percent of the farmers in Lilongwe and 27 percent in Dedza did not know how to use the tools to source market information while 26 percent in Lilongwe and 24 percent in Dedza were not interested in using modern ICT tools. These results agree with Taragola and Van Lierde (2009) study on horticultural farmers in Flanders, Belgium on internet use for sourcing farm business information. Taragola and Van Lierde (2009) indicated that lack of technical proficiency and understanding of how to benefit from the various ICT options were reasons for low internet use. Since MIPs were in limited places, 9 percent of the farmers in Dedza indicated that they had no access to free market information at an MIP. Overall, 39 percent of the respondents considered modern ICTs to be expensive to use for accessing marketing information.

5.7 Summary

The chapter has shown that information among sampled smallholder farmers in Lilongwe and Dedza Districts was mainly through modern, non-modern and a combination of both modern and non-modern ICTs. The modern ICTs included radio, SMS from mobile phone and MIPs, whereas the non-modern ICTs included sourcing market information through neighbours or relatives, traders or middlemen and extension officers. Of the whole sample, 18.2 percent accessed information mainly through the modern ICTs. In Lilongwe, 13 percent were modern ICT farmers as opposed to 23 percent in Dedza District.

There were significant differences in the socioeconomic variables of respondents from Lilongwe and Dedza Districts. The significant differences were observed in mean annual household income, asset wealth, distant to market and farm size; gender, education, marital status, age of household head and membership to an association. Household size and access to credit were not significantly different within the ICT categories in the Districts.

The chapter has also shown that the main source of income for the respondents was agricultural sales, supplemented by small business or employment. Credit was observed to be accessed by very few respondents and many farmers indicated that they lacked opportunities of getting loans.

In the sample, 58.8 percent were not using modern ICTs despite initiatives by IDEAA to make information easily accessible to the farmers. The major reason for not accessing modern ICTs was high initial capital cost. Since the main source of income was agriculture supplemented by business, the respondents mainly traded at the main trading centers within their proximity.

CHAPTER SIX

FACTORS INFLUENCING USE OF MODERN ICT

6.1 Introduction

This chapter presents results of a logit model and discusses the challenges associated with use of modern ICT based market interventions. The logit model was used to identify socioeconomic factors that influence use of modern ICTs. The use of modern ICTs was compared with that of non-modern ICTs smallholder farmers in the sampled districts based on the estimated propensity score matched groups. The modern ICTs include SMS through mobile phone, Radio programs and MIP.

Variables considered were age, gender, education of the household head; household farm size; physical asset wealth; access to credit and extension services; membership to an association or club; and distance to the main market center. The chapter therefore tests the hypothesis that socioeconomic factors listed above influence the use of ICT based market interventions among smallholder farmers. It further describes the challenges encountered when using modern ICTs.

6.2 Factors Influencing Use of Modern ICTs

6.2.1 Empirical results and discussion

The logit model was applied separately to each district (Lilongwe and Dedza) and to the aggregate sample. Each model was run based on propensity score matched groups. The three logit models were run in STATA and results are presented in Table 6.1.

Table 6. 1: Socioeconomic factors affecting use of modern ICT

VARIABLES	Lilongwe Model		Dedza Model		Aggregate Model	
	Coefficient	**Marginal Effects**	Coefficient	**Marginal Effects**	Coefficient	**Marginal Effects**
Age	0.180* (0.094)	**0.034***	0.0540 (0.084)	**0.014**	0.110* (0.059)	**0.026***
Age Squared	-0.00203** (0.001)	**-0.0004****	-0.000632 (0.001)	**-0.00016**	-0.00125** (0.001)	**-0.00029****
Female	-1.735 (1.191)	**-0.225**	-1.338** (0.520)	**-0.316****	-1.164*** (0.437)	**-0.239*****
Education	0.0130 (0.058)	**0.002**	0.0613 (0.060)	**0.015**	0.0275 (0.039)	**0.006**
Farm size	-0.0474 (0.093)	**-0.009**	-0.224** (0.113)	**-0.056****	-0.120* (0.069)	**-0.028***
Distance to main market	-0.0602 (0.074)	**-0.011**	0.270* (0.158)	**0.067***	0.0264 (0.050)	**0.006**
Access to Extension	1.313* (0.772)	**0.200***	0.665 (0.976)	**0.164**	0.800 (0.543)	**0.176**
Once a week extension visits	-1.095 (0.730)	**-0.175**	-0.657 (1.018)	**-0.162**	-0.706 (0.545)	**-0.155**
Once a month extension visits	-0.0272 (0.623)	**-0.005**	-0.325 (0.968)	**-0.081**	-0.102 (0.495)	**-0.023**
Access to credit	0.713 (0.792)	**0.153**	0.126 (0.447)	**0.031**	0.0525 (0.367)	**0.012**

Table 6.1: continues

Membership to association	0.113 (0.659)	**0.021**	0.770* (0.448)	**0.189***	0.593* (0.360)	**0.143***
Poor in physical asset wealth	-2.153*** (0.505)	**-0.362*****	-0.480 (0.465)	**-0.119**	-1.377*** (0.317)	**-0.302*****
All season road	1.439** (0.587)	**0.220****	0.393 (0.413)	**0.096**	0.762** (0.329)	**0.171****
Mitundu	-0.725 (0.534)	**-0.136**	- -		-0.953** (0.466)	**-0.305****
Lobi	- -		0.242 (0.431)	**0.059**	0.315 (0.415)	**0.230**
Mpingu	- -		- -		-0.670 (0.482)	**0.067**
Constant	-4.832** (2.339)		-1.322 (2.167)		-2.395* (1.452)	
N	161		157		318	
Log likelihood X^2	49.70		41.15		82.78	
Prob X^2	0.000		0.000		0.000	
Percentage of correct prediction	77		70		70	

Source: Smallholder Household Survey in Lilongwe and Dedza Districts – March 2010
Note: The figures in in parentheses are standard errors
Significance level *** p<0.01, ** p<0.05, * p<0.1

6.2.1.1 *Lilongwe model*

Lilongwe model correctly predicted 77 percent of the observations. The model was significant at 1 percent with chi-square of 49.70. The variables that significantly influenced use of modern ICTs were age of household head, access to extension, all season roads and physical asset wealth. Although the other variables were not significant, almost all had the hypothesized signs (Table 6.1).

Poverty in physical asset wealth greatly influenced use of modern ICT and had the highest marginal effect of 0.362. This implies that when a household is poor in asset wealth, the probability of using modern ICT declines by 0.362 units compared to a non-poor household. Concurring with the results, Barrett (2008) indicated that ownership of means of transport like bicycle and oxcart, which are physical assets, increases food grain market participation. Zeller *et. al*. (1997) also observed reduced adoption rate of new high valued crop technologies in Malawi when the farmer was very poor.

The decision to participate in distant markets depends on transaction cost arising from distance to the exchange place and road condition. The results show that all season roads increase the probability of searching market information using modern ICTs by 0.22. The variable was significant at 1 percent. This agrees with Makhura *et.al.* (2001) who observed a positive effect of good roads on smallholder maize marketing in Northern Province of South Africa.

From Table 6.1, age and age squared significantly influenced the use of modern ICTs at 10 percent and 5 percent, respectively. Age was squared to assess the decision of elderly farmers. For age variable, the marginal effect implies that unit increase in age increases the probability of using modern ICT by 0.034. Beyond economically active age (above 60 years in Malawi), increase in age decreases the probability of use of modern ICT as shown by age squared (Asfaw and Admassie, 2004). The results agree with Taragora and Van Lierde (2009) who indicated that age beyond the threshold negatively affects use of e-commerce as a source of information. The aged depend more on accumulated knowledge than modern ICTs.

Access to extension also positively influenced use of modern ICT at the 10 percent level of significance. The marginal effect shows that contact with extension workers increased the probability of using modern ICTs by 0.20. As observed by Adesina and Chianu (2002) and Adesina *et. al.* (2000), contact with extension agencies increases the probability of adopting new technologies. Farmers are made aware of the new technologies through extension agencies. Thus, the results show that the probability of using modern ICTs was higher for farmers who had contact with extension officers.

From the Lilongwe model, gender, education, frequency of extension visit, access to credit, membership to associations and EPA location were not significant but had the hypothesized signs. Despite Asfaw and Admassie (2004) indicating that education level is critical to household decision making, the observed education levels in this study were low to signify importance of education in the use of modern ICTs. As presented in

Table 5.5, almost 90 percent of the respondents had primary education only which influenced their literacy levels in accessing the modern ICTs. From Table 6.1, access to extension significantly influenced use of modern ICTs, but frequency of visit was not significant. As presented in Table 5.17, only 29 percent of the respondents had a once in a week visit by the extension worker and mostly the information was related to crop production and not marketing. Thus, frequency of visits did not significantly influenced use of modern ICTs among smallholder farmers.

Farm size and distance to the main market were not significant and had unexpected sign. Although gender of household head, frequency of extension visit, farm size, distant to the main market and Mitundu EPA location were not significant, the negative sign shows that the variables might decrease probability of using modern ICTs if significant. The positive sign on education, access to credit and membership to association indicates increase in the probability of using modern ICTs if the variables were significant (Table 6.1).

6.2.1.2 *Dedza model*

The Dedza logit results in Table 6.1 show that the model predicted correctly 70 percent of the observations. With a log likelihood chi-square of 41.15, the model was significant at 1 percent. The variables that significantly influenced use of modern ICTs were gender of household head, farm size, distant to main market place and membership to an association.

Gender of household head negatively affected the use of modern ICTs at the 5 percent level of significance. The marginal effect of 0.316 means that, if the household head is female, the probability of using modern ICT reduces by 0.316. This is in line with Adesina *et.al.* (2000); Hareth and Takeya (2003); and Adesina and Chianu (2002) who observed that female farmers are less likely to use new technologies due to socially conditioned inequalities in testing and using the new technologies, and poor access to agricultural resources.

Total farm size was hypothesized to positively influence use of modern ICTs but the results show a negative and significant relationship at 5 percent. The marginal effect shows that for every unit increase in farm size, the probability of using modern ICT reduces by 0.56 (Table 6.1). This can be attributed to the fact that virgin land is scarce in Dedza and the only way of increasing farm size is through renting or leasing at a cost. Thus smallholder farmers' decision to participate in marketing and search for market information is reduced by the perceived cost of leasing more land. According to Lee and Stewart (1983) the potential for technologies to reduce cost and provide economic benefits in the short run could create incentives for adoption even among renters and part-time operators. With modern ICT, farmers did not perceive short term benefits to increase farm size through renting or leasing.

From Table 6.1, distance to market places positively influenced use of modern ICTs in Dedza at 10 percent. The marginal effect of 0.067 implied that unit increase in distance increase the probability of using modern ICTs by 0.067 units (Table 6.1). Thus, the long distance made farmers to use modern ICTs to access market information in Dedza. As indicated by Makhura *et. al.* (2001), transaction cost include the cost of searching for a trading partner, hence farmers in Dedza used modern ICTs to obtain such marketing information.

Table 6.1 also shows that membership to an association positively influenced use of modern ICTs at 10 percent. The marginal effect of membership to association means that if a farmer is subscribed to an association, the probability of using modern ICTs increases by 0.189 units compared to farmers who are not in an association. This was the case because IDEAA MACE in Dedza was very active in encouraging the use of associations in marketing. This was a deliberate move for farmers to supply in bulk and gain economies of scale in transporting their produce to potential markets. The positive influence of membership to associations and adoption is due to the fact that associations reduce fixed travel costs in marketing and provide opportunity of sharing and processing information (Winter-Nelson and Temu, 2005).

In the Dedza model, age, age squared, education, extension, frequency of extension visits, access to credit, physical asset wealth, all season road condition and EPA location were insignificant but they had the hypothesized sign. From the insignificant variables age, education, extension, access to credit, all season roads and Lobi EPA location had positive signs. The results imply that the variables could increase the probability of using modern ICTs in Dedza if significant. The frequency of extension visit, age squared and physical asset wealth had negative signs. Thus, the variables could decrease the probability of using modern ICTs if significant.

6.2.1.3 *Aggregate model*

The aggregate model combines information from the two districts. The model was significant at 1 percent with a chi-square of 82.78 and 70 percent correct prediction of variables. From Table 6.1, variables that significantly affected the use of modern ICTs were age and gender of household head, farm size, membership to an association, physical asset wealth, road condition and location variable for EPA. As discussed in the district models, the variables that positively influenced the use of modern ICT were physical asset wealth at 1 percent, all seasonal accessible roads at 5 percent, age and membership to association at 10 percent. Gender of household head; age squared; Mitundu EPA location; and farm size, negatively influenced use of modern ICT at 1 percent, 5 percent and 10 percent significance levels, respectively (Table 6.1).

Physical asset wealth and gender of household head were significant at 1 percent and had large marginal effects, implying a greater influence in use of modern ICT. The significance of physical asset wealth is in line with Barrett (2008), who observed that the decision to participate in market and supply response to price changes are a factor of productive household endowment or physical asset wealth and cost of market access. For gender variable, the probability of using modern ICTs decreases by 0.239 if it is a female headed household. Since men are more likely to adopt new technologies and venture into risky business than females (Asfaw and Admassie, 2004), being a female headed household decreases the probability of using modern ICTs.

Of interest in the aggregate model is the variable on EPA location. The negative sign for Mitundu EPA implies that the probability of using modern ICTs declines if the farmer is a resident of Mitundu EPA, ceteris paribus. This was because IDEAA MACE market information point was seen as any ordinary market point and not as an information source for farmers. As observed by Herath and Takeya (2003), active dissemination of new technologies in early days of introduction help farmers to understand and learn how to benefit from such technologies. Thus, modern ICTs were not common among farmers in Mitundu.

From the aggregate model (Table 6.1), education, access to extension, frequency of extension visits, access to credit, distant to the main market, Mpingu EPA and Lobi EPA were not significant but had the hypothesized sign. Mpingu EPA indicated a negative effect on use of modern ICT while Lobi EPA in Dedza had a positive sign though not significant.

Comparing the Lilongwe and Dedza models shows that asset household wealth, all season roads, access to extension and age were factors that influenced use of modern ICTs in Lilongwe. In Dedza, gender of household head, farm size, distant to main market and membership to association were significant in influencing use of modern ICTs. Although farm size was not significant in Lilongwe, the negative sign might imply the challenge of increasing farm size through rents or lease as discussed in Dedza model results. The negative sign on distant to main market in Lilongwe implies that the probability of using modern ICTs to search for information declines when distant increases. As observed by Barrett (2008), this can be a result of overlooked institutional marketing infrastructure like contract laws, uniform grades and standards; and physical marketing infrastructure like roads and electricity which leads to spot markets.

6.3 Challenges Associated with Using ICT

New interventions such as modern ICT are introduced to positively address information asymmetry and gaps but such interventions have challenges that users encounter. Table 6.2 presents the challenges associated with use of each modern ICT when accessing information through SMS from mobile phones, radio and MIP. The subsequent sections describe the challenges encountered in each modern ICT category.

6.3.1 SMS through mobile phone

The biggest challenge encountered with mobile phones (62 percent of the respondents) was limited knowledge on how to send SMS to obtain the required information. IDEAA MACE hub has four codes for accessing information. The codes are for price information at wholesale; and retail and offers and bids. For instance, requesting maize retail price for Karonga market, one is supposed to indicate ‘MOA maize karonga’ and send to 08200777 at normal SMS charge of 10 units of airtime. This was the knowledge that was lacking among smallholder farmers with mobile phones.

Table 6.2 indicates that phone network was also a challenge in the EPAs. Of the respondents, at least 50 percent indicated network as a problem in their district while 43 percent felt the SMS charge was a problem. As indicated by Mehta and Kalra (2006), the financial affordability of modern ICTs like internet kiosks is a challenge for households within a village despite perceived low rates of obtaining price information.

6.3.2 Radio

The major challenge of accessing information through radio was that the announced prices were not offered in local market. Table 6.2 shows that 81 percent and 66 percent of the respondents in Lilongwe and Dedza, respectively were not offered the announced prices when transacting in local markets. Although IDEAA was announcing better prices, market intermediaries were free to offer their prices as it is a liberalized economy. Thus information dissemination initiatives without perfect competition still posed a challenge among smallholder farmers. The second problem was on cost of managing the radio like battery cost. Eleven percent of the respondents indicated unreliable network during call-in programs to bid or offer products as a third problem (Table 6.2).

Table 6. 2: Challenges associated with use of modern ICT

SMS from mobile phone	Lilongwe %	Dedza %	All %	Radio	Lilongwe %	Dedza %	All %	MIP	Lilongwe %	Dedza %	All %
Illiterate to operate phone to request information	58.9	63.8	61.6	The announced better prices were not offered in local markets	80.9	66.1	72.6	Unreliable price information	90.7	58.9	72.2
Operates where there is a network	53.6	50.7	52.0	Need batteries	24.7	29.5	31.4	Need to physically visit nearest MACE office	25.6	67.2	50.0
Cannot connect without the SMS charge	37.5	47.8	43.2	Not sure of quality of the product	14.6	11.6	12.9	Requires a group or an association to market at an MIP	4.7	4.9	2.9
Price variation between contact with buyer and actual sells	3.6	5.8	4.8	Unreliable network during call-in programs	1.1	19.6	11.4				
Lack of surety when transacting over the phone	1.8	4.3	3.2	No feedback	1.1	7.1	2.5				
Battery charge	3.6	1.4	2.4								

Source: Smallholder Household Survey in Lilongwe and Dedza Districts – March 2010

6.3.3 Market information point (MIP)

Apart from just displaying price information, IDEAA MACE was also buying products based on offers made by different stakeholders. In Lilongwe and Dedza Districts, 91 and 59 percent of the respondents, respectively, highlighted that they did not source information at an MIP because the offers through IDEAA MACE were unreliable. The offers depend on demand offered to IDEAA MACE at any given point in time, which is not consistent (Table 6.2). This means that, although displayed price information was better, farmers were still selling at local markets.

In Dedza, 67 percent of the respondents indicated the need to actually visit the MACE MIP as a challenge. Considering the geographical size of Dedza District, famers in Linthipe EPA and parts of Lobi EPA were far from Lobi MIP. In Lilongwe, 26 percent of the respondents, mostly farmers in Mpingu EPA noted that distance to MIP was a challenge.

6.4 Summary

The chapter has presented and discussed logit model results and challenges associated with use of modern ICTs. The socioeconomic factors that significantly affect the use of modern ICTs are gender and age of household head, household physical wealth, all season road condition, farm size, distant to main market place, access to extension, membership to associations and EPA location. In Lilongwe, household wealth negatively affected use of modern ICTs with elasticity of 0.362. For Dedza District, gender of household head highly influenced use of modern ICTs with elasticity of 0.316.

Smallholder farmers who accessed information using modern ICT experienced several challenges. The main challenges were the need to be literate in operating a phone and requesting information through SMS; phone network problems; unreliable price information when transacting in local markets and lack of physical evidence on quality of products when interacting over the radio.

CHAPTER SEVEN

SPATIAL INTEGRATION OF MAIZE MARKETS IN MALAWI

7.1 Introduction

This chapter presents empirical results of spatial integration for selected nine markets in Malawi. Using both linear and threshold error correction models, the chapter analyses co-integration and price transmission of spatially separated markets based on monthly real price data from January 1992 – December 2009. The co-integration analysis was done on full sample to identify co-integrating markets in Malawi.

Based on the identified co-integrating markets, price transmission was assessed in pre modern ICT period from 1992 to 2003 and post-modern ICT period from 2004 to 2009. This was done to analyse the contribution of ICT based market intervention in improving maize marketing efficiency through spatial integration. It tested the hypothesis that use of ICT based market interventions has not improved maize marketing efficiency in Malawi. The subsequent sections give data and statistical properties of data; and results of co-integrating markets.

7.2 Monthly Maize Prices and Statistical Properties

As presented in Chapters Three and Four, spatial integration of nine markets in Malawi was analyzed using monthly real price data valued in Malawi Kwacha. From the co-integrating markets, price transmission analysis was compared in pre and post ICT market intervention periods.

Agricultural production is mainly done in one rainy season in Malawi. This results in prices exhibiting seasonality related distribution and variations from several factors. The supply related factors include (i) natural disasters; (ii) economic factors such as structural transformation in markets; length of different marketing channels; transport and marketing infrastructure; or (iii) demand related changes like consumer habits. To understand the data in pre and post ICTs periods, basic descriptive analysis was done and the results are presented below.

7.2.1 Pre-ICT period

Table 7.1 gives real monthly maize price data from the specified nine markets before modern ICT interventions. The table shows that Lilongwe and Lunzu markets had the highest real market prices of MK28.99 and MK26.96 respectively. These are city markets where production is low and maize supply is mainly from rural areas (Jayne *et. al.*, 2008). Thus, high prices reflect the movement of maize from high producing areas to urban markets.

Mzuzu market had a maximum price of MK17.03 and a minimum price of MK4.00 while Rumphi had a maximum price of MK21.29 and a minimum price of MK2.89. This indicates that there were price variations within markets in the Northern Region. Although Mzuzu is a city market, the maximum observed price was lower than that of Rumphi market. This can be a result of high market supply to city markets as opposed to Rumphi market. As a city market, Mzuzu supply can be high since primary assemblers are optimistic of better prices in Mzuzu than Rumphi. Bangula market had the lowest observed price of MK2.14. Since Bangula is a border market, during lean maize supply periods it act as a major supply of maize from across the border (Jayne *et. al.*, 2008). Thus, prices can go low because of more supply from across the border.

Table 7.1 also shows the variations in maize prices over the years. From the estimated coefficient of variation, prices in all markets had variation of between 34 and 57 percent. Bangula and Mitundu markets had the highest variation of 56.52 and 55.28 percent, respectively. These variations can be attributed to fluctuations in maize grain production and supply from persistent natural disasters, among others, over the past decades (GoM, 2010b).

Table 7. 1: Pre-ICT real monthly maize prices (MK/Kg)

Variable	N	Mean	Standard error	Maximum	Minimum	Coefficient of Variation (%)
Karonga	144	7.51	0.22	18.27	3.51	34.85
Rumphi	144	6.82	0.26	21.29	2.89	46.59
Mzuzu	144	8.08	0.23	17.03	4.00	34.51
Mitundu	144	6.91	0.32	24.62	2.48	55.28
Lilongwe	144	8.90	0.37	28.99	3.10	49.44
Lizulu	144	7.40	0.32	21.18	2.84	51.38
Lunzu	144	9.22	0.37	26.96	3.06	47.97
Luncheza	144	8.61	0.35	23.68	2.86	48.41
Bangula	144	6.82	0.32	22.51	2.14	56.52

Source: Ministry of Agriculture and Food Security (2000 = 100)

Figures 5, 6 and 7 present the graphical distribution of maize prices in three regions of Malawi.

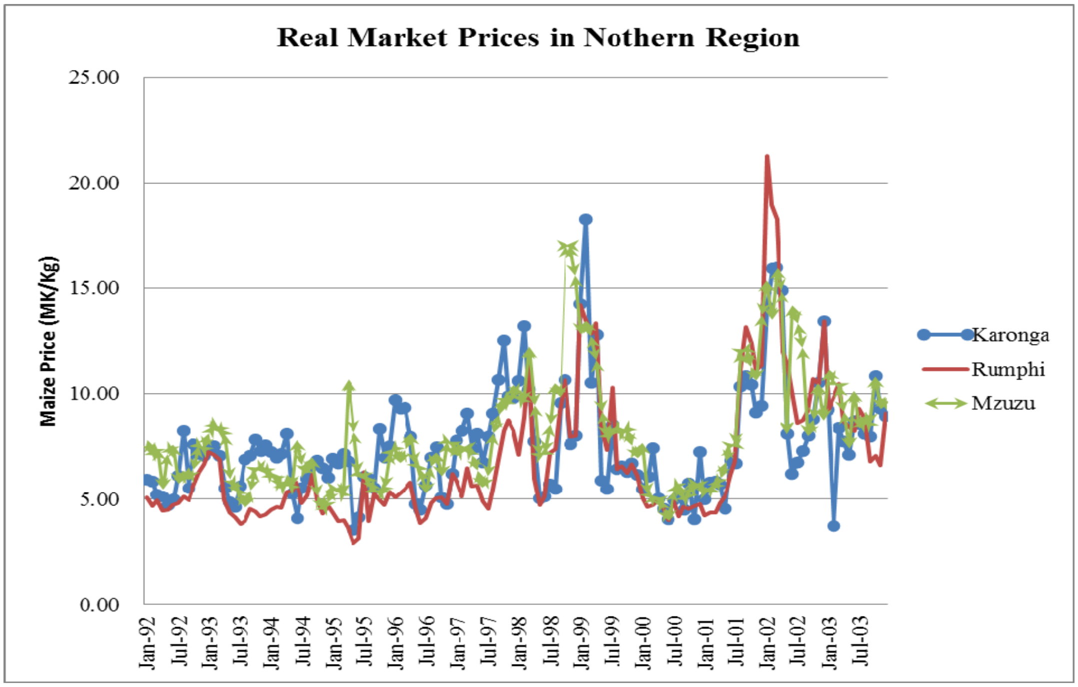

Figure 5: Seasonal distribution of real maize prices in Northern Region (2000 = 100)

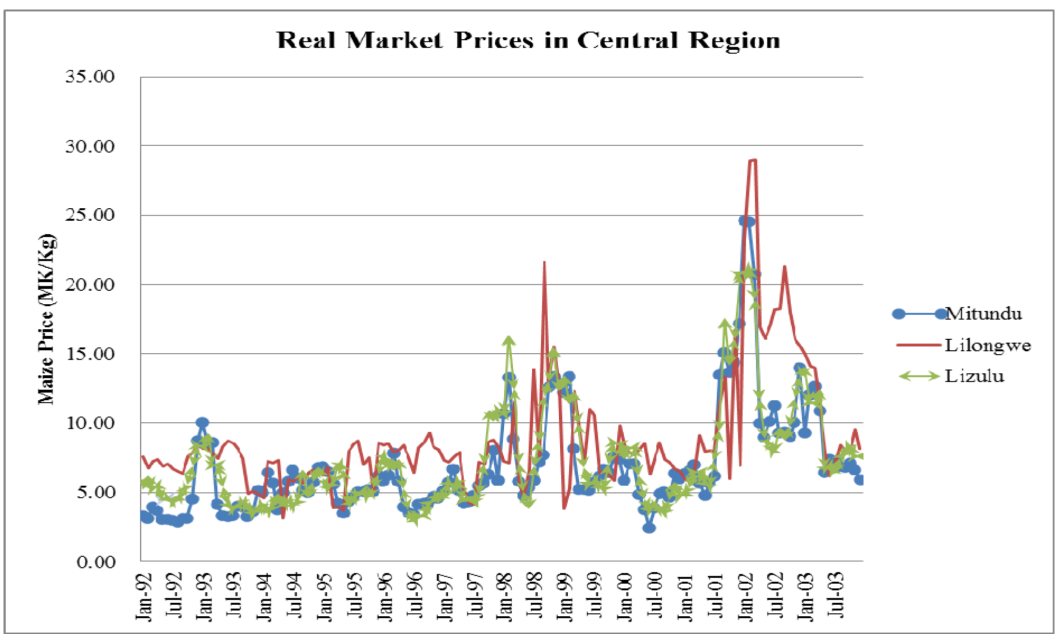

Figure 6: Seasonal distribution of real maize prices in Central Region (2000 = 100)

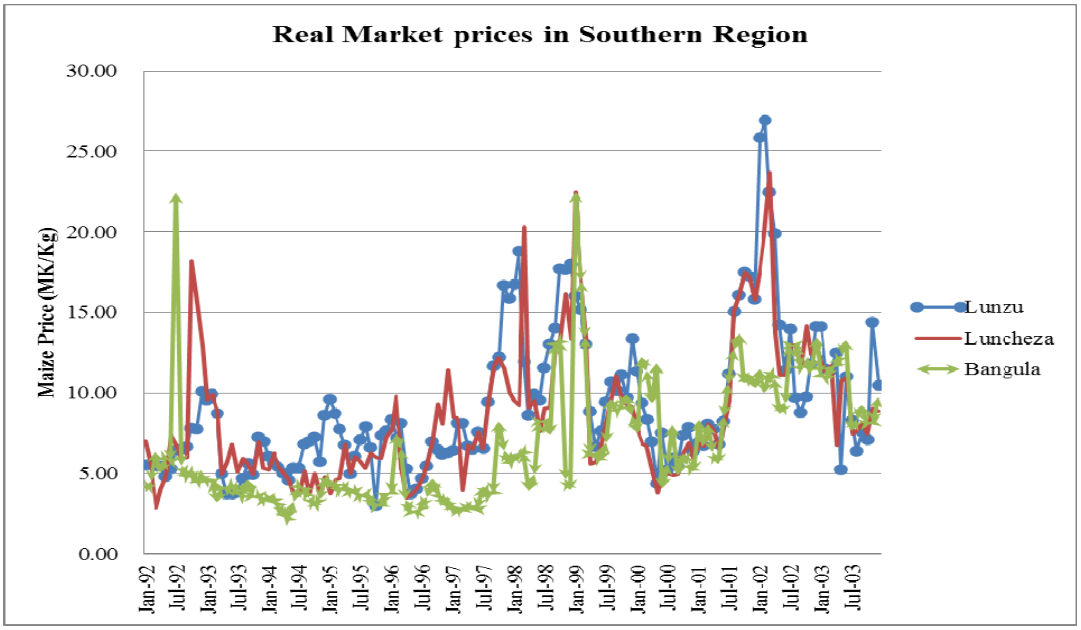

Figure 7: Seasonal distribution of real maize prices in Southern Region (2000 = 100)

The three figures indicate that price distribution follows the same pattern in the regions. In all markets, prices were high in 2002. This is due to low maize production following a drought that affected all parts of the country (GoM, 2010b). For the rest of the years, visual observation of the figures shows that there were price variations in all markets. This is mainly a factor of maize production and maize market supply in the regions. Although Central Region is the main maize producing area in Malawi while production is usually low in Southern and Northern Regions (GoM and WFP, 2010), the figures show that prices were distributed in the same pattern.

7.2.2 Post-ICT period

In post ICT period, Luncheza and Bangula markets had the highest observed market price of MK95.45 and MK94.84, respectively. GoM and WFP (2010) indicated that maize production is usually low in the Southern Region which affects market supply and prices. Therefore, the higher prices in Luncheza and Bangula reflect low maize supply and that supply is mostly from high producing areas like Central Region. Thus, the distance required to move maize from high producing areas to Luncheza and Bangula or the dependency on cross border informal trade (Jayne *et. al.*, 2008), raises the transaction cost and results in higher market prices. The lowest maximum market prices were observed in Mzuzu and Karonga markets at MK64.22 and MK66.45, respectively. Karonga District is a major producer of rice and not maize. As such, supply of maize is low since most people prefer rice (Katengeza, 2008). At the same time, high maize supply to Mzuzu City influences low prices. Thus, the lowest prices in Mzuzu and Karonga markets might reflect the high maize supply and low demand.

Table 7. 2: Post-ICT real monthly maize prices (MK/Kg)

Variable	N	Mean	Standard Error	Maximum	Minimum	Coefficient of Variation (%)
Karonga	72	31.02	1.93	66.45	10.41	52.69
Rumphi	72	32.13	1.91	89.33	12.45	50.42
Mzuzu	72	31.05	1.71	64.22	14.46	46.83
Mitundu	72	27.59	1.89	68.85	9.90	58.15
Lilongwe	72	31.73	1.87	72.00	14.22	49.94
Lizulu	72	28.66	2.02	76.39	11.69	59.86
Lunzu	72	31.92	2.16	79.86	9.50	57.38
Luncheza	72	33.11	2.48	95.45	13.35	63.59
Bangula	72	33.21	2.40	94.84	12.52	61.23

Source: Ministry of Agriculture and Food Security (2000 = 100)

Minimum prices were observed in Lunzu and Mitundu markets. As a major producing area of maize, low prices in Mitundu market reflect high maize supply from smallholder farmers. For Lunzu market, the easy access to the market provides an opportunity for traders to supply more maize thereby influencing lower prices.

Variations in the markets ranged from 46.83 percent to 63.59 percent, implying high variations in prices. This is reflected in the graphical presentation of price data in Figures 8, 9 and 10.

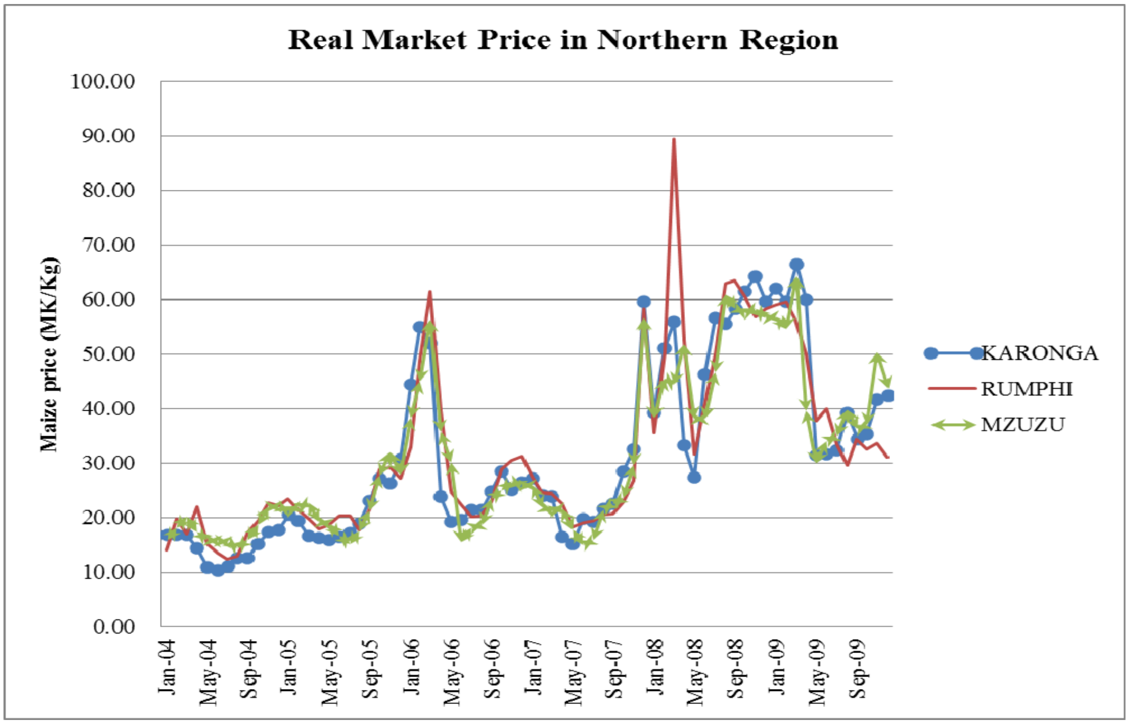

Figure 8: Seasonal distribution of maize real prices in Northern Region (2000 = 100)

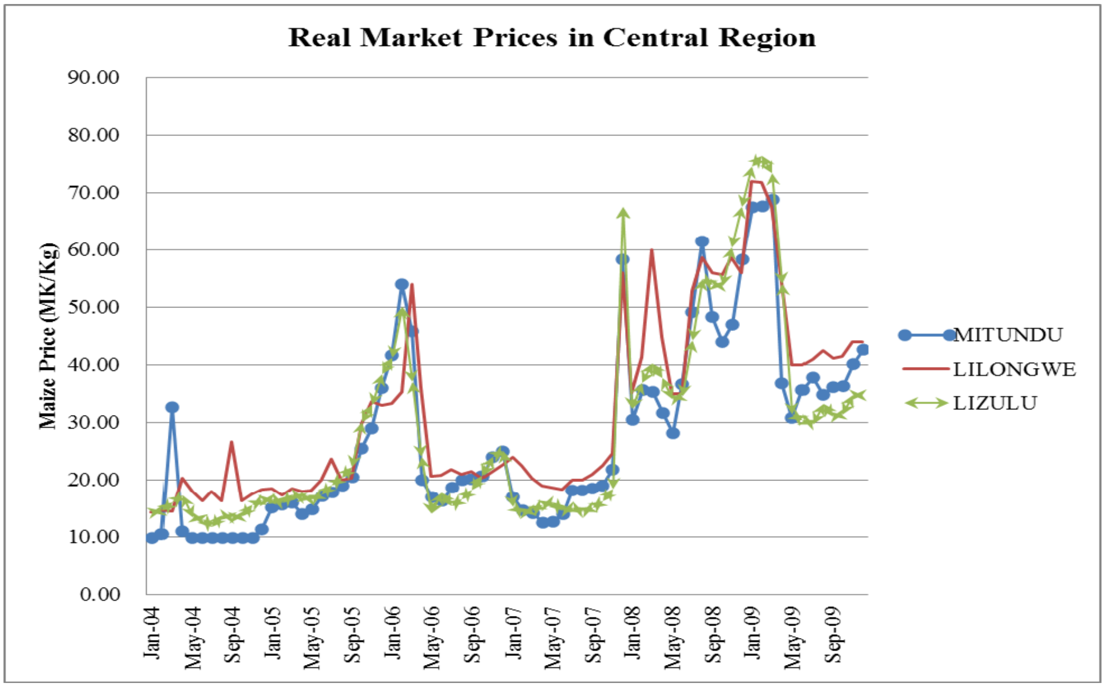

Figure 9: Seasonal distribution of maize real prices in Central Region (2000 = 100)

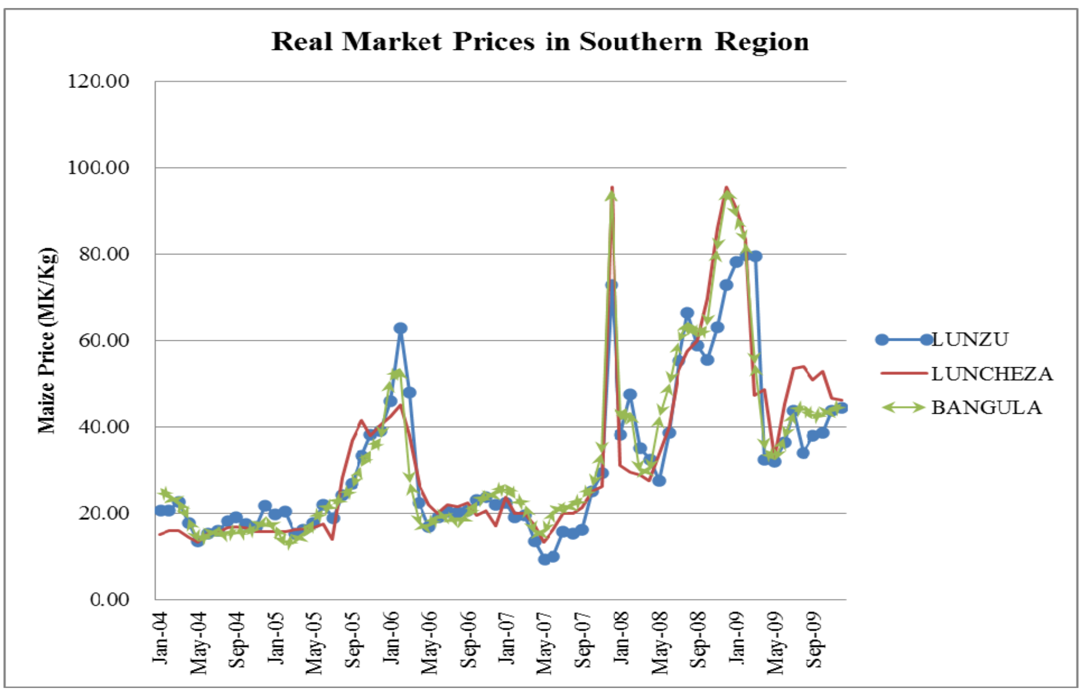

Figure 10: Seasonal distribution of maize real prices in Southern Region (2000 = 100)

The three figures show price distribution was following the same pattern in all markets. Looking at prices among the regions in pre and post-modern ICT periods, higher prices were observed in the Southern Region as opposed to the Northern and Central Regions. This can be attributed to low maize production and low market supply in the Southern Region. As observed by Ng'ong'ola *et. al*. (1997), Southern Region maize supply is mostly from Central Region which is considered as a maize food basket of Malawi. Therefore, the distance required to move maize from Central Region to Luncheza and Bangula markets in Southern Region increases transaction costs, thereby increasing prices. From Figures 5 to 10, price distribution was similar in pre and post-modern ICT periods.

7.3 Long-run Co-integration and Price Transmission

Modern ICTs were introduced to improve co-integration and price transmission, thereby contributing to market efficiency. To assess the effect of modern ICTs on price transmission, basic trend analysis and stationarity test were done for the whole period. After determining data stationarity, long-run bivariate co-integrating markets and the direction of causality were determined for the whole period (1992 – 2009). Based on the long-run bivariate co-integrating markets and the direction of causality in the whole period, price transmission was assessed in pre and post ICT periods.

7.3.1 Trend analysis

Trend analysis in time series data captures gradual and long-term factors that can have powerful influence on markets which may significantly alter seasonal patterns

(Goodwin, 1994). The analysis covers changes in market prices over time. As indicated by Goodwin (1994), trend factors are significant if time alone explains at least 15 percent or more of the variations in price series. The results of trend analysis for monthly real prices from January 1992 to December 2009 are presented in Table 7.3.

Table 7. 3: Maize Market Real Price Trend Analysis

Market	Trend coefficient	t-statistic of linear trend	R-squared of trend equation (%)
Karonga	0.0523	12.60	42.6
Rumphi	0.0654	15.70	53.5
Mzuzu	0.0515	13.81	47.1
Mitundu	0.0542	12.08	40.5
Lilongwe	0.0547	11.87	39.6
Lizulu	0.0530	11.40	37.7
Lunzu	0.0539	10.30	33.1
Luncheza	0.0601	10.49	33.9
Bangula	0.0743	14.25	48.6

The positive sign on all coefficients in Table 7.3 shows that maize market real prices have been increasing over time in all the specified markets. In all the markets, trend factors have had influence of more than 33 percent but less than 55 percent on real prices of maize as shown by the R-squared of the trend equation. Rumphi market had the highest trend factor of 54 percent. In Bangula market, trend factors influenced as much as 49 percent of the real price increases in the whole period. Thus, trend factors were significant in the specified period (Goodwin, 1994).

7.3.2 Stationarity test

The data on real maize prices was tested for stationarity as a pre – condition for co-integration analysis from 1992 to 2009. Augmented Dickey Fuller (ADF) test was used to test the hypothesis that the price series are non-stationary. Table 7.4 presents the results of the stationarity test for the markets in the sampled period. The appropriate lag length was selected based on Akaike Information Criteria (AIC). Considering the significance of trends in maize market, as estimated in Section 7.3.1, the stationarity test was done with and without trend entered as a time variable.

Table 7.4 shows that the analysis without trend had almost all price series being integrated of order zero I(0) at 5 percent significance level except for Rumphi, Mzuzu and Lilongwe. This implies that market price series in all market were stationary without differencing (Guajarati, 2004). Rumphi, Mzuzu and Lilongwe markets were not integrated of order zero when the analysis was without trend, meaning the price series were non-stationary. Considering the significance of trends, the results with trend indicate that all markets are stationary or integrated of order zero I(0) at 5 percent significance level. This implies that all market series were stationary with trend factor included. Following Shahidur (2004), further co-integration analysis includes markets with same order of integration. Thus, all markets were included in co-integration analysis with trend.

Table 7. 4: Unit Root Test for Real Maize Market Prices

Market	Real market price before differencing without trend					Real market price before differencing with trend				
	t-statistic	No of lags	Order of Integration	Critical Values		*t*-statistic	No of lags	Order of Integration	Critical Values	
				1%	5%				1%	5%
Karonga	-3.646 (0.004)	1	I (0)	-3.47	-2.88	-5.149 (0.000)	1	I (0)	-4.00	-3.44
Rumphi	-2.339 (0.159)	4	NS	-3.47	-2.88	-3.760 (0.032)	4	I (0)	-4.00	-3.44
Mzuzu	-2.045 (0.267)	7	NS	-3.47	-2.88	-3.568 (0.033)	7	I (0)	-4.00	-3.44
Mitundu	-3.925 (0.002)	1	I (0)	-3.47	-2.88	-5.402 (0.000)	1	I (0)	-4.00	-3.44
Lilongwe	-2.437 (0.131)	4	NS	-3.47	-2.88	-3.615 (0.028)	4	I (0)	-4.00	-3.44
Lizulu	-3.333 (0.013)	1	I (0)	-3.47	-2.88	-4.397 (0.002)	1	I (0)	-4.00	-3.44
Lunzu	-3.758 (0.003)	1	I (0)	-3.47	-2.88	-4.746 (0.001)	1	I (0)	-4.00	-3.44
Luncheza	-3.794 (0.003)	2	I (0)	-3.47	-2.88	-4.928 (0.000)	2	I (0)	-4.00	-3.44
Bangula	-3.750 (0.004)	1	I (0)	-3.47	-2.88	-5.770 (0.000)	1	I (0)	-4.00	-3.44

Note: The values in parenthesis are *P-values*

NS = Not Stationary
I (0) = Integrated of order zero (Stationary)

7.3.3 Long-run co-integration

The approach for testing integration of spatially separated markets is based on the fact that deviations from equilibrium conditions of two non-stationary variables should be stationary. This implies that while price series may wander extensively, pairs should not diverge from one another in the long run (Abdulai, 2006). The bivariate co-integration analysis used the eigenvalue and trace statistic in Johansen vector error correction model to test the spatial integration of two markets based on maximum co-integrating rank (*r*). This tests the null hypothesis that there is no co-integrating relationship ***(r = 0)*** between the two specified markets against the alternative that there is at least one co-integrating markets ***(r = 1).*** The long-run bivariate co-integration was done for the whole period to determine the co-integrating markets in the sample.

Table 7.5 shows the bivariate co-integrating markets. Within the regions the bivariate co-integrating markets are Karonga with Rumphi and Mzuzu in the north; Mitundu with Lilongwe and Lizulu; and Bangula with Lunzu and Luncheza. This implies that markets in each region were integrated. This is in line with price distribution in Figures 5, 6, 7, 8, 9 and 10.

Table 7. 5: Bivariate Co-integration coefficients of maize markets

Market j / i	Karonga	Rumphi	Mzuzu	Mitundu	Lilongwe	Lizulu	Lunzu	Luncheza	Bangula
Karonga	**0.000**								
Rumphi	31.262*	**0.000**							
Mzuzu	30.323*	11.149	**0.000**						
Mitundu	32.229*	15.311	13.770	**0.000**					
Lilongwe	11.746	15.115	21.314*	35.370*	**0.000**				
Lizulu	19.128*	23.704*	15.391	44.254*	17.022	**0.000**			
Lunzu	21.363*	17.798	16.845	23.990*	9.723	19.172*	**0.000**		
Luncheza	25.164*	20.426*	16.769	22.735*	13.232	20.192*	11.548	**0.000**	
Bangula	19.358*	10.938	11.868	14.931	16.587	12.520	26.425*	24.820*	**0.000**

Note: The asterisk * show the co-integrating relationship between markets *i* and *j* at 5 percent.

An integrating link *(r = 1)* is the one in which the trace statistic value is greater than the critical value. The critical value at 5 percent significance level is 18.17.

From Table 7.2, the inter-regional co-integrating markets were Karonga with Mitundu, Lizulu, Lunzu, Luncheza and Bangula; Rumphi with Luncheza and Lizulu; Mzuzu with Lilongwe; Mitundu with Lunzu and Luncheza; and Lizulu with Lunzu. Among the regions, Karonga market is integrating with almost all markets except Lilongwe market. Karonga District in the north is separated from the Central and Southern region by the Chiweta mountain range while Luncheza and Bangula markets in the south are separated from the country by Chikhwawa Mountains (Goletti and Babu, 1994).

Despite the geographical size, Karonga market was integrating with almost all markets including Luncheza and Bangula markets. Jayne *et. al.* (2008) observed that during lean period of maize supply in Malawi (from December to March), primary assemblers travel to remote areas and border districts to acquire maize supplies. Thus, Karonga market would integrate with Luncheza and Bangula markets when supply is influenced by informal imports. This is also the case with Rumphi and Luncheza markets. Where the integration between Rumphi and Luncheza happens informal imports supply maize in border districts and primary assemblers move the crop to low supplied areas.

Lunzu and Lizulu markets lie along the main road running across the country from the Northern to the Southern Region. The accessibility of these markets along the road creates a high probability of co-integrating with other regional markets as revealed by the results. Mitundu area in Lilongwe is one of the major maize producing areas (Lilongwe District Assembly, 2006). During post-harvest period (from April to May), supply is high and prices are low in main producing areas like Mitundu (Jayne *et. al.*, 2008). At Mitundu market, primary assemblers[11] acquire maize from smallholder farmers and transport it to urban markets or low producing areas. Considering that Karonga is a major producer of rice and not maize, the integration with Mitundu implies the link in maize supply from Mitundu (a high producing area) to Karonga that influences prices between the markets.

Lilongwe and Mzuzu are markets located in major cities in the two regions, where there is low maize production. The supply of maize to these areas depends on production from district and remote areas (Jayne e*t. al.*, 2008). The co-integration of Lilongwe and Mzuzu markets shows the integration of urban markets in Central and Northern Regions that are supplied by remote areas. As city markets, the co-integration is influenced by demand of the urban population.

7.3.4 Determining causal relationship between co-integrating markets

Co-integration of markets is an indicative measure of non-segmentation between two price series. It is a good tool that shows the existence (or not) of relation between two economic time series. Based on the co-integrating markets, the analysis allows for causality test to determine causal relationship between markets (Goletti and Babu, 1994). Using Granger Causality test, Table 7.6 shows the causal relationship between co-integrating markets for the whole period.

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[11] The primary assemblers include small scale traders on bicycle, local buyers in rural market, mobile buyers, and agents buying for large trading companies (Jayne *et. al.*, 2008)

From the table, there are eight unidirectional causal relationships and the rest are independent relationships. In the regional markets, Karonga was observed to Granger cause Rumphi market but there was an independent causal relationship between Karonga and Mzuzu. Since Karonga mainly produces rice, it cannot Granger cause Mzuzu market, which is an urban market. At the same time, Mzuzu did not Granger cause Karonga market.

Table 7. 6: Granger causality relationship between co-integrating markets

Market *i*	Market *j*	F_1	Prob > F_1	F_2	Prob > F_2	Direction of causality
Karonga	Rumphi	1.470	0.228	5.776	0.017**	**Unidirectional**
	Mzuzu	1.662	0.199	2.429	0.120	Independent
	Mitundu	6.520	0.011**	0.272	0.603	**Unidirectional**
	Lizulu	2.179	0.142	0.162	0.688	Independent
	Lunzu	0.130	0.719	0.086	0.769	Independent
	Luncheza	0.007	0.930	0.732	0.393	Independent
	Bangula	9.852	0.002***	0.003	0.954	**Unidirectional**
Rumphi	Lunzu	3.105	0.080*	0.128	0.720	**Unidirectional**
	Luncheza	8.348	0.004***	0.351	0.554	**Unidirectional**
Mzuzu	Lilongwe	0.125	0.723	0.281	0.596	Independent
Mitundu	Lilongwe	0.419	0.518	9.721	0.002***	**Unidirectional**
	Lizulu	1.042	0.309	2.564	0.100*	**Unidirectional**
	Lunzu	0.589	0.444	0.388	0.534	Independent
	Luncheza	1.574	0.211	0.548	0.460	Independent
Lizulu	Lunzu	6.119	0.014***	0.026	0.872	**Unidirectional**
Lizulu	Luncheza	0.169	0.681	1.879	0.197	Independent
Lunzu	Bangula	2.318	0.129	0.105	0.745	Independent
Luncheza	Bangula	0.478	0.490	0.718	0.398	Independent

Note: Values with asterisk (*) show granger causality. That is, Prob > f is higher at 1%, 5% and 10% and we fail to accept the null hypothesis.

H_o: $F_1 \neq 0$ (Market *j* does not granger cause market *i*)

H_o: $F_2 \neq 0$ (market *i* does not granger cause market *j*)

In Central Region, Mitundu market Granger caused Lilongwe and Lizulu markets. Being a major producer of maize, Mitundu market is a major supplier of maize to Lilongwe urban market. This signifies the co-integration between Mitundu and Lilongwe markets causing market integration. Although Dedza District produces maize, geographical size results in low maize production among smallholder farmers. Thus, the supply of maize to Lizulu market partly depends on supply from Lilongwe District especially Mitundu market. There was no unidirectional causal relationship in the Southern Region. This might have arisen from the fact that maize production and supply have been low in the specified markets to Granger cause each other. Luncheza and Bangula are low producing areas while Lunzu is an urban market.

Among the regions, Mitundu and Bangula markets Granger caused Karonga market while Lunzu and Luncheza Granger caused Rumphi market prices. Lunzu Granger caused Lizulu. The regional market causality signifies the integration of markets across the country, such as Luncheza and Rumphi; Bangula and Karonga. The casual relationship between Lunzu and Lizulu means that prices in Lizulu can be predicted based on Lunzu prices but not the other way round. Although there were only eight unidirectional causality, the independent causality in other co-integrating markets does not imply a total absence of price transmission. This might mean price signals are transmitted instantaneously under special conditions like relief or donation supply as indicated by Abdulai (2000).

7.3.5 Symmetric spatial price transmission

Co-integration and Granger causality test shows the co-movement of prices and the direction of causality, respectively. However, the analysis is not powerful to highlight how strong the relationship is between the two markets and how long it takes for a shock to be transmitted from one market to another (Goletti and Babu, 1994). Assuming symmetric price transmission, the analysis used the co-integrating markets with unidirectional causality to estimate price transmission. Using both the standard AR and TAR error correction models, the analysis compared price transmission in pre and post ICT periods in Malawi. The models were estimated without a constant. Table 7.7 gives the estimated price adjustment factors and half-life in standard AR and TAR models. The TAR model is a three regime symmetric model with unit root behavior imposed within the band formed by the thresholds. The thresholds are estimated through a grid search while half-life is the estimated time that is needed for a given shock to return to half its initial value presented in weeks.

7.3.5.1 *Pre-ICT price adjustment results*

Table 7.7 shows that the fastest significant price adjustment factor was observed in Lizulu-Luncheza market link both in AR and TAR models. The adjustment factor of 0.05 in AR model implies that it took 12.5 weeks for half of the price shock to return to the equilibrium price. In TAR model, the estimated adjustment factor of 0.07 implies that it took 9.3 weeks for half of the price shock to return to the equilibrium neutral price band. In the TAR model, the estimated transaction cost was 3.1 percent of the mean price in the markets. This indicates that price adjustment speed is faster in TAR model because it considers the threshold where there is no price adjustment. As indicated by Van Campenhout (2007) and Goodwin and Piggott (2001), TAR models are more appropriate in estimating price adjustment because they represent the amount that proportional price differences must exceed to cross the threshold and trigger the 'outside-band' regime adjustments.

Except for Mitundu – Lizulu link and Lizulu – Lunzu link, all the other co-integration market combinations show significant price adjustment factor of approximately 0.30 implying half-life of between 22.8 and 27.4 weeks in standard AR model. The results show that a shock in Mitundu – Lilongwe market link took 22.8 weeks for prices to adjust half way back to the equilibrium price. In pre ICT TAR model, Mitundu – Lilongwe link had a significant price adjustment factor of 0.05 implying 15 weeks half-life price adjustment to the equilibrium price neutral band. Karonga – Rumphi link; Karonga – Mitundu link and Lizulu – Lunzu link had a significant price adjustment of approximately 0.04 percent and half-life of between 16 and 20 weeks. As observed by Van Campenhout (2007), it was taking few weeks for price to adjust back to the parity price band in TAR model than in AR model.

Table 7. 7: Price adjustment factors in AR and TAR error correction models

Market Pair	Pre -ICT						Post - ICT				
	Distance (km)	AR Model		TAR Model			AR Model		TAR Model		
		ρ	Half-Life	δ	ρ	Half-Life	ρ	Half-Life	δ	ρ	Half-Life
Karonga – Rumphi	176	-0.029*** (0.010)	23.6	2.533	-0.043*** (0.009)	15.8	-0.148*** (0.025)	4.3	3.006	-0.189*** (0.023)	3.3
Karonga – Mitundu	620	-0.030*** (0.010)	22.8	3.107	-0.041*** (0.009)	16.6	-0.065** (0.033)	10.3	2.878	-0.078** (0.034)	8.5
Karonga - Bangula	804	-0.078*** (0.018)	8.54	4.038	-0.124*** (0.015)	5.23	-0.069* (0.026)	9.69	3.5719	- 0.084* (0.024)	7.90
Rumphi – Lunzu	545	-0.025*** (0.005)	27.4	3.960	-0.034*** (0.006)	20.0	0.057 (0.041)	11.8	3.392	0.069 (0.045)	9.7
Rumphi – Luncheza	821	-0.050*** (0.106)	13.5	3.167	-0.069*** (0.115)	9.7	-0.004 (0.024)	173.0	4.421	-0.009 (0.026)	76.7
Mitundu – Lilongwe	30	-0.030*** (0.010)	22.8	4.129	-0.045*** (0.012)	15.1	-0.120*** (0.039)	5.4	3.556	-0.142*** (0.041)	4.5
Mitundu – Lizulu	90	-0.014*** (0.006)	49.2	1.740	-0.019*** (0.007)	36.1	-0.186*** (0.060)	3.4	1.944	-0.209*** (0.062)	2.9
Lizulu – Lunzu	201	-0.024*** (0.008)	28.5	2.1822	-0.035*** (0.009)	19.5	-0.001 (0.036)	692.8	1.6510	-0.003 (0.037)	203.7

Note: ρ denotes adjustment parameter on the lagged price difference (expressed as a percentage of mean prices in the two markets), δ is the estimated thresholds, expressed as percentage of mean price in the two markets

Figures in parenthesis are standard errors. *** and ** denote significance levels at 1 percent and 5 percent, respectively.

This signifies that considering transaction costs when assessing price adjustment is important. As indicated by Abdulai (2000) in developing countries, vast distances and poor infrastructure lead to high transaction cost, thereby making arbitrage unprofitable and isolating markets. These transaction costs may lead to a neutral band within which prices are not linked to one another. Therefore TAR models are appropriate because price equalizing arbitrage is triggered only when shocks result in price differences that exceed the neutral band as opposed to AR models that do not consider transaction costs. From the results, TAR models had faster adjustment and fewer weeks of price adjustment half way back to the price band compared to AR models.

7.3.5.2 *Post-ICT price adjustment results*

The fastest significant price adjustment in post-ICT was observed in Mitundu – Lizulu market link. In standard AR model, the adjustment factor was 0.186 which implied a half-life of 3.4 weeks. This means that, when transaction costs are not considered in estimating the speed of price adjustment, it takes 3.4 weeks for half of the price shock to return to the equilibrium price. In TAR model, the significant adjustment factor was 0.209 percent which implied a half-life of 2.9 weeks. The estimated half-life shows that it took 2.9 weeks for a price shock in Mitundu market to return half way back to parity bound or threshold that covers transaction costs (Myers, 2008). The estimated threshold was 1.94 percent of the mean price. This entails that influencing factors that reduce transaction costs also influence the speed of price adjustment if there is a shock in the markets.

In Karonga – Rumphi market link the estimated price adjustment factor was 0.148 indicating half-life of 4.3 weeks in standard AR. This shows that it took 4.3 weeks for a price shock to adjust half way back to the equilibrium price. In TAR model, the adjustment factor of 0.189 implied 3.3 weeks half-life. This means that price adjustment is faster in TAR model because it took only 3.3 weeks for half of the price shock to return to parity bound compared to 4.3 weeks half-life in AR model. This agrees with Goodwin and Piggott (2001), who observed that threshold models suggest much faster adjustments in response to price deviations from equilibrium price band than in cases where thresholds are ignored. Since vast distances and poor infrastructure lead to high transaction costs, especially in developing country, TAR models are appropriate in estimating price adjustment (Abdulai, 2000).

7.3.5.3 *Comparison between pre – ICT and post – ICT price adjustment results*

Considering that availability of information reduces transaction cost by reducing search cost, the analysis compared the TAR models in pre and post ICT periods in order to assess effectiveness of modern ICTs in post – ICT period. The analysis used the market links that were significant in pre and post ICT periods. From Table 7.7, the co-integrating links that were significant in both periods were Karonga-Rumphi; Karonga – Mitundu; Karonga – Bangula; Mitundu-Lilongwe and Mitundu-Lizulu.

In Karonga - Rumphi pre ICT market link, the estimated price adjustment factor of 0.043 implied 15.8 weeks half-life and estimated threshold of 2.5 percent of mean price. In post-ICT period, the estimated price adjustment factor of 0.189 indicated 3.3 weeks half-life and estimated threshold of 3.0 percent of mean price. This shows that in post ICT period, prices were adjusting faster than in pre ICT period. Based on the conceptual framework presented in Chapter 3 in sections 3.3, improving information services influence transaction costs thereby improving market efficiency and participation. Thus, the introduction of modern ICTs improved price adjustment. As observed by Sopo (2008), the introduction of market information systems improves the co-integration of spatially separated maize markets and improves price transmission in Malawi. This also concurs with Katengeza (2008), who observed that price adjustment factor was faster in post ICT period for spatially separated rice markets in Malawi. In the Mitundu – Lizulu market link, price adjustment was also faster in post-ICT with a half-life of 2.9 weeks only, compared to the pre ICT period. This agrees with Jansen (2007), who observed that availability of information through mobile phones reduces price dispersion between markets.

The integration between regional markets of Karonga and Mitundu show a faster adjustment in post-ICT period than in pre-ICT. Table 7.7 showed that it used to take 17 weeks for half of the price shock to return to parity bound in pre-ICT period with 3.1 percent estimated threshold. In post-ICT period, the estimated threshold was 2.9 percent and 9 weeks half-life, implying that the transaction costs decreased and it was taking few weeks for half of the shock to return to the parity bound. This shows that availability of information assisted in reducing transaction costs and increased price adjustment even in distant markets (Jensen, 2007 and Katengeza, 2008). Thus, modern ICTs were effective in improving maize marketing efficiency.

Although price adjustment was faster in post-ICT period, the adjustment was not instantaneous. This implies that reduction in transaction cost is not only a factor of reducing the search cost or reducing information asymmetry but a combination of several factors as indicated in the conceptual framework. As observed by Myers (2008) price transmission not being instantaneous might be because (i) TAR models measure deviations from long-run transfer cost but not unmeasured short-run deviations from long-run level like temporary increase or decrease in fuel cost; (ii) that it is possible that some route become temporarily impassable due to weather; and (iii) trade volumes become high enough that transportation system reaches a capacity constraint. Thus, higher cost alternative routes are used which increase transfer cost above its long-run equilibrium level and increase the price spreads. These scenarios would indicate an efficient response to a temporary increase in transfer cost which is not reflected in long-run transfer cost. Therefore, the slow adjustments might be a result of other transportation cost.

7.4 Summary

The chapter has estimated co-integrating markets and associated price transmission among nine selected markets in Malawi. Using Johansen vector method, the co-integrating markets were observed within and among the three regions. Granger causality test was used to determine price causality among the co-integrating markets. From the results, the bivariate co-integrating markets were determined and among the co-integrating, eight bivariate co-integrating markets had unidirectional causality for the whole period from 1992 to 2009.

Assuming symmetric price adjustment, the standard AR and TAR autoregressive models were used to estimate price adjustment in co-integrating markets with unidirectional causality in pre-ICT and post-ICT periods. The results showed that price adjustments were faster in TAR models than AR models in both periods. This is because transaction costs create a parity bound where there is no trade or where arbitrage is unprofitable. For developing countries like Malawi, vast distances and poor infrastructure lead to high transaction costs, therefore TAR model assists to understand price transmission better than AR models. This suggests that transaction costs are significant in estimating spatial price linkages.

A comparison of TAR models in pre-ICT and post-ICT periods indicated that price adjustment was faster in post-ICT period. Based on half-life estimates, the results further show that it was taking few weeks in post-ICT for a shock to return half way back to parity bound and the estimated threshold was also small in post ICT period. This signifies the important influence ICT based market interventions have had in reducing search transaction costs and improving market efficiency of markets in Malawi a. Although, ICT based market interventions have had a significant influence on transaction costs, price adjustment was not instantaneous. This can be attributed to, among other factors, transaction costs or market charges related to volume of trade.

CHAPTER EIGHT

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

8.1 Summary and Conclusion

The main objective of this study was to analyse the effectiveness of ICT based market interventions on maize marketing efficiency in Malawi. The focus was on how the use of modern ICTs improved market efficiency among spatially separated maize market in Malawi. The study also identified the socioeconomic factors that influence use of modern ICTs and the associated challenges when using modern ICTs among smallholder farmers. The hypotheses tested in this study were (1) socioeconomic factors (such as education, age, extension visits, distance to market place and access to credit) do not influence use of ICT based market interventions and (2) the use of ICT based market interventions has not improved maize marketing efficiency. To analyse spatial co-integration and price transmission, the study used monthly real maize market prices from January 1992 to December 2009 for the nine selected markets across the country. Primary data to identify the socioeconomic factors and associated challenges was collected from smallholder farmers in Lilongwe and Dedza districts.

The logit model results identified the socioeconomic variables that influenced use of modern ICTs in Lilongwe District, Dedza District and the aggregate sample. The significant factors in Lilongwe District were age of household head, access to extension, household physical asset wealth and all season road condition. Poor household physical asset wealth negatively influenced use of modern ICT with a high marginal effect of 0.362 in Lilongwe. This implies that decrease in asset wealth reduces use of modern

ICTs. In the Dedza logit model results, the significant socioeconomic variables were gender of household head, farm size, distance to main market and membership to an association. Gender of household head negatively influenced use of modern ICTs with a high marginal effect of 0.316. This rejects the hypothesis that age and gender of household head, access to extension, household physical asset wealth, all season road condition, farm size, distance to main market and membership to an association do not influence use of ICT based market interventions. Thus, changing these factors can influence the use of modern ICT for smallholder farmers. The main challenges encountered when using modern ICT were illiteracy in operating a phone and requesting information through SMS; phone network problems; unreliable price information when transacting in local markets; operational cost like batteries and SMS charge.

Assuming symmetric price adjustment, spatial price adjustment results show that adjustment was faster in TAR models than AR models. This signifies that transaction costs are significant in estimating spatial price linkages. Comparing TAR models in pre and post ICT periods showed that estimated thresholds were lower in post ICT TAR models and that it took fewer weeks for a shock to return half-way back to parity bound. Therefore, the results signify that modern ICT based market interventions influenced reduction in search transaction cost thereby improving maize marketing efficiency in the post ICT period. Thus, the hypothesis that use of ICT based market interventions has not improved maize marketing efficiency in Malawi in post ICT period was rejected. Although price adjustment was faster in post-ICT period, the adjustment was not instantaneous. This can be attributed to, among other factors, transportation transaction costs and market charges related to volume of trade.

8.2 Policy Recommendations

Based on the study results and conclusions, the following recommendations are made:

- **Increase awareness of modern ICT among smallholder farmers**

From the results only 18 percent of the respondents were using modern ICTs. Among the farmers who did not use modern ICTs, some farmers indicated that they were not aware of how to use such tools to access information and use it for their benefit while others were not aware that such tools existed. The bigger challenge was on using SMS to access price information. Therefore, there is need to improve the dissemination of the modern ICTs especially at farm gate level.

Despite that market prices are announced on national radio, farmers have learned that this does not influence local market and farm gate prices when transacting with primary assemblers. As a result, farmers depend more on offered prices and have no bargaining power. Thus, if government continues with price dissemination, it should put complementary policies to enforce competition at farm gate and local level. This can involve promoting selling in bulk at farm gate for farmers to bargain. Furthermore, MACE should actively disseminate the modern ICTs and continue with price dissemination in all market points especially in Mitundu area where farmers rely more on information from primary assemblers. In conjunction with the extension officers in government system, MACE should increase awareness of modern ICT at smallholder level.

- **Improve market infrastructure**

The co-integration results showed that transaction costs are significant in understanding the integration and price transmission of spatially separated markets. It was further shown that initiatives that aim at reducing transaction cost are effective in improving spatial market integration. Although spatial integration improved after the introduction of modern ICTs, price transmission was not instantaneous. Therefore, improvements in marketing infrastructure like roads and communication facilities can reduce transaction costs and improve price transmission and market efficiency in Malawi.

The results further showed that all season road condition increases the use of modern ICTs among smallholder farmers. Thus, improving marketing infrastructure will also encourage smallholder farmers to make informed decisions when trading in local markets or at farm gate. The integration within regional markets, between regions markets and between markets in major cities like Lilongwe and Mzuzu indicates that there is maize price transmission within the country. The price transmission was mainly from high producing areas to low producing areas. Therefore, government can promote competition in high producing areas which will be transmitted to low producing areas and urban centres.

- **Improve dissemination of modern ICTs at farm gate**

The results showed that the use of modern ICTs was not gender neutral. The probability of using the tools was higher for men than women farmers. Since many female smallholder farmers mainly market at farm gate, deliberate dissemination efforts can be made at farm gate where women will be available than at a market place where men dominate. Dissemination at farm gate would not only assist female headed households but also females in male headed household to access market information using modern ICTs

- **Improving household asset wealth**

Household physical asset wealth was observed to highly influence use of modern ICTs especially in Lilongwe District. Since modern ICT requires some monetary expenditure when accessing information using phone or radio, initiatives that improve household asset wealth can complement efforts made by MACE in reducing information asymmetry. Considering that agricultural sales is the main source of income for smallholder farmers, policies that improve marketing and pricing of agricultural products can assist smallholder farmers to consider farming as business.

8.3 Areas for Further Research

- ✓ The study looked at spatial integration and price transmission for nine selected markets using the standard linear and threshold autoregressive error correction models. The study assumed symmetric price transmission and constant thresholds throughout the study period. Therefore, further studies can apply parity bound models and threshold vector error correction models that take into account asymmetric price transmission and estimate thresholds that vary over period of study.

- ✓ The study focused on smallholder farmers in only two districts in Central Region. Therefore, further studies can sample farmers from all regions so as to understand factors that influence use of ICT based market interventions in Malawi. This can help to develop general policies that apply to the country.

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APPENDIX 1

Splicing Method

The deflation process used two Food CPI series with difference base years. The first CPI series was from January 1990 to June 2001 with 1990 as the base year while the second series was from January 2001 to December 2009 with 2000 as the base year. Thus the splicing method was used to generate a Food CPI series from January 1992 to December 2009 with 2000 as the base year.

This method used the overlap ratio obtained from two CPI series from the interaction period of January to June 2001 in both Food CPI series. In this case, the overlap ratio was divided into the CPI series with 1990 base year in order to re-base it to 2000. Therefore, the whole CPI was re-based to 2000.

APPENDIX 2

Sample Size Calculation

Sample size calculation formula for population larger than 10,000

$$n = \frac{Z^2 pq}{d^2}$$

Where

n Sample size

Z Confidence limits of the survey. At 95% confidence level, where Z = 1.96

P Proportion of the population using ICT based market interventions, assuming 70 percent rate

q (1-P) the proportion of the population not using ICT based market interventions

d Absolute size of the error in estimating p, in this case 5% precision estimation

Planning for non-response of about 5% the formula will be used

where $$\frac{100}{100 - \%loss}$$

$$n^* = n^* \left(\frac{100}{100 - 5} \right)$$

APPENDIX 3

Smallholder Farmer Questionnaire

District Name:	1 = Lilongwe	2 = Dedza		
EPA:	1 = Mitundu	2 = Lobi	3 = Linthipe	4 = Mpingu
Section:	1= Chifungo	2 = Lobi	3 = Makowe	4 = Kafisi
	5 = Chiweta			
MIP Name:	1 = Mitundu	2 = Lobi		

Name of Respondent: ____

Village of Respondent ____

Name of Enumerator: ____

Date of Survey |___|___| |___|___| |___|___|___|___|

A. HOUSEHOLD SOCIO-DEMOGRAPHIC CHARACTERISTICS

No	Name of Household member	Age	Gender **(code 1)**	Level of education **(code 2)**	Marital Status **(code 3)**	Main occupation **(code 4)**	Relation to household head **(code 5)**	Have working Cell phone **(code 6)**
1								
2								
3								
4								
5								
6								

KEY CODES

Code 1 (Gender)
1 = Male
2 = Female

Code 2 (Education)
1 = None
2 = Std 1-5
3 = Std 6-8
4 = Secondary
5 = Tertiary
6 = Adult literacy

Code 3 (Marital status)
1 = Single
2 =Married
3 = Divorced
4 = Widowed
5 = widower
6 = Separate

Code 4 (Employment)
1 = Agriculture
2 = formal employment
3 = School going
4 = unemployed
5 = petty trading
6 = ganyu
7 = fishing
8 = fish-selling
9 = charcoal-selling
10 = Other small business
11 = None
12= Others (specify) ____

Code 5 (relation to HH)
1= Head
2= Spouse (specify)
3= Child
4= Orphan
5= other relations

Code 6 (Cell phone)
0 = No
1 = yes

FARM AND HOUSEHOLD ASSET

Asset name	Number	Roof Type	Floor Type	
1. Own House? 0 = No 1 = Yes		1 = Iron Sheets 2 = Glass Thatched 3= Others (specify)	1 = Smeared 2 = Cement 3 = Others (specify)	
		Year bought	**Value per Unit**	**Total Value (MK)**
2. Ox-cart				
3. Axe				
4. Shovel				
5. Hoes				
6. Chemical Sprayer/pump				
7. Plough				
8. Wheel barrow				
9. Bicycle				
10. Tractor				
11. Radio/radio cassette				
12. Mobile phone				
13. Television (TV)				
14. Water pump				
15. Sofa seats/coach				
16. Other….............				

B. AGRICULTURE AND FOOD SECURITY

1. What is the total land owned by the household? ________ acres.
2. How much land did you cultivate for production last season? (2008/09)? ________ acres
3. How much land was leased or borrowed for agricultural production, if any? ____ acres.

4. (a) What crops did you grow last rainy season (2008/2009)? And what was the main reason for growing these crops?

Crop grown **(Code A)**	Plot size **(Acres)**	Crop variety **Code B**	Seed		Fertiliser type 1		Fertiliser type 2		Used manure? **Code D**	Herbicide		Pesticide		Irrigation? **Code D**	Crop Output		Main reason for crop production **Code F**	Total sales if sold
			Qty	Unit **Code C**	Qty	Unit **Code C**	Qty	Unit **Code C**		Qty	Unit **Code C**	Qty	Unit **Code C**		Qty	Units **Code C**		

Codes A
[Use the CROP CODE]

Codes B (seed)
1. Improved
0. Local

Codes C (Unit)
1 Kg, **2**. Litre, **3**. 90 Kg Bag, **4**. 50Kg Bag,
5. Basket **6**. Wheel barrow **7**. ox-cart **8**. bucket
9. Small plate **10.** Big plate **11.** Other(specify)……………

Codes D (irrigation)
0. No
1. Yes

Codes F (reason of production)
1. Food
2. Cash
3. Food and Cash
4. Others (specify) _____

4. (b) What crops did you grow last winter season (2008/2009)? And what was the main reason for growing these crops?

Crop grown **(Code A)**	Plot size **(Acres)**	Crop variety **Code B**	Seed		Fertiliser type 1		Fertiliser type 2		Used manure? **Code D**	Herbicide		Pesticide		Irrigation? **Code D**	Crop Output		Main reason for crop production **Code F**	Total sales if sold
			Qty	Unit **Code C**	Qty	Unit **Code C**	Qty	Unit **Code C**		Qty	Unit **Code C**	Qty	Unit **Code C**		Qty	Units **Code C**		

Codes A
[Use the CROP CODE]

Codes B (seed)
1. Improved
0. Local

Codes C (Unit)
1 Kg, **2**. Litre, **3**. 90 Kg Bag, **4**. 50Kg Bag,
5. Basket **6**. Wheel barrow **7**. ox-cart **8**. bucket
9. Small plate **10.** Big plate **11.** Other(specify)……………

Codes D (irrigation)
0. No
1. Yes

Codes F (reason of production)
1. Food
2. Cash
3. Food and Cash
4. Others (specify) _____

5. (a) Input Source for rainy seasons

Input	Crop Type **(Use Crop code)**	Source 1			If bought, cash amount (MK) and Distant to buying point (Km)		Source 2			If bought, cash amount (MK) and Distant to buying point (Km)	
		Qty	Unit	Source 1 **(code A)**	MK	Km	Qty	Unit	Source 1 **(code A)**	MK	Km
Seed											
Fertilizer	Fertilizer Type										
Agro-chemicals	Agro-chemicals Type										
Others											

Codes A

1. Saved from last season
2. Farmers union
3. Input for work
4. Bought from local seed producers
5. Bought from local trader or agro-dealers
6. Farmer to farmer seed exchange
7.Provided free by NGOs
8. Provided free by other govt agency
9. Inherited from family
10. Bought from neighbor
11. Subsidized government seed scheme
12. Public works
13. ADMARC
14. Extension demo plots
15. Bought from farmer club
16. Research
17. Other, specify ……….

5. (b) Input Source for winter seasons

Input	Crop Type **(Use Crop code)**	Source 1			If bought, cash amount (MK) and Distant to buying point (Km)		Source 2			If bought, cash amount (MK) and Distant to buying point (Km)	
		Qty	Unit	Source 1 **(code A)**	MK	Km	Qty	Unit	Source 1 **(code A)**	MK	Km
Seed											
Fertilizer	Fertilizer Type										
Agro-chemicals	Agro-chemicals Type										
Others											

Codes A

1. Saved from last season
2. Farmers union
3. Input for work
4. Bought from local seed producers
5. Bought from local trader or agro-dealers
6. Farmer to farmer seed exchange
7.Provided free by NGOs
8. Provided free by other govt agency
9. Inherited from family
10. Bought from neighbor
11. Subsidized government seed scheme
12. Public works
13. ADMARC
14. Extension demo plots
15. Bought from farmer club
16. Research
17. Other, specify ……….

6. What are the two main staple foods for the household? |____| |______| **(Use Crop Code)**

7. What is the main source of food for the household?

Own production [ ] *1*
Buying [ ] *2*
Free distribution [ ] *3*
Others (specify)___________ [ ] *4*

8. If own production, during which month do you normally harvest your main staple during rainy season? (Maize) _________

9. If own production, during which month do you normally harvest your main staple during winter season? (Maize) ________

10. What major challenges do you face in crop production? _______________

1=lack of fertilizer,
2=lack of seed
3=Lack of labor
4= Extension advice,
5= drought,
6= Pests and diseases
7= others specify _________________________________

11. Do you still have your staple food from last season's harvest? ___________

0 = No
1=Yes,

12. If yes, which month do you think the food will run out? ______________

13. If No, which month did the food run out?_________________________________

14. Do your food stocks usually last from one harvest to the other? _________________

0 = No
1 = Yes

15. If No, during which months do you run out of food stocks?___________________

16. How do you mainly cope with the food shortages in these months?

1 = purchasing food from ganyu labour
2= Ganyu (exchange labor with food)
3=Purchasing food from other business sales or employment
4 = Reducing quantity of meals
5 = Reducing number of meals
6=Begging
7 =Received from Government or other NGOs (relief food),
8=cutting firewood
9=sale of household assets
10= Change staples (diet) e.g. buy cheaper staples,

11 = Borrow food from neighbour/family/friend
*12= others (specify*______________________

17. Do you have livestock? ________________________ 0 = No 1= Yes

18. If yes, specify:

Type of livestock	Quantity or number	Estimated Economic Value			
Cattle		Per Unit value	Beginning of year (2009)	Per Unit value	End of year (2010)
Bulls					
Heifers					
Calves					
Goats					
Sheep					
Chicken					
Pigs					
Rabbits					
Guinea fowls					
Others (Specify)					

19. What are the major problems you face in livestock production?
1= Pests and diseases;
2 = lack of grazing land
3 = theft
4 = lack of markets
5= predators
*4 = Others (Specify)*________________________________

20. What are your two major sources of income? (Tick what is applicable)
1 = Agriculture
2 = Permanent Employment
*3 = Business (specify)*_________________________
4 = Casual Farm labour
5 = Remittances
6 = Season employment
7 = Others (specify) _______________

21. What is your average income per year? MK ____________________________________

22. On average, how much do you spend per month? MK ____________________________

23. Do you have access to any extension services?

0 = No
1= Yes

24. If yes, who is the provider?

1 = MoA&FS	*2 = Forestry*
3 = Health	*4 = Community Development (Gender)*
5 = NGO	*6 = Other, specify______________________________*

25. How many times did the extension workers visit you ____________________________

1. *None*
2. *Once a week*
3. *3 times a week*
4. *Once a month*
5. Others (Specify) ____

C MARKET ACCESS

1. Where do you normally sell your crop produce? ________________________ **(Name three markets in order of importance)**

1 = Local market
2 = Private trader
3 = Main trading centre
4 = ADMARC
5 = Farmgate
6= Others (specify) ____

2. Where do you normally sell your livestock produce? ____________________________ **(Name three markets in order of importance)**

1 = Local market
2 = Private trader
3 = Main trading centre
4 = ADMARC
5 = Farmgate
*6 = Others (specify)*____

3. If private trader, what type of trader?

1. Large scale traders
2. Middle scale traders
3. Small scale traders
4. Others (specify) ____

4. Where do you normally buy your inputs? ___________________________ **(Name three markets in order of importance)**

1 = Local market
2 = Private trader
3 = Main trading centre
4 = ADMARC
*5 = Others (specify)*____

5. If local market in 1, 2 or 3, when was the market established? (year) _______________

6. How far is the main market place from your household? _________ km or __________ walking minutes, and ___________transport cost (MK)

7. What is the condition of the road to the main market? ____________________________

1= all season car accessible tarmac,
2=All season car accessible dirt road,
3= seasonal car accessible dirt road,
4= partially seasonal car accessible dirt road,
5=non accessible by car,
*6= Other (specify)*____

8. What makes you decide where to sell your agricultural produce? (Reason for choosing the market)____

9. How do you normally sell your agricultural produce?

		Why?
1	As an individual (……..) 0 = No 1 = Yes	
2	In a group/association (…..) 0 = No 1 = Yes	

Market Information

10. Do you have access to any market information in this area? |____|

0 = No
1=yes,

11. If yes, what are the two main sources of market information (in order of importance)?

1 = MIC/MIP;
2 =mobile phone (SMS);
3 =Radio programmes;
4 = News-papers;
5 = Television Malawi;
6 = Neighbors/Private Traders;
7 = ADMARC/traders
*8 = Others(specify)*__________

12. Do you use modern ICT tools? **(If Yes go to question 13, if No go to question 28)**
0 = No
1 = Yes

13. If Yes, which ICT tools do you use?
1 = Radio
2 = Mobile Phone (SMS)
3 = Television
4 = MIC/MIP
5 = Others (specify) ________________________________

14. When did you start using modern ICT tools? (year)

ICT Tools	**Year**	**Who introduced the Intervention** **1. IDEAA** **2. GoM** **3. Civil Society Organisations** **4. Farmer Trader Organisation** **5. Others (specify)**	**Term and conditions of access to ICT, If any**
Radio			
Mobile Phone (SMS)			
Television			
MIC/MIP			
Others (specify)			

15. For what purpose do you use modern ICT tools (radio, SMS and MIC/MIP). (Tick what is applicable)
1 = Contact produce buyers [ ]
2 = Contact input sellers [ ]
3 = Receive agricultural production information from extension workers [ ]
4 = Receive market information from other farmers [ ]
5 = Other (specify) [ ]

16. For which crops do you normally use modern ICT tools to source information? List three main crops in order of importance **(Use crop code)**
1______________________________
2 ______________________________
3 ______________________________

17. How often do you use the ICT tools and what is the cost each time you use it?

ICT-based interventions	Days per month	Cost per usage	Main Information obtained
Radio program			
Radio call-in program			
Mobile telephone (SMS)			
MIP/MIC			
Other (specify)			

18. What is the most reliable modern ICT tool and why

ICT Tools	Why
Radio	
Mobile Phone (SMS)	
Television	
MIC/MIP	
Others (specify)	

19. What problems did you face when in acquiring inputs before the use of modern ICT?
    1 = low quality inputs
    2 = High prices offered by local traders
    3 = High cost of searching for markets
    4 = Unreliable markets
    *5 = Others, specify*____

20. How did you address these problems?
    1 = Source more money to acquire the input
    2 = Did not know how to address these problems
    3 = Others (specify) ____

21. What problems did you face in marketing of maize and beans produce before the use of modern ICT?
    1 = Low prices offered
    2 = Unreliable market
    3 = market too far
    *4 = Others, specify*____

22. How did you address these problems?
    1 = Just sell even at low prices
    2 = Did not know how to address these problems
    3 = Others (specify) ____

23. How has the use of modern ICT tools improved your marketing of maize and beans? (Tick what is applicable)

1. *Get timely and reliable market information.* [ ]
2. *Able to get better prices for produce* [ ]
3. *People know what is available on the market place and not only a few individuals* [ ]
4. *Has increased my ability to compete in the market* [ ]
5. *There are fewer middlepersons/intermediaries* [ ]
6. *Link farmers to better paying markets* [ ]
7. *Improve access to market information on prices* [ ]
8. *Improve market information on volume/supplies* [ ]
9. *Improve market information on quality of produce* [ ]
10. *Reduce costs for looking for markets* [ ]
11. *Improve operations in the market* [ ]
12. *Can choose where to sell their produce* [ ]
13. *Other (specify)*____

24. What problems do you face when in acquiring inputs after the use of modern ICT?

1 = low quality inputs
2 = High prices offered
3 = High transport cost to input market
4 = Unreliable markets
5 = low income to acquire good inputs
*6 = Others, specify*____

25. How do you address these problems?

1 = Source more money to acquire the input
2 = Do not know how to address these problems
3 = Others (specify) ____

26. What problems do you face in marketing of maize and beans produce after the use of modern ICT?

1 = Low prices offered;
2 = Unreliable markets;
3 = Better markets very far
4 = Markets not available when needed for sales
*5 = Others, specify*____

27. How do you address these problems?

1 = Just sell even at low prices
2 = Do not know how to address these problems
3 = Others (specify) ____

28. Characteristics of the modern ICT tools. (Circle appropriate answer)

Tool	Do you use this ICT tool	Advantages	Disadvantages	Other Challenges and Comment
Mobile phone SMS	0 = No 1= yes	1. Available 24 hours 2. Convenient to use at the farm, home or market. 3. Cost effective (you do not have to visit MACE office to give your requirements to buy or sell). 4. Can access agricultural prices from different markets and also buying prices for some agricultural prices. 5. Cheap as the cost is the normal SMS charge 6. Can be used using any local language and English. 7. Others (specify)	1. Operates where there is a network. 2. Cannot connect without the SMS charge 3. Expensive for smallholder farmers 4.One should be literate to operate the phone and read SMS 5. Others (Specify)	
Radio programme	0 = No 1= yes	1. Reaches a lot of people at the same time. 2. Provides reliable information than the neighbors 3. Cheap because it uses battery or power. 4. Allows farmers to have their agricultural ideas aired on MBC if you write a letter to IDEAA or during call-in-program 5. Others (specify)	1. You need to listen to programme as it is being aired. 2. Its costly for the institution buying airtime from MBC for the program to be aired, hence can be stopped when funds are not there. 3. unreliable network during call-in-program 4. One is not sure about the quality of the product that time 5. Others (specify)	
Information displayed at MIP/MIC boards	0 = No 1= yes	1. Wide range of commodities is displayed. 2. Price discovery. 3. Easy access 4.Others (specify)	1. Have to physically visit nearest MACE office. 2. May differ with what is real in markets 3. Others (specify)	
Others (specify)	0 = No 1= yes			

29. MACE requires that farmers or traders contribute to the cost of service in form of offer/bid placement fee, commission and annual subscription, .Which one are you practicing if any (Yes/No)

Tool	Which one are you practicing in?	If No Why	Advantages	Disadvantages
Offer/bid placement fee	0 = No 1 = Yes		1. Paid to cover for the cost of making phone 2. Shows seriousness of the bidder/seller 3. Others (specify)	1. Not refundable whether a market is identified or not. 2. Others (specify)
Commission MK100 in MIPs, and MK500 in MICs	0 = No 1 = Yes		1. Paid based on volume of trade. When you sell less you pay less. 2. Others (specify)	1. Expensive 2. Others (specify)
Annual subscription MK5,000	0 = No 1 = Yes		1. No need to pay bid/offer placement fee. 2. Pay reduced commission. 3. Others (specify)	1. Expensive 2. Others (specify)

30. If **No to modern ICT tools**, Why not using? List three most important reasons.

1. ________________________________
2. ________________________________
3. ________________________________

31. What is the most reliable tool for getting marketing information?

1. Neighbor/friends
2. Private trader
3. Others (specify) ____________________________

32. What problems do you face when in acquiring inputs?

1 = low quality inputs
2 = High prices offered by local traders
3 = High cost of searching for markets
4 = Unreliable markets
*5 = Others, specify*____

33. How do you address these problems?

1 = Source more money to acquire the input
2 = Do not know how to address these problems
3 = Others (specify) ____

34. What problems do you face in marketing of maize and beans produce?

1 = Low prices offered;
2 = Unreliable markets;
3 = market too far;
*4 = Others, specify*____

35. How do you address these problems?

1 = Just sell even at low prices
2 = *Do not know how to address these problems*
*3 = Others (specify)*____

Membership to Association and Access to Credit

1. Are you a member of any farmers' association? __________________ 0 = No 1 = Yes

2. If yes, what is the name of the association ______________________________________
____

3. What are the crops covered by the association? **(Use Crop Code)** ____________________
____

4. How long has the association been in existence?__________________________ (years)

5. Who initiated the formation of the association?

1 = Agriculture AEDO,
2 = NASFAM,
3 = FUMA,
*4 = NGO (specify)*____
*5 = Others (specify)*____

6. What is the main purpose of the association?
____

7. If they market, how does the association market its produce?__________________________
____

8. Did you have access to any formal credit in the past 2 years? (**If Yes, go to question 9. If No, go to question 11)**

0 = No
1 =Yes

9. **If yes**, where did you obtain the credit? |________| |____________|

1= MRFC
2 = FINCA
3 = MARDEF
4= OIBM
*5 = NGO (specify)*____
6= Others (specify) ____

10. What was the main reason for getting the credit?

1 = Buying inputs
2 = Buying food
3 = Buying other household assets
4 = For medical help
5 = For children school fees
6 = Capital for business
7 = Others (specify) ____

11. **If No,** why not accessing credit

1. = High interest rates
2. = Less opportunities of getting loans
3. = Fear of losing household assets
4. = No collateral
5. = Others (Specify) ___________________________________

THANK YOU

No.	**Crop code**	**No.**	**Crop code**
1	Maize	11	Bambara nuts (Nzama)
2	Rice	12	Sweet potato
3	Soybean (soya)	13	Irish potato (Kachewere)
4	Beans (Nyemba)	14	Sorghum (Mapila)
5	Pigeon peas	15	Green peas
6	Groundnuts	16	Onion
7	Cassava	17	Chinese cabbage
8	Paprika (Tsabola)	18	Mustard
9	Tobacco	19	Tomatoes
10	Millet	20	Green paper
			Others (specify)