DOES THE FARM INPUT SUBSIDY PROGRAM DISPLACE COMMERCIAL FERTILIZER SALES? EMPIRICAL EVIDENCE FROM AGRO-DEALERS IN MALAWI

MSC. (AGRICULTURAL AND APPLIED ECONOMICS) THESIS

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LILONGWE UNIVERSITY OF AGRICULTURE AND NATURAL RESOURCES

BUNDA CAMPUS

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OCTOBER, 2015

DECLARATION

I, Stevier Kaiyatsa, declare that this thesis is a result of my own original effort and work, and that to the best of my knowledge, the findings have never been previously presented to the Lilongwe University of Agriculture and Natural Resources or elsewhere for the award of any academic qualification. Where assistance was sought, it has been accordingly acknowledged.

Stevier Kaiyatsa

Signature: ________________________________

Date: __________/________/___________

CERTIFICATE OF APPROVAL

We, the undersigned, certify that this thesis is a result of the authors own work, and that to the best of our knowledge, it has not been submitted for any other academic qualification within the Lilongwe University of Agriculture and Natural Resources or elsewhere. The thesis is acceptable in form and content, and that satisfactory knowledge of the field covered by the thesis was demonstrated by the candidate through an oral examination held on 06/10/2015.

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DEDICATION

To Jehovah, the Almighty

My mother, Mrs. Margret Kaiyatsa

My late father, Mr. Simon Kaiyatsa

My late sister, Susan Kaiyatsa

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LIST OF ABBREVIATIONS AND ACRONYMS

ADF	Augmented Dickey-Fuller
ADMARC	Agricultural Development and Marketing Corporation
AERC	African Economic Research Consortium
AIC	Akaike's Information Criterion
AISAM	Agricultural Input Suppliers Association of Malawi
AISS	Agricultural Inputs Support Survey
APE	Average Partial Effects
APIP	Agricultural Productivity Investment Program
ARDL	Autoregressive Distributed Lag
BC	Benefit-Cost
BSc	Bachelors of Science
CARD	Centre for Agricultural Research and Development
CNFA	Citizens Network for Foreign Affairs
CRE	Correlated Random Effects
CUSUM	Cumulative Residuals
CUSUMSQ	Cumulative Sum of Squares of Recursive Residuals
DW	Durbin-Watson

ECM	Error Correction Model
EPA	Extension Planning Area
FISP	Farm Input Subsidy Program
GDP	Gross Domestic Product
GPS	Global Positioning System
Ha	Hectare
HQIC	Hannan and Quinn Information Criterion
IFDC	International Fertilizer Development Centre
ihs	Inverse Hyperbolic Sine
IHS	Integrated Household Survey
IMF	International Monetary Fund
IRLADP	Irrigation, Rural Livelihoods and Agricultural Development Project
JB	Jarque and Bera
Kg	Kilogram
LH	Lognormal Hurdle
LM	Lagrange Multiplier
LR	Likelihood Ratio

LUANAR	Lilongwe University of Agriculture and Natural Resources
m	Metre
MK	Malawi Kwacha
MLE	Maximum Likelihood Estimator
Mt	Metric ton
NASFAM	National Smallholder Farmers Association of Malawi
NFS	National Fertilizer Strategy
NSO	National Statistical Office
OLS	Ordinary Least Square
PPS	Proportional Probability Sampling
RESET	Ramsey Regression Equation Specification Error Test
RUMARK	Rural Agricultural Marketing Program
SACCO	Savings and Credit Cooperatives
SAPs	Structural Adjustment Programs
SBC	Schwarz’s Bayesian Criterion
SBIC	Schwarz’s Bayesian Information Criterion
SFFRFM	Smallholder Farmers’ Fertilizer Revolving Fund of Malawi

SOAS	School of Oriental and African Studies
SPS	Starter Pack Scheme
SSA	Sub-Saharan Africa
TIP	Targeted Inputs Program
US$	United States Dollar
VECM	Vector Error Correction Model
VIF	Variance Inflation Factor
VNRMC	Village Natural Resources Management Committee

ABSTRACT

Using cross-sectional retail level data collected in twenty districts of Malawi in 2014, the study applied a lognormal hurdle model to identify factors that influence independent agro-dealers' participation in the fertilizer market and its effect on the volume of commercial fertilizer sales in Malawi. The study further applied an Autoregressive Distributed Lag (ARDL) model to estimate long and short run relationships among commercial fertilizer sales, subsidy fertilizer sales and commercial fertilizer price over time using quarterly time series data from 1998 to 2011. The study found that initial start-up capital increased the likelihood of the independent agro-dealer's participation in the fertilizer market. Conditional upon participation, having more than one selling points, number of other agro-dealers at the market centre, store ownership, store size, the number of full time employees, population density per district, and spatial differences positively influenced the volume of commercial fertilizer sales. Further results showed that the volume of subsidized fertilizer sold significantly increased the volume of commercial fertilizer sales by about 0.83 percent and 0.85 percent for fertilizer distributor retail outlets at both EPA and district levels. The ARDL results showed that the subsidized fertilizer sold over time displaced the volume of commercial fertilizer sales by about 0.03 percent in the long run and 0.04 percent in the short run. From this analysis, the provision of support that boost the start-up capital to small agro-dealers is likely to promote their participation in the fertilizer market. The study further recommends the Government to open more ADMARC/SFFRRM depots in areas that are not served by the private sector. This will also stimulate the establishment of private agro-dealers to serve smallholder farmers who may need smaller quantities of fertilizer that is supplied by small-scale agro-dealers.

CHAPTER ONE

INTRODUCTION

1.1 Background Information

Increased use of agricultural technologies such as inorganic fertilizers and hybrid seeds is widely recognized as the means to boost agricultural production in Sub-Saharan Africa (SSA). According to Kelly *et al*. (2003), the adoption of such technologies helps to meet economic growth, poverty reduction and food security goals. However, use of such agricultural technologies is low in SSA compared to other developing countries (Mwangi, 1996; Kelly and Naseem, 2004; Kelly *et al*., 2003). For instance, during the 1980 - 89 and 1996 - 2000 growing seasons, total fertilizer consumption and fertilizer use per hectare in SSA rose by 16% and 5%, respectively (Kelly *et al*., 2003). As a result, average cereal yields moderately increased from 0.8 to 1.5 Mt/ha between 1962 and 2008 (Dittoh *et al*., 2012; Hunt, 2011). In terms of supply, most countries in SSA import their fertilizer requirements (Hernandez and Torero, 2013). According to Gregory and Bumb (2006), fertilizer imports increased in SSA during the past decades. For example, nitrogen and phosphate fertilizers imported increased by 50 percent and 40 percent as a percentage of global production, respectively.

Although there are variations among SSA countries in fertilizer use and adoption of hybrid seed varieties, there has been substantial increase in private sector participation in the input markets in most countries. Fertilizer markets were liberalized and deregulated following the World Bank and International Monetary Fund (IMF) structural adjustment programs (SAPs) in most countries in the 1980s (Kelly *et al*., 2003; Gregory and Bumb, 2006; Government of Malawi, 2010). This enabled the private sector to participate in the fertilizer business at all levels of the supply chain (*i.e*. import, distribution, wholesale, and retail). Liberalization of fertilizer markets was expected to facilitate the development of well-functioning markets and enhance farmers' access to fertilizers thereby enhancing agricultural production (Gregory and Bumb, 2006). Despite the greater involvement of the private sector in the fertilizer market, the input markets remain underdeveloped and fragmented. Poor dealer network, inadequate infrastructure, uncertain policy environment, credit constraints, limited market information and access to inputs are some of the challenges facing smallholder farmers in rural areas (Gregory and Bumb, 2006; Seini *et al*., 2011; Hernandez and Torero, 2013). As a result, most SSA countries such as Nigeria, Kenya, Tanzania, Ghana, Zambia and Malawi have intervened by providing free or subsidized inputs (fertilizer and hybrid seed) to smallholder farmers in order to enhance access to these inputs.

1.2 Structure of the Input Supply in Malawi

In Malawi, the main players in the input supply is government and private input suppliers. The government operates through the Smallholder Farmers' Fertilizer Revolving Fund of Malawi (SFFRFM) and Agricultural Development and Marketing Corporation (ADMARC). The Government has about 58 SFFRFM and more than 600 ADMARC market depots throughout the country. ADMARC operates in areas that are not served adequately by the private sector (Dorward *et al*., 2007; Kelly *et al*., 2010). The private input suppliers are categorized into major distributors and independent agro-dealers. According to Dorward *et al*. (2007), major distributors such as Farmers' World, Export Trading, Nyiombo Investment, Transglobe, AGORA and Kulima Gold have a network of over 1000 retail outlets across the country. These distributors import and supply different fertilizers to their network of retail outlets as well as informal network of independent agro-dealers.

By definition, an independent agro-dealer is as a local entrepreneur who sells seeds, fertilizer and agro-chemicals to small-scale farmers in rural areas (Alliance for a Green Revolution in Africa, 2007 and Chinsinga, 2011). Most independent agro-dealers operate in same locations as the large distributors. They purchase fertilizer from the large distributors and sell it in the quantities needed by small-scale farmers. Some of them have diversified their businesses to other products such as farm equipment, groceries, hardware and clothing. Citizens Network of Foreign Affairs (CNFA)/Rural Agricultural Marketing Program (RUMARK) and Agricultural Input Suppliers Association of Malawi (AISAM) networks provide training, capital and credit to independent agro-dealers who are not registered. For example, RUMARK guaranteed a 50 percent on any credit that was extended to independent agro-dealers by fertilizer distributors in its network from 2005 to 2007.

1.3 The Role of Private Sector in the Malawi's Farm Input Subsidy Program

In Malawi, like other countries in SSA implementing fertilizer subsidy program, the government implemented a free inputs program called Starter Pack Scheme (SPS) which benefitted about 2.86 million smallholder farmers in 1998/99. In 2000/01, the scheme was changed to Targeted Input Program (TIP) which ceased in 2004/05 agricultural season. Parallel to these two initiatives, the government also implemented Agricultural Productivity Investment Program (APIP) since 1997/98 season. Through APIP, government provided credit and agricultural inputs to creditworthy smallholder farmers. The large scale Farm Input Subsidy Programme (FISP) succeeded the TIP which the government introduced in 2005/06 season (Dorward and Chirwa, 2011; Government of Malawi, 2007). The program targets resource-poor farmers who own a piece of land and are resident in the village, with special consideration to guardians looking after physically challenged persons and vulnerable groups such as child-headed households, female-headed or orphan-headed households and households affected by HIV and AIDS (Chirwa *et al*., 2010).

Since the subsidy program started in 2005/06 season, the private sector, ADMARC and SFFRFM have been involved in the procurement and supply of fertilizer to the subsidy program through competitive tendering procedures (Government of Malawi, 2010). This has resulted in increased participation of the private sector in the supply of fertilizer to the subsidy program and relatively large volume of fertilizer is supplied by the private sector (Dorward *et al*., 2010; Chirwa and Dorward, 2012; Chirwa and Dorward, 2013). For example, between 2009/10 and 2011/12 period, the number of private bidders increased from 24 to 65 private companies and the number of successful awards of contracts also increased from 10 to 20 private companies over the same period (Chirwa and Dorward, 2012; 2013).

Following implementation of FISP, performance of the private sector in the fertilizer market can be assessed from either customer, competitor or internal perspectives (Mutonyi and Gyau, 2013). From the internally oriented perspective, marketing performance is determined by the subsequent effect of customer behavior as seen in terms of unit sales and sales revenue. The volume of sales per year is one of the financial indicators of assessing the marketing performance of any dealership towards achieving its objectives (Omamo and Mose, 2001; Velimirovic *et al*., 2011; Asiegbu *et al*., 2011; Pont and Shaw, 2003). In agro-dealership, the sales volume is total annual commercial fertilizer sale measured as total fertilizer sale less subsidized fertilizer sale. Kundakchyan and Zulfakarova (2013) reported that the decrease in the volume of sales implies a loss of market share to a business.

In terms of the volume of fertilizer sales, Chirwa and Dorward (2012) reported that the volume of subsidized fertilizer supplied by private sector to the program increased from 70 percent to 95 percent relative to volumes handled by ADMARC/SFFRFM between 2007/08 and 2010/11 period. However, in the 2011/12 the private sector share fell to 71 percent from the 2010/11 season. At the retail level, the volume of commercial fertilizer retailed by the private sector before FISP was more than quantities of subsidy sales under SPS, TIP and APIP particularly, between 1998 and 2005. The private sector had the major share of fertilizer sales compared to ADMARC and SFFRFM. Implementation of FISP in 2004/05 season resulted in a tremendous increase in subsidy fertilizer sales by ADMARC and SFFRFM at the expense of the private sector up until 2009.

Under FISP, the retail sale of subsidized fertilizer has been solely by government through its network of SFFRFM and ADMARC market depots, except for 2006/07 and 2007/08 seasons. In 2006/07 and 2007/08 seasons, the major distributors and cooperatives[1] were allowed to accept fertilizer vouchers from smallholder farmers (Chirwa and Dorward, 2012; Kelly *et al.*, 2010; Fitzpatrick, 2012; Government of Malawi, 2010). In the 2006/07 season, a total of 174,688 Mt of subsidized fertilizers was sold to smallholder farmers with ADMARC and SFFRFM accounting for 72 percent and the private retailers 28 percent of the subsidized fertilizer sales (Dorward *et al.*, 2008; Chirwa and Dorward, 2013). However,

[1] Cooperatives stopped participating in fertilizer input market.

the volume of commercial fertilizer sales was less than the subsidy fertilizer sales in 2005/06 to 2006/07 seasons. Dorward *et al*. (2008) attributed this decline to a 20 percent rise in fertilizer price and low tobacco prices. On the other hand, independent agro-dealers were excluded from retail sell of subsidized fertilizers in 2006/07 and 2007/08 seasons.

In 2007/08, the government stimulated the expansion of the private sector to remote rural areas where their presence was limited in 2006/07 season. The government offered an incentive bonus of about MK 100 (US$[2]0.71) or MK 200 (US$1.42) on top of the district value of the subsidy voucher depending on the distance to remote rural areas (Kelly *et al*., 2010; Chirwa and Dorward, 2013). This encouraged some private sector actors to deliver to more remote rural areas than in the previous 2006/07 season. According to Kelly *et al*. (2010), the private sector delivered the subsidized fertilizer either through direct deliveries to temporary distribution points or through independent agro-dealers who acted as agents for the distributors. The expansion of the private sector to the remote rural areas was affected by the government's decision to withdraw the private sector from retailing subsidized fertilizers in 2008/09 season. Private sector companies that were mostly negatively affected were those that expanded access in rural areas (fertilizer importers with distribution networks) compared to those that import and supply the Government with fertilizers were unaffected (Kelly *et al*., 2010). Thus, the Government's decision disrupted the private sector distribution network in the rural areas. According to the previous evaluations by Dorward *et al*. (2007), Kelly *et al*. (2010) and Chirwa and Dorward (2013), the subsidy program is found to promote the development of private sector seed outlets.

[2] 1US$= MK140.5 as of 2007.

While there are new private sector entrants in the fertilizer market under the subsidy program, there has also been noticeable exits of some market players in the fertilizer market. For example, the National Association of Smallholder Farmers of Malawi (NASFAM), Rab Processors, and Yara who participated in the 2006/07 season have since stopped participating in the fertilizer market (Kelly *et al*., 2010; Chirwa and Dorward, 2013). According to Chirwa and Dorward (2013), Yara turned over its exclusive right to import Yara fertilizers to Agricultural Resources Limited.

The seed component of the subsidy program was introduced in 2006/07 season to increase farmers' access to hybrid maize varieties. Unlike subsidized fertilizer, both the government through SFFRFM and ADMARC market depots and the private sector participate in retail sale of subsidized seed (Government of Malawi, 2010; Chirwa and Dorward, 2013). Thus, seed growers' distributor retail outlets, agro-dealers (*i.e*. both major fertilizer distributors and contracted independent agro-dealers by seed companies), cooperatives, supermarkets, SFFRFM and ADMARC market depots are allowed to accept the seed vouchers from smallholder farmers. The majority of the agro-dealers operate in well-developed trading centres depriving the remotest smallholder farmers from accessing the seed (Government of Malawi, 2010).

Transportation of subsidized fertilizers from the central depots to ADMARC and SFFRFM depots across the country is entirely by private transporters through a competitive bidding process. Similarly, there has been increased involvement of the private sector in transportation of subsidized fertilizers across the country. For instance, 23 transporters in the 2011/12 season participated in the distribution of subsidized fertilizer compared to 16 transporters in 2008/09 season (Chirwa and Dorward, 2013). Unlike subsidized fertilizers, the delivery of subsidized seed to the farmers is solely by the private sector, particularly recognized seed growers such as Pannar, Monsanto, Seed Co and Demeter (Kelly *et al*., 2010).

1.4 Supply of Fertilizer in Malawi

Private firms are currently the major importers of fertilizers with about 92 percent of fertilizer imported and sold in Malawi. Between 1994 and 2003, fertilizer imports increased from 54,000 Mt to 215,000 Mt (Government of Malawi, 2007). Imported fertilizer is usually in small packages which drives up fertilizer prices and freight costs. These costs are borne by farmers who purchase the fertilizer at very high prices. Due to poor road network in remote rural areas, fertilizers are stocked at rural trading centres making farmers travel 10 - 50 km to get the product (Government of Malawi, 2007). Because of limited information about sources of fertilizers, prices, types and uses in the fertilizer market, most independent agro-dealers purchase fertilizer from retail outlets of major fertilizer distributors at retail price within the market centre. The product (*i.e.* the traditional 50 kg fertilizer bag) is then packed in smaller packs which are affordable by most smallholder farmers.

About 8 percent of the fertilizers is domestically blended. There are two blending plants and one small granulation plant. Malawi Fertilizer Company owns the blending plant at Liwonde which has a capacity of producing 30,000 Mt of fertilizers per annum. Optichem 2000 Limited owns the second blending and granulation plant situated in Blantyre. The plant has the capacity of producing 40,000 Mt of fertilizers per year. However, the product from this plant satisfies the requirements of estates and not smallholder farmers (Government of Malawi, 2007).

1.5 Problem Statement

Having an effective and vibrant private input supply sector is vital for enhancing smallholder farmers' access to productivity enhancing technologies such as fertilizer and hybrid seeds (Kelly *et al*., 2010; Seini *et al*., 2011). Agro-dealers play a critical role in shortening farmers' distance to input markets. In addition, agro-dealers enhance farmers' access to agricultural inputs for both rainy season and winter cropping under irrigation schemes such as Greenbelt Initiative and the Irrigation, Rural Livelihoods and Agricultural Development Project (IRLADP), as most government retail outlets operate on a seasonal basis. Since agro-dealers are not involved in selling subsidized fertilizer, we might expect the subsidy program to have some effects on their business (Dorward *et al*., 2007; Kelly *et al*., 2010; Fitzpatrick, 2012; Chirwa and Dorward, 2013). The effects of the FISP on private sector commercial fertilizer sales have not been fully analyzed (Fitzpatrick, 2012). Chinsinga (2011) and Dorward and Chirwa (2011) noted that most studies have focused on the overall evaluation of the subsidy program as it relates to a broadly defined private sector. Thus, there is limited empirical evidence about the extent to which the program affects the commercial fertilizer supply system, separately for different market players, namely independent agro-dealers and retail outlets of fertilizer distributors. According to Dorward *et al*. (2008) the efficiency of fertilizer subsidy as a means of enhancing famers' productivity and food security might be undermined if commercial fertilizer sales by agro-dealers are substituted by subsidized sales through the subsidy program over time. This study therefore empirically determined the effect of subsidy program on the volume of commercial fertilizer sales by independent agro-dealers and retail outlets of fertilizer distributors at the retail level. Furthermore, the study established both the short and long run relationships among commercial fertilizer sales, subsidy sales and commercial fertilizer prices over time.

1.6 Objectives

1.6.1 Overall Objective

The overall objective of the study is to assess the effect of the Farm Input Subsidy Program on commercial fertilizer sales by agro-dealers.

1.6.2 Specific Objectives

Specifically, the study addressed the following specific objectives:

i. To analyse factors that influence independent agro-dealers' decision to participate in fertilizer market and its effect on commercial fertilizer sales.
ii. To estimate the extent to which input subsidy program reduces or stimulates commercial fertilizer sales by private agro-dealers.
iii. To determine long and short run relationships among subsidy fertilizer sales, commercial fertilizer sales and average commercial fertilizer price over time.

1.7 Hypotheses

The following null hypotheses were tested:

i. Socio-economic factors (education of agro-dealer, gender, age, experience in agro-dealership) and institutional factors (number of other dealers at the market centre, distance between agro-dealer's store and ADMARC/SFFRFM depot, selling maize seed, access to credit, state of infrastructure at the market centre and store ownership) do not influence agro-dealer's decision to participate in fertilizer market.

ii. The fertilizer input subsidy program reduces the volume of commercial fertilizer sales by private agro-dealers.

iii. There is no short and long run relationships among subsidy fertilizer sales, commercial fertilizer sales and average commercial fertilizer price both in long and short runs.

1.8 Justification

The exclusion of independent agro-dealers and retail outlets of fertilizer distributors from selling subsidized fertilizer implies loss of business to agro-dealers during the peak periods of the subsidy program. If the exclusion of agro-dealers reduce demand for commercial fertilizers, it poses questions about the continued existence and growth of fertilizer businesses (Kelly *et al*., 2010). On the other hand, if the exclusion of agro-dealers increase sales of commercial fertilizers, agro-dealers may handle larger volumes of commercial fertilizer. This may raise agro-dealers' profitability through economies of scale which in turn may draw new players into the market, thereby increasing supplies (Morris *et al*., 2007; Takeshima *et al*., 2012). This means that, if the subsidy program was to phase out or be scaled down, agro-dealers would be responsible for meeting input demand for farmers (Kelly *et al*., 2010; Chirwa and Dorward, 2012). In this regard, a thorough understanding of how the volume of commercial fertilizer sales is affected by the volume of subsidized fertilizer retailed has important policy implications if the subsidy program reduces sales of commercial fertilizers. This may help policy makers to redesign the program to alleviate adverse effects of the subsidy program on the sustainable growth of a private input supply system in both long and short runs. Furthermore, the study findings provide lessons for other SSA countries implementing fertilizer subsidy programs to redesign their programs in the manner that increase the efficiency of the program and promote the development of the vibrant private input supply system over time.

1.9 Organisation of the Thesis

The foregoing chapter has presented the trend, consumption and use of fertilizer and the development of fertilizer markets in SSA countries. The chapter highlighted the challenges that fertilizer input market players are facing. The chapter also presented the programs prior to FISP, the role of the private sector in FISP and fertilizer market situation in Malawi. The chapter also presented the research gap in fertilizer input market and the rationale for the study. Objectives and hypothesis of the study were also outlined.

The rest of the thesis is organized as follows. Chapter two presents literature review. Past studies on evaluating the effects of agricultural input subsidies at the household and retail level in SSA countries were reviewed. Studies that assessed the factors that influence agro-dealers' volume of fertilizer sales were also reviewed. The chapter further reviewed studies that applied cointegration approaches such as Engle and Grangers Two Step Estimation Method, Johansen's Maximum Likelihood Method, Vector Error Correction Model (VECM) and Autoregressive Distributed Lag (ARDL) framework to determine the long and short run relationships among variables.

Chapter three narrates the methodology of the research starting with conceptual and theoretical frameworks. Later, the double hurdle and ARDL models are discussed.

Measurements of variables, sampling techniques and data collection are also discussed. The chapter concludes with limitations of the study.

Chapter four presents the descriptive statistics of surveyed agro-dealers. Chapter five presents empirical results from the lognormal hurdle and ARDL models. The thesis concludes with policy implications and recommendations in chapter six.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter reviews studies that have evaluated the effects of agricultural input subsidies at the household and retail level in SSA countries. The literature on studies that have assessed the factors that influence agro-dealers' volume of fertilizer sales are also reviewed in this chapter. This chapter, further, reviews studies that have applied cointegration approaches such as Engle and Grangers Two Step Estimation Method, Johansen's Maximum Likelihood Method, VECM and ARDL framework to determine the long and short run relationships among variables.

2.2 Demand Side Analysis of the Effects of Agricultural Subsidies

Ricker-Gilbert *et al*. (2011) applied a Double Hurdle model to determine how receiving subsidized fertilizer affects a farmer's decision to participate in the commercial fertilizer markets, and the amount of fertilizer purchased. Panel data for Malawi from the nationally representative Integrated Household Survey II (IHS2) and the 2007 Agricultural Inputs Support Survey (AISS) conducted in 2002/03 - 2003/04 and 2006/07 cropping season, respectively were used in the study. It was found that distance to a paved road make farmers less likely to participate in commercial fertilizer markets whereas having a farm credit organization in the village, expected maize price and fertilizer price are positively associated with commercial fertilizer market participation. The quantity of subsidized fertilizer received, value of household assets, farm size, market prices, and weather conditions significantly affect how much commercial fertilizer a farmer purchases once participation decision has been made. The study empirically revealed that there was some displacement of commercial fertilizer sales, although the subsidy program resulted in an increase in total fertilizer use. A one kilogram of subsidized fertilizer was found to significantly reduce the demand for commercial fertilizer by 0.22 kg.

Jayne *et al.* (2013) applied a Double Hurdle model to assess how fertilizer subsidy programs affect total fertilizer use after accounting for crowding out and diversion in Sub-Saharan African countries of Kenya, Malawi and Zambia. The study used an unbalanced national representative panel data of 7,311 households (*i.e.* IHS2, AISS1 and AISS2) from Malawi, 1,065 households (*i.e.* 1995/96, 1996/97, 2000, 2004, and 2010) from Kenya, and 6,922 households (*i.e.* 2001, 2004, and 2008) from Zambia. The study found that each additional ton of subsidized fertilizer distributed through the subsidy program in Malawi, Zambia and Kenya crowds out 180 kg, 134 kg, and 431 kg of commercial fertilizer purchased by farmers and adds 820 kg, 866 kg and 569 kg to total fertilizer use if diversion is not accounted for, respectively. Given that 16.5 percent, 33 percent and 40 percent of total program fertilizer in Zambia, Malawi and Kenya may be diverted, the study found that an additional ton of fertilizer retailed through the subsidy program displaces 464 kg, 490 kg, and 761 kg of commercial fertilizer purchases and contributes about 510 kg, 536 kg, and 239 kg to total fertilizer use, respectively. Thus, accounting for program diversion, the estimated contribution of the subsidy program to total fertilizer use in Zambia, Malawi and Kenya is overestimated by 61.6 percent, 67.3 percent, and 138 percent, respectively.

Holden and Lunduka (2012) used a correlated random effects (CRE) probit models and the CRE tobit models to investigate the relationship between household use of fertilizer and organic manure and how this relationship is affected by fertilizer subsidies at the household level. The study used more than 3000 farm plot level data from six districts in central and southern Malawi over three years (2006, 2007, and 2009). It was found that both the probability of manure use and intensity of manure use were positively correlated with the intensity of fertilizer use. A one percent increase in fertilizer use intensity was found to be associated with a 1.94 - 1.96 percent increase in the intensity of manure use outside the subsidy program and a 0.62 - 1.66 percent increase in manure use with the program. Furthermore, a one percent increase in average fertilizer price was found to be associated with a 0.43 - 0.76 percent increase in the probability of manure use and a 3.5 - 5.3 percent increase in the intensity of manure use.

Chibwana *et al*. (2012) assessed the effect of agricultural subsidy on forest conversion in Malawi. A two-stage regression analysis was applied to household survey data from Chimaliro and Liwonde Forest reserves in Kasungu and Machinga districts, respectively. The study found that receiving a full subsidy (coupons for seed and 100 kg of fertilizer) reduced the probability of forest clearing by approximately 60 percent. Lower rates of forest clearing were found in public forests, and in settings where Village Natural Resources Management Committees (VNRMC) exist. Furthermore, indirect negative impacts of the program on forests was found from offtake of trees to construct drying sheds for tobacco. Using the same sample, Chibwana *et al*. (2010) further found that subsidy program induced land use change by increasing the allocation of land to maize by 20 percent in households that received a complete packet of coupons compared to those that did not. However, this was achieved at the expense of other crops (legumes, cassava and sweet potatoes) which were allocated 24 percent of land on average. In terms of the effect of the program on farmers' decision to clear forests for agricultural expansion, the study found that households that accessed subsidized fertilizer cleared 1.5 acres less forest land per household than those that did not receive the subsidy.

Xu *et al*. (2008) used a Double Hurdle model to analyze farmers' input use decisions accounting for the effects of government input subsidy program on the commercial demand for inputs. The study used rural households panel data for Zambia from the nationally representative Post-Harvest Survey (1999/2000) and Supplemental Surveys (1999/2000 and 2002/2003). The study found that the effect of the fertilizer subsidy program on overall fertilizer use depends on the type of area in which the program operates. An additional 1 kg of fertilizer distributed through the subsidy program raised total fertilizer use by 0.92 kg. In areas where the private sector had been active, an additional ton of subsidized fertilizer resulted in a 0.12 ton reduction in total fertilizer use on average. A 1 kg per household increase in the distribution of subsidized fertilizer increased total use by 1.06 and 1.7 kg per household in areas of relatively low private sector activity and in the poorest areas, respectively. In terms of targeting, the study found that subsidized fertilizers were more likely to benefit wealthier households, and in areas where average wealth is higher the program contributed to lower incremental fertilizer use.

Takeshima *et al*. (2012) applied a system of endogenous Tobit regressions to evaluate the crowding-in or crowding-out effect on the private fertilizer sector by the fertilizer subsidy program. The study used households' panel data for Nigeria from the nationally representative National Survey on Agricultural Export Commodities (2003, 2005, 2006 and 2007) and Living Standard Measurement Survey (2010). The study found that each additional ton of subsidized fertilizer supplied by government reduced the demand for commercially supplied fertilizer by between 0.19 and 0.35 tons. The crowding-out effect of the subsidy program was likely greater in states with higher state-level subsidy rates. In addition, the subsidy program was found to reduce the open-market fertilizer price. Households closer to urban centres and being headed by males with higher education were more likely to have access to subsidized fertilizer compared to their counterparts.

In a similar study, Mason and Jayne (2013) extended the framework that was used by Xu *et al*. (2008) and Ricker-Gilbert *et al*. (2011) on the crowding in/crowding out effects of subsidized fertilizer on commercial fertilizer purchases to account for leakage. The study used smallholder households panel data for Zambia from the nationally representative Post-Harvest Survey (1999/2000) and Supplemental Surveys (1999/2000, 2002/2003 and 2006/2007). The study found that each additional kg of subsidized fertilizer received by a household decreased its fertilizer purchases from commercial retailers by 0.13 kg. The displacement rate was higher in areas where the private sector was initially more active in fertilizer retailing (0.23 percentage points) than in areas where private sector was less active (0.07 percentage points). Displacement rate was higher among households that cultivate two or more hectares of land (0.21 percentage points) than among households cultivating smaller areas (0.11 percentage points). Displacement rates were also higher among male-headed households (0.15 percentage points) than among female-headed ones (0.09 percentage points). Accounting for leakage, the study found that each additional kg of subsidized fertilizer increased total fertilizer use by 0.54 kg. Without controlling for leakage of subsidized fertilizer into the commercial market, the estimate would have been 0.87 kg, an overestimate of 61 percent.

2.3 Supply Side Analysis of the Effects of Agricultural Subsidies

2.3.1 Descriptive Analysis

Kelly *et al*. (2010) evaluated the effects of the 2007/08 and 2008/09 subsidy programs on the performance of fertilizer retailers using descriptive analysis. The study used panel data for Malawi from 230 fertilizer retailers in six purposively selected districts (*i.e.* Mzimba, Rumphi, Kasungu, Lilongwe, Blantyre, and Machinga). The study found that improvements were recorded in tendering procedures and increased private sector involvement in importation. In 2007/08, the private sector also expanded its participation in subsidized fertilizer sales, distribution networks and developed innovative partnerships with independent agro-dealers. Between 2005/06 and 2008/09 seasons, the study found that the average number of independent agro-dealers within a market centre increased from 5.82 to 6.72, representing a 15 percent increase. During the same period, average number of major distributor retail outlets at the market centre increased from 5.78 to 5.98, representing a 3 percent increase whereas ADMARC/SFFRFM depots experienced a 7 percent growth in the average number of competitors. However, when the private sector was excluded from the retail sale of subsidized fertilizer in 2008/09, the average number of competitors for ADMARC/SFFRFM depots declined to 3.03, below the 3.09 level for 2005/06. In addition, the study found that the private sector responded to financial incentive that was provided by Government to expand geographic coverage to include remote locations.

Chirwa and Dorward (2012) reviewed the participation of the private sector in the subsidy program from the period 2006/07-2011/12 using Logistics Unit reports from Malawi and analyzed household survey data collected in 2006/07, 2008/09 and 2010/11 seasons. The study found increasing trends in both the number of private sector bidders interested in procuring fertilizers and the number of bidders that were awarded contracts to supply the fertilizers particularly from the 2009/10 season. In terms of commercial sales, the study used import[3] data to extrapolate the available fertilizer for commercial sales after accounting for subsidized fertilizers due to difficulties in obtaining commercial sales data from the private sector. The trend in the fertilizers available for commercial sales showed a marginal increase of about 20 percent between 2004/05 and 2005/06 season. This was followed by a sharp decline of about 69 percent in 2006/07. Available commercial fertilizer in 2008/09 were below the 2004/05 level by 21 percent. There was a decline in importation of fertilizers and availability of commercial fertilizers in 2009/10 compared to 2008/09 level by about 21 percent and 25 percent, respectively. Fertilizer imports increased by about 26 percent and available commercial fertilizers by about 71 percent, whereas subsidized fertilizer remained constant between 2010/11 and 2009/10. In 2011/12, there was a drop in imports, subsidized fertilizer and commercial fertilizers by about 21 percent, 13 percent and 28 percent, respectively, from the 2010/11 levels. Using household level data, the study found that the proportion of farmers accessing private company market outlets for commercial purchases increased from about 6 percent in 2006/07 to about 30 percent in 2010/11 season. During the same period, commercial fertilizers purchase from parastatals decreased from 18 percent to about 13 percent.

[3] Official import data include fertilizer for both estates and smallholder farmers.

2.3.2 Econometric Analysis

Dorward *et al*. (2007; 2008[4]) assessed the impact of the subsidy program on the input sector. Displacement of commercial and subsidized sales was examined by regressing aggregate fertilizer sales through commercial and subsidized channels against time over the period 1997/98 to 2006/7 cropping seasons in Malawi. A simple regression of the private sector sales on parastatal sales showed a significant negative relationship between private sector and parastatal sales. Parastatal sales in 2005/6 and 2006/7 led to 32 percent and 26 percent reductions in private sector sales, respectively, as compared with what private sector sales would have been in the absence of both the subsidy and parastatal sales. Higher displacement was recorded in tobacco fertilizer when compared with maize fertilizer. However, the estimate of the effect of subsidized sales on unsubsidized sales did not account for the effects of other variables on unsubsidized sales which might include fertilizer prices, income per capita and variables representing the density of sale outlets. This was due to lack of data for some variables and very short data series (due to structural change in the mid 1990's) and hence limited degrees of freedom.

Fitzpatrick (2012) assessed the impact of excluding the private sector retailers from participating in the subsidy program on commercial fertilizer sales using difference-in-difference approach between 2006/07 and 2008/09 seasons in Malawi. The study evaluated how retailers who were allowed to participate in the 2006/07 subsidy program and were then excluded in the 2008/09 subsidy program experienced this policy change in comparison to retailers who were not allowed to participate at any point in the program.

[4] Note that Report by Dorward *et al*. (2007; 2008) refer to an Interim and final reports, respectively.

Using the same data by Kelly *et al*. (2010) for Malawi, the estimated total sales model did not find evidence of decreased sales by distributors and agro-dealers after being excluded from the subsidy program. However, the quality of the data were affected by high levels of attrition. In addition, the sample size was relatively small which also created econometric problems. It was suggested, however, that increased demand for fertilizer and hybrid maize varieties may have at least partially compensated for any negative effects of the changes in subsidy implementation.

The studies by Dorward *et al.* (2008), Kelly *et al*. (2010), and Fitzpatrick (2012) were conducted in six purposively selected districts (Mzimba, Rumphi, Kasungu, Lilongwe, Blantyre, and Machinga) of Malawi. The study findings from these studies are not nationally representative; rather they reflect the situation in each selected districts. Fitzpatrick (2012) reports that one major problem with the collected retail data in 2006/07 was lack of a complete inventory of agro-dealers which meant that non-members of CNFA or AISAM networks were not included in the sampling frame. In 2009 survey, only 65 percent of the retailers interviewed in 2006/07 were located and re-interviewed. In addition, there was significant changes in both geographic distribution and composition of the retailers surveyed. The change in composition was due to lack of sampling frame and not a reflection of the change in population of retailers.

2.4 Cross-sectional Input Supply Analysis

Few studies have been conducted in SSA to understand factors that influence entry of agro-dealers into the fertilizer market and the volume of commercial fertilizer sales. Omamo and Mose (2001) applied an Ordinary Least Square regression to identify supply-side and demand-side factors influencing trade in inorganic fertilizer following market liberalization in Kenya. The study used cross-sectional data from the countrywide survey of fertilizer traders undertaken in 17 districts and 37 market centres in 1997. The variables used were fertilizer sales revenue, the price of a 90 kg bag of maize at the time of the survey in the market centre, agroecological potential, number of years that a trader has been selling fertilizer, access to credit, stiff competition and low trading margins as a constraints to fertilizer trade, and if trader perceived business conditions to have improved under market liberalization. The analysis showed that revenues for traders in areas with low agroecological potential were less (-51 percent) than those in high agroecological potential areas. Revenue from fertilizer sale was positively correlated with maize prices and access to credit and inversely correlated with years in fertilizer trade.

In a similar study, Freeman and Kaguongo (2003) used a Heckman two-stage econometric model to examine the factors influencing the entry and sales decision of private traders in fertilizer retail trade in a liberalized market. The study used cross-sectional data from the survey of private input traders conducted in Machakos district of eastern Kenya in 1997. The variables used were agro-ecological zone trader is operating, selling agrochemicals, technical knowledge on fertilizer use, access to credit, access to fertilizer trade information, access to wholesale suppliers, store ownership, gender, demand for fertilizer, education, population density in store location, number of people employed in the store, vehicle ownership, offering technical advice on fertilizer use, relative return to fertilizer trade, price margin per kg of fertilizer, and the value of fertilizer sold. The study found that traders in wetter zones with experience selling agro-chemicals and access to financial resources, fertilizer trade information and wholesale suppliers were more likely to respond to the retail trade opportunities arising from liberalization of fertilizer markets. On the other hand, the variation in level of fertilizer sales was positively correlated with the size of the business (number of people employed in the store), relative profitability of fertilizer and price margins.

The previous studies by Dorward *et al*. (2007; 2008), Kelly *et al*. (2010), and Fitzpatrick (2012) are supplemented by expanding the geographic coverage of agro-dealers (*i.e*. Sampling both CNFA or AISAM members and non-members) in order to capture a nationally representative situation. The lognormal hurdle model and Ordinary Least Square (OLS) regression were applied to determine the effect of the subsidy program on commercial fertilizer sales by independent agro-dealers and retail outlets of fertilizer distributors, respectively using retail level data. Thus, measurement of displacement based on cross-sectional retail was estimated as a counterpart to the calculations made from the household level data.

2.5 Estimation of Short and Long Run Relationships among Variables

Cointegration approaches such as Engle and Grangers Two Step Estimation Method, Johansen's Maximum Likelihood Method, VECM and ARDL framework have been used in the economic literature to empirically determine the long and short run relationships among variables. Weliwita (1998) applied the Engle and Granger two-step cointegration procedure and the Johansen's cointegration technique to price and exchange rate data from six developing countries in Asia. The study tested the validity of the long-run purchasing power parity. The results of both methods rejected the existence of long-run purchasing power parity for all countries included in the analysis. Brooks (2008) and Maggiora *et al.* (2009) argued that Engle-Granger procedure needs a larger sample size to avoid possible estimation errors, and can only be run on a maximum of two variables. Further, the Engle-

Granger procedure does not allow for hypothesis testing on the cointegrating relationships themselves.

Asari *et al*. (2011) applied a VECM to analyse the relationship between interest rate, inflation rate, and exchange rate volatility. The study used data from Malaysia covering the period from 1999 to 2009. The Granger causality test revealed that inflation rate influences the interest rate and interest rate influences the exchange rate. The study found that interest rate was positively associated with inflation rate and inflation rate was negatively associated with exchange rate volatility in the long term.

Waliullah *et al*. (2010) applied the bounds testing approach to cointegration developed within an ARDL framework to examine the short and long-run relationships between the trade balance, income, money supply, and real exchange rate. The study used annual data from Pakistan for the period 1970 to 2005. The study found a stable long-run relationship between the trade balance, income, money supply, and real exchange rate variables. Exchange rate was found to positively relate to the trade balance both in the long and short run. In addition, money supply and income were found to play a role in determining the behavior of the trade balance.

Out of these approaches, the ARDL approach is the most preferred model for estimating long and short run relationships. The major limitation of Engle-Grangers, Johansen, and VECM approaches over ARDL framework is that these approaches concentrate on cases in which the underlying variables are integrated of order one (*i.e.* integrated of the same order) (Pesaran *et al*., 2001). This inevitably involves a certain degree of pre-testing. Pesaran *et al*. (2001) argued that pre-testing of underlying variables introduce a degree of uncertainty into the analysis of levels relationships. The ARDL approach does not involve pre-testing variables for unit roots, which means that the test for the existence of relationship between variables is applicable irrespective of whether the underlying regressors are $I(0)$, $I(1)$, or fractionally integrated (Pesaran *et al*., 2001; Bahmani-Oskooee and Ng, 2002; Waliullah *et al*., 2010; Hassani and Nojoomi, 2010; Afzal *et al.*, 2013). In addition, the ARDL procedure gives consistent and robust results both for the long-run and short-run relationships in small or finite samples consisting of 30 to 80 observations (Nosier, 2012; Afzal *et al*., 2013).

The ARDL model popularized by Pesaran and Shin (1999) and Persaran *et al*. (1996) was estimated to establish the direction of causation among commercial fertilizer sales, subsidy fertilizer sales, and average fertilizer prices over time. This study improves the previous work by Dorward *et al.* (2008) and Chirwa and Dorward (2012) by applying an ARDL Model on quarterly time series data with 56 observations from 1998 to 2011 and accounted for the effect of average fertilizer prices in determining short and long run association between commercial fertilizer sales, subsidy fertilizer sales and commercial fertilizer prices over time. Similarly, measurement of displacement based on national quarterly time series data was estimated as a counterpart to the calculations made from the household level data.

CHAPTER THREE

MATERIALS AND METHODS

3.1 Introduction

This chapter presents the methodology of the study. It starts with conceptual, theoretical and then empirical frameworks. The double hurdle and ARDL models are discussed. This chapter further presents measurements of variables, sampling techniques and data collection procedures. The chapter concludes with limitations of the study.

3.2 Conceptual Framework

The study postulates that independent agro-dealers' decision to participate in the fertilizer market as a seller is conditioned by socio-economic factors (level of education, age, gender and experience in agro-dealership) and institutional factors (number of other agro-dealers at the market centre, distance between agro-dealer's store and ADMARC/SFFRFM depot, selling maize seed, access to credit, state of road connecting the market centre and store ownership) (Freeman and Kaguongo, 2003) (Figure 3.1). The study recognizes that some of these factors are unobservable (risk preference) or difficult to measure empirically (for example, size of the firm and transaction costs); hence, proxy variables were used for empirical analysis.

The influence of age on entry decision is expected to be negative because older agro-dealers may be more risk averse and therefore, less inclined to invest in fertilizer trade. Agro-dealers that have at least attended formal education and those with experience in agro-dealership are hypothesized to have higher management skills and therefore, more likely to accurately assess opportunities for fertilizer trade. These agro-dealers are expected to expand trading activities in response to new opportunities (Freeman and Kaguongo, 2003). Agro-dealers with experience in agro-dealership are also hypothesized to have developed contacts with input suppliers that facilitate entry into fertilizer markets. Access to resources and opportunities for fertilizer trade is hypothesized to favor male agro-dealers compared to female agro-dealers. Gender of the agro-dealer is therefore expected to have a positive influence on entry decision. Years of experience of an agro-dealer in selling fertilizer is hypothesized to influence volume of fertilizer sales (Omamo and Mose, 2001). Years of experience in selling fertilizer is expected to be positively associated with volume of fertilizer sales. Agro-dealers who have spent more time in fertilizer business are more likely to have reduced transaction costs and therefore, more inclined to expand sales.

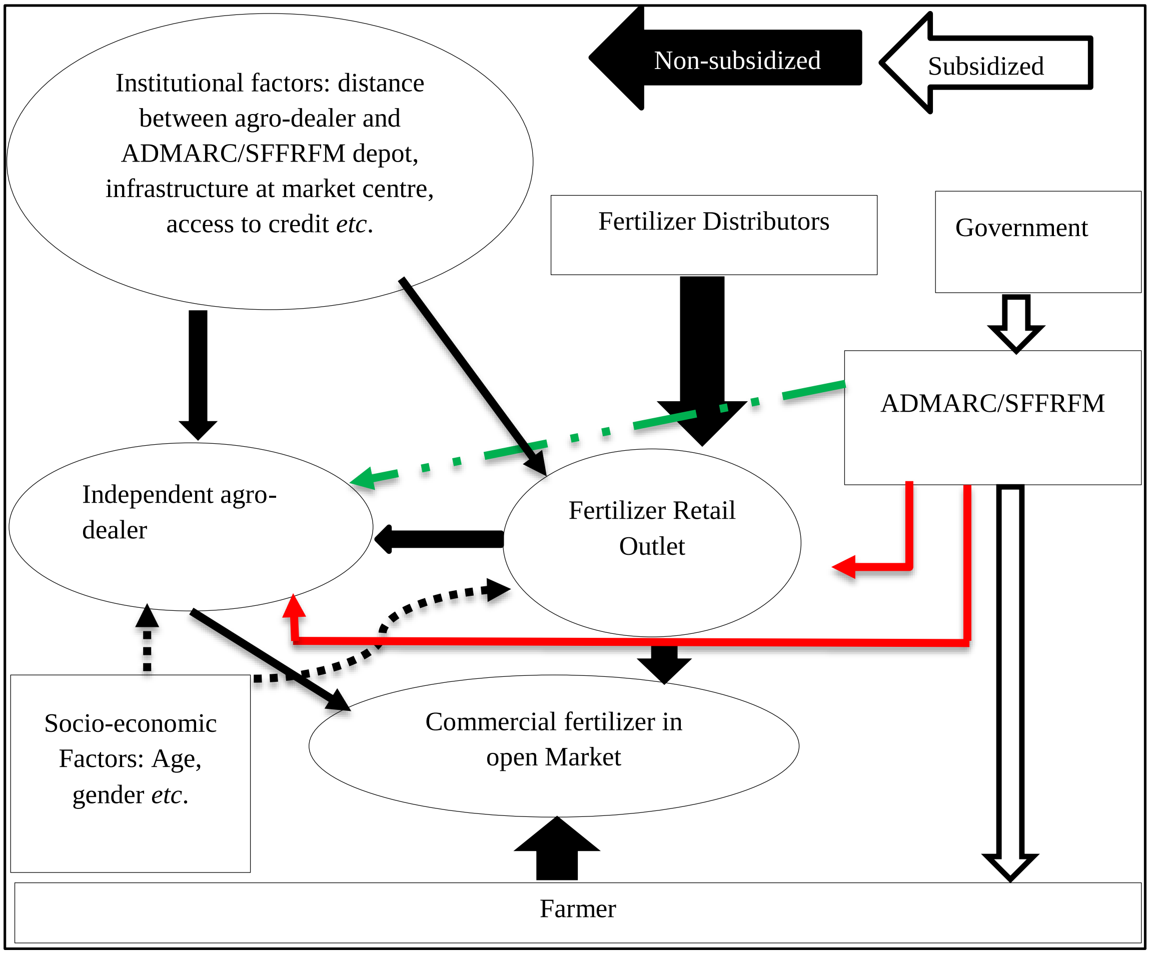

Figure 3.1 Conceptual framework for factors that influence entry and fertilizer sales of agro-dealers.

The ability to finance trading activities is determined by the overall liquidity position of the agro-dealer (Omamo and Mose, 2001; Freeman and Kaguongo, 2003). It is influenced by whether an independent agro-dealer obtained credit for fertilizer business or not. High cost of initial capital and liquidity constraint impose severe entry barrier to trade in input markets (Kherallah *et al*., 2000; Freeman and Kaguongo, 2003). It is hypothesized that access to credit and amount of initial starting capital are positively associated with entry decision into the fertilizer market. Store ownership and the size of the store are used as asset variables. Storeowners and agro-dealers with big stores are hypothesized to have storage facilitates and are therefore, more likely stock large volumes of fertilizer and keep the fertilizer until prices are better. Therefore, store ownership is expected to have positive influence on the entry and sales decisions whereas size of the store is expected to positively influence the volume of commercial fertilizer sales for independent agro-dealers.

Total number of full time employees is used as a proxy variable for size of business for an independent agro-dealer. An independent agro-dealer that is operating on medium scale (*i.e.* considered to be well established) is more likely to have better access to financial and human resources that are necessary for investing and day-to-day management of the fertilizer business. As a result, number of full time employees is hypothesized to positively associate with the volume of commercial fertilizer sales. Agro-dealers selling maize seed are hypothesized to have developed contacts with input suppliers that facilitate entry into fertilizer market. Therefore, agro-dealers selling maize seed are expected to have high probability of participating in fertilizer market. Owning more than one selling point is hypothesized to positively associate with the volume of commercial fertilizer sales. Independent agro-dealers with more than one selling point are expected to have increased market share in the fertilizer market which eventually results in increased levels of fertilizer sales. The number of agro-dealers at the market centre is a good proxy for level of competition and sound economic activities. As a result, the number of agro-dealers at the market centre is expected to positively influence (peer effect) entry decision and negatively correlate with volume of commercial fertilizer sales.

Freeman and Kaguongo (2003) reported that extensive levels of agricultural market segmentation imply that supply conditions and the state of infrastructure at the market centre influence agro-dealer's ability to respond to trading opportunities. Poor rural infrastructure raises marketing and distribution costs that is passed on to consumers. Collectively, these factors reduce the derived demand for fertilizer and results in low fertilizer sales. The state of the road network to the market centre is used as a proxy variable for the state of infrastructure at the market centre. It is expected to positively influence traders' entry decision in the fertilizer market. Furthermore, demand conditions are expected to influence commercial fertilizer sales. The number of farm families at an EPA and population density per district are used as proxy variables to capture potential market demand for fertilizer. It is expected that high concentration of farm families within the market selling point positively correlate with high level of local market demand for fertilizer and favorable trade prospects. Hence, commercial fertilizer sales are expected to increase with rising number of farm families per EPA at the EPA level and population density at the district level (Freeman and Kaguongo, 2003; Omamo and Mose, 2001).

If the distance between an agro-dealer and ADMARC/SFFRFM depot is shorter, it is expected to positively influence the agro-dealers' decision to participate in the fertilizer business and fertilizer sales. This is because locations in which ADMARC/SFFRFM depots are located are well-developed in terms of infrastructure. The location the agro-dealer is operating is assumed to further capture important supply, infrastructure and demand conditions influencing entry and sales decisions. More efficient agro-dealers are expected to have lower fertilizer selling prices. Therefore, lower fertilizer selling price is expected to be positively associated with the volume of commercial fertilizer sales.

The study also postulates that commercial fertilizer sale by fertilizer distributor retail outlets is influenced by some of the factors that affect commercial fertilizer sales by independent agro-dealers except number of full time employees, store ownership, size of the store and having more than one selling point. This is due to the fact that fertilizer distributors have relatively adequate storage facilities for fertilizers (*i.e.* capacity to stock large volumes of commercial fertilizer) and a network of retail outlets across the country using various rented stores. In addition, the retail outlets of fertilizer distributors are centrally managed by fertilizer importers; hence the size of their operation is considered to be large-scale (*i.e.* they are well established).

Selling of subsidized fertilizer through ADMARC/SFFRFM depots is expected to reduce the volume of commercial fertilizer sales by both independent agro-dealers and distributor retail outlets. An informal channel exists in which subsidized fertilizer is diverted from the ADMARC/SFFRFM depots and sold in the open market by independent agro-dealers who are well-connected with ADMARC/SFFRFM and Government officials (Kelly *et al*., 2010; Dorward and Chirwa, 2011). This may benefit independent agro-dealers and not fertilizer distributor retail outlets.

3.3 Theoretical Framework and Empirical Models

3.3.1 Theoretical Framework for Participation Decision and Commercial Fertilizer Sales

The study considered an independent agro-dealer's sell of fertilizer in the input market and recognizes that the decision may be made in a sequential two-step process or it may be a simultaneous decision. In the sequential process, the independent agro-dealer decides whether or not to participate in the fertilizer input market (*i.e.* as a buyer or seller) and if market participation is chosen (*i.e.* as a seller), the next step is the sales decision. On the other hand, simultaneous decision making means that the independent agro-dealer makes market participation and sales decisions at the same time. Simultaneous market participation decisions in the input demand have been modelled by Minot *et al.* (2000) and Chirwa (2005). Sequential market participation decisions have been modelled by Freeman and Kaguongo (2003) in the input supply and by Ricker-Gilbert *et al*. (2011) and Xu *et al*. (2008) in the input demand.

Fafchamps (2004) observed that microeconomic theory has devoted a lot of attention to the study and modelling of two categories of economic agents, namely producers and consumers. Traders play a crucial role, as middlemen, in matching producers' technologies such as fertilizer with consumers' preferences. Therefore, this study adapted a random utility theoretical structure from McFadden (1977) to understand an independent agro-dealer's decision to participate in the fertilizer input market following Freeman and Kaguongo (2003). Under the assumption of sequential choice, utility of profit function for an independent agro-dealer can be expressed as follows (Ng, 1974; Kobayashi, 1975):

$$U(M, L; H, G, S) \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots.. [1]$$

Subject to:

$$M = PY(x^1, \dots, x^n, y) - \sum_{i=1}^{n} p^i x^i + w^m(z - y^h) \dots\dots.\dots.\dots [2]$$

$$L = T - y^s - z \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots..\dots..\dots.. [3]$$

$$y = y^s + y^h \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots.. [4]$$

where U represent the utility of profit function for the agro-dealer, M is money income, L is the amount of leisure time, T is total given time, P is parametrically given price of fertilizer, Y is total volume of fertilizer sold, p^i is similar price of ith input, x^i is the quantity of ith input used, y is amount of time spent managing the business, y^s is amount of time spent managing own business, y^h is amount of managerial services hired, z is amount of time spent supporting other agro-dealers, w is imputed wage-rate for services, and w^m is the market wage-rate for managerial services. $PY(x^1, \dots, x^n, y)$ is the total revenue and $\sum_{i=1}^{n} p^i x^i$ is the total outlays, $w^m(z - y^h)$ is the difference between the amount of earnings which the agro-dealer gains from other businesses and the amount of payments for hired managerial services. The utility of profit is subject to factors exogenous to the agro-dealer current decisions, H, such as state of road connecting market centre, access to credit, amount of start-up capital and other agro-dealer characteristics, G, such as age of agro-dealer, gender of agro-dealer and education level of agro-dealer. S represents the policy variable, quantity of subsidized fertilizer, that affects utility of profit for agro-dealers by reducing the volume of commercial fertilizer sales.

All variables in equation [2] to [4] are non-negative. The agro-dealer maximizes utility of profit [1] subject to [2], [3] and [4]. The Lagrangian is expressed as:

$$\mathcal{L} = U(M, L; H, G, S) + \varrho_1 \left(M - PY(x^1, \dots, x^n, y) + \sum_{i=1}^{n} p^i x^i - w^m(z - y^h)\right) +$$
$$\varrho_2(L - T + y^s + z) + \varrho_3(y - y^s - y^h) \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots [5]$$

where parameters ϱ_1, ϱ_2, and ϱ_3 represent Lagrangian multipliers. The following necessary conditions can then be derived:

$$PY_i - p^i \leq 0 \qquad \text{or} \qquad x^i = 0 \qquad (i = 1, \dots, n) \dots\dots [6]$$

$$PY_y - w^m \leq 0, \qquad \text{or} \qquad y^h = 0 \dots\dots\dots\dots\dots\dots\dots\dots\dots [7]$$

$$U_M PY_y - U_L \leq 0 \qquad \text{or} \qquad y^s = 0 \dots\dots\dots\dots\dots\dots\dots\dots [8]$$

$$U_M w^m - U_L \leq 0 \qquad \text{or} \qquad z = 0 \ldots\ldots\ldots\ldots\ldots\ldots\ldots [9]$$

where a subscript denotes partial differentiation, e.g., $Y_i = \partial Y/\partial x^i$, *etc*. Equation [6] shows that the marginal revenue of participation, PY_y minus the marginal cost of participating in the fertilizer market, P^i should be equal to or less than zero in order to maximize utility of profit. Equation [7] shows that workers (*i.e*. managerial services) will be hired up to the point when the marginal revenue product, PY_y should be equal to the wage rate, w^m in order to maximize utility of profit from participating in the fertilizer market. Equation [8] may be interpreted to mean that marginal utility of income, $U_M PY_y$ from participating in the fertilizer market minus marginal utility of leisure time, U_L and marginal utility of income, $U_M w^m$ from supplying managerial services to other independent agro-dealers minus marginal utility of leisure time, U_L should be equal to or less than zero to maximize utility of profit in the fertilizer market. If $y^s \neq 0$, and either $y^h \neq 0$ or $z \neq 0$, namely, if the owner of the business inputs his managerial services to his/her business and there is selling or buying of managerial services, two equations can be derived from either from the equality parts of equation [7] and [8], or [8] and [9].

$$U_L/U_M = w^m \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots [10]$$

$$PY_y = w^m \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots [11]$$

Equation [10] and [11] measure the slope of the indifference curve and the slope of the owner of the business's income curve. Therefore, equation [10] and [11] mean that the slopes of the income and indifference curves must be equal to the slope of the market wage rate of managerial services. In the case when the possibility of buying and selling managerial services is excluded, conditions [7] and [9] become irrelevant. Then from equation [8], the tangency point becomes:

$$U_L/U_M = PY_y \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots [12]$$

Equation [12] shows that tangency point of income and indifference curves will be chosen for utility maximization, provided $y^s \neq 0$.

3.3.2 Model Specifications

There is no general consensus with regards to treatment of genuine zeros in economic data. It is argued that a tobit or double hurdle is credible than a Heckman selection model (Ricker-Gilbert *et al*., 2011; Humphreys, 2013). Heckman selection approach is applicable for incidental truncation where the missing values encountered in the data set are due to non-observable response leading to estimates which are conditional on participation in the outcome equation (Ricker-Gilbert *et al*., 2011; Yu and Abler, 2007; Humphreys, 2013). A tobit or double hurdle model is applicable when the distribution of the dependent variable is spread out over a large range of positive values, but with a pileup at the value zero. Here we do not observe the expected outcome (*i.e.* dependent variable) because of the outcome of another variable. Thus, Heckman selection model assumes correlation between the participation (*i.e.* the error terms of the selection equation) and the amount of sales decisions in the fertilizer market (*i.e.* the error term of the outcome equation) (Wooldridge, 2009; Humphreys, 2013). Therefore, we applied a tobit or double hurdle model because there was a significant proportion of independent agro-dealers with zero sale of fertilizer and the rest with a positive level of fertilizer sale at the time of the survey. In addition, the zero values in the data set might reflect agro-dealer's optimization decision in the fertilizer market at the time of the survey.

The independent agro-dealer's market participation and commercial fertilizer sale can be viewed from two different perspectives. The first incidence is where the agro-dealer makes the decision to participate and how much fertilizer to supply simultaneously. In this regard, market participation and fertilizer supply can be estimated via tobit estimator. Thus, factors affecting market participation and sale decisions are one and the same (Ricker-Gilbert *et al*., 2011; Wooldridge, 2009). On the other hand, where the agro-dealer makes decision to participate and how much fertilizer to supply sequentially, the double hurdle model to address corner solutions is appropriate. In the double hurdle model, factors influencing market participation and factors influencing commercial fertilizer sales may be different (Ricker-Gilbert *et al*., 2011; Yu and Abler, 2007). Thus, the same factors can potentially affect market participation and sale decisions differently. Fixed costs such as infrastructure at the market centre may affect agro-dealer's decision to participate in the fertilizer market but they may not affect the fertilizer sales (Wooldridge, 2009; Ricker-Gilbert *et al*., 2011).

From the theoretical framework, we considered the i^{th} independent agro-dealer ($i = 1, \dots, n$) which was facing a decision on whether or not to participate in the fertilizer input market. Let U_i represents the utility of profit (*i.e.* profit for participating in seed and agro-chemical markets) to the independent agro-dealer from not participating in the fertilizer input market and U_{ipf} represents the utility of profit from participating in the fertilizer input market, f.

$$\left.\begin{aligned} U_{ipf} - U_{iN} \geq 0 \\ U_{ipf} = Z_{if}\gamma + \varepsilon_{if} \geq 0 \end{aligned}\right\} \dots\dots\dots\dots\dots\dots\dots\dots\dots [13]$$

$$D_{if} = \begin{cases} 1 \ if \ U_{ipf} - \varepsilon_{if} \geq Z_{if}\gamma \\ 0 \ if \ U_{iPf} - \varepsilon_{if} \leq Z_{if}\gamma \end{cases} \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots . \ldots \ldots \ldots \ldots \ldots \ldots [14]$$

where U_{ipf} is the utility of profit an independent agro-dealer i gained from participating in fertilizer input market and U_{iN} is the utility of profit from not participating in the fertilizer input market (*i.e.* utility of profit an independent agro-dealer gained from participating in seed and agro-chemical markets). Z_{if} is the vector of conditional explanatory variables that influence participation in the fertilizer input market (such as age of the agro-dealer, gender, education level, access to credit, number of other dealers at the market centre, distance between independent agro-dealer and ADMARC/SFFRFM depot, selling maize seed, years of experience in input market, amount of initial start-up capital, state of road connecting the market centre, and store ownership) and γ is the vector of corresponding parameters to be estimated. The decision to participate in the fertilizer market by agro-dealers is voluntary. Independent agro-dealer participates in the fertilizer input market if $U_{ipf}^{*} - U_{iN} > 0$. We do not observe utility directly; rather D_{if} which takes on a value of one if the agro-dealer participates in the fertilizer input market and zero otherwise. ε_{if} represents the time constant unobservable factors that conditioned fertilizer input market participation such as business management skills and level of risk preference.

When participation decision in the fertilizer input market is made, the next step is to decide on the quantity of fertilizer to stock for selling. Modifying the adapted general format by Ricker-Gilbert *et al*. (2011) we specified commercial fertilizer sale equation as follows:

$$Y_{if} = P_{if}\left(Y_{if}^{*}\right) \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots [15]$$

$$Y_{if}^{*} = X_{if}\beta + v_{if} \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots [16]$$

where Y_{if} represents the total quantity of commercial fertilizer sales from the independent agro-dealer in 2013/14 season. Y_{if}^* represents a latent variable for the amount of commercial fertilizer the independent agro-dealer would like to sell regardless of market participation. We only observe Y_{if} if $P_{if} = 1$. X_{if} represents a vector of variables that influence the volume of fertilizer sales (such as amount of subsidized fertilizer retailed in 2013/14 season, number of other dealers, years of experience in fertilizer business, store ownership, store size, number of farm families, distance to ADMARC/SFFRFM depots, number of full time employees, owning more than one selling point, average fertilizer selling price per kg in 2013/14 season, number of farm families per EPA, and population density per district). β is corresponding parameters to be estimated. Some of the variables (distance to ADMARC/SFFRFM depot, number of other dealers at market centre, shop ownership, and location of the agro-dealer) were expected to influence both the entry and the volume of commercial fertilizers while others (education level of agro-dealer, gender of independent agro-dealer, average age of independent agro-dealer, selling maize seed, experience in input market, initial capital, credit access and state of road connecting market centre) to influence the entry decision but not the volume of commercial fertilizer sales. Therefore, the variables in X_{if} were not the same as those in Z_{if} from equation [13]. Variables that influence commercial fertilizer sales were considered in X_{if}. v_{if} represents the time constant unobservable factors in fertilizer sales, and was different from ε_{if} in the participation model. The model assumed the error terms, ε_{if} and v_{if} to be uncorrelated in the two hurdles (Wodjao, 2007; Engel and Moffat, 2012; Humphreys, 2013). Therefore, the error terms in equation [13] and equation [16] were distributed as follows:

$$\begin{pmatrix}\varepsilon_{if}\\ v_{if}\end{pmatrix} \sim N\left[\begin{pmatrix}0\\0\end{pmatrix}, \begin{pmatrix}1 & 0\\ 0 & \sigma^2\end{pmatrix}\right] \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.. [17]$$

Note from the diagonality of the covariance matrix that the two error terms were assumed to be independently and normally distributed and the covariance between the two error terms was equal to zero (*i.e.* cov $(\varepsilon_{if}, v_{if}) = 0$) (Wooldridge, 2009; Ricker-Gilbert *et al.*, 2011). Participation in fertilizer market is conditioned by independent agro-dealers' willingness and capacity to invest in fertilizer business. However, the variables that influence willingness and capacity to invest may differ; some independent agro-dealers may be willing to sell fertilizer but prevented from doing so because of various constraints such as access to credit, and initial start-up capital. On the other hand, the propensity to sell fertilizer is conditioned by relative returns to fertilizer trade (Freeman and Kaguongo, 2003).

Considering the fact that National Fertilizer Strategy (NFS) promotes joint forward planning between Government and private sector to ensure reasonable sharing of fertilizer market (*i.e.* eliminating issues of uncertainty in the fertilizer market by the private sector) (Government of Malawi, 2007), it was assumed that independent agro-dealers make market participation and fertilizer sale decisions sequentially. According to Wooldridge (2000), log-likelihood function for the double hurdle model was specified as follows:

$$\ell_i(\gamma, \beta) = 1[Y_{if} = 0] \log[1 - \Phi(Z_{if}\gamma)] + 1[Y_{if} > 0] \log[\Phi(Z_{if}\gamma)]$$
$$+ 1[Y_{if} > 0] \left\{- \log\left[\Phi\left(\frac{X_{if}\beta}{\sigma}\right)\right] + \log\left\{\emptyset\left[Y_{if} - \left(\frac{X_{if}\beta}{\sigma}\right)\right]\right\} - \log(\sigma)\right\}. [18]$$

where Y_{if} represents total annual commercial fertilizer sale in 2013/14 season, Φ represents the standard normal cumulative density function, ϕ represents the standard normal probability density function and σ represents the standard deviation. When the assumption of independent and normally distributed error terms in hurdle 1 and hurdle 2 is maintained, first the maximum likelihood estimator (MLE) of γ in the first hurdle measuring participation in fertilizer market could be obtained using a probit estimator. Second, the MLE of β which represents the parameter for the second hurdle measuring volume of fertilizer sales, could be estimated from a truncated normal regression model (Tobit model). When $\gamma = \beta/\sigma$ equation [18] collapses to the tobit log-likelihood function. The model specification of the double hurdle estimator could be tested against the tobit using a likelihood ratio (LR) test. This test determines whether or not the data supports sequential or simultaneous decision making.

When the assumption of normality in the error terms is violated which is often the case with survey data, Cragg (1971) also suggested the lognormal distribution conditional on a positive outcome, called the lognormal hurdle (LH) model. Following Wooldridge (2009), log-likelihood function in equation [18] was specified as follows:

$$\ell_i(\gamma,\beta) = 1[Y_{if} = 0]\log[1 - \Phi(Z_{if}\gamma)] + 1[Y_{if} > 0]\log[\Phi(X_{if}\gamma)]$$
$$+ 1[Y_{if} > 0]\{\log(\phi[(\log(Y_{if}) - X_{if}\beta)/\sigma]) - \log(\sigma) - \log(Y_{if})\} \dots [19]$$

As with the truncated normal hurdle model, estimation of the parameters proceed in two steps. The first step is probit model and then an OLS regression of $\log(Y_{if})$ for observations with $Y_{if} > 0$. Unlike the normal hurdle model, the lognormal hurdle model does not nest tobit model (Wooldridge, 2009; Sitko, 2013; Hagos *et al*., 2008).

The post-estimation analysis that were conducted include calculation of the Average Partial Effects[5] (APE) on the probability of positive commercial fertilizer sale ($P(Y_{if} > 0|X_{if})$), and on the expected value of commercial fertilizer sale given that it is positive ($E(Y_{if}|Y_{if} > 0, X_{if})$). The conditional APE of the subsidized fertilizer coefficient averaged across i calculate an overall measure of crowding in/out given participation in commercial fertilizer markets. The standard errors for inference on APE were obtained using Delta method (Burke, 2009).

In order to determine the factors that influence the volume of commercial fertilizer sales through retail outlets of fertilizer major distributors, an Ordinary Least Square (OLS) regression model was estimated. Fertilizer distributors are already in fertilizer business; hence we cannot estimate factors that influence their entry in fertilizer market. Instead, we can analyse factors that influence the volume of the commercial fertilizer sales. The reduced form equation for the OLS regression was specified as follows:

$$Y_{iR} = W_{iR}\tau + \xi_i \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots [20]$$

where Y_{iR} represents the actual annual quantity of commercial fertilizer sales from the fertilizer distributor retail outlet in 2013/14 season. W_{iR} represents a vector of variables that affect commercial fertilizer sales. These include quantities of subsidized fertilizer retailed in 2013/14 season, number of other dealers, average fertilizer selling price in 2013/14 season, years of experience in fertilizer business, number of farm families per EPA, distance to ADMARC/SFFRFM depots and population density per district. τ is

[5] Wooldridge (2001) defines partial effect as an effect of an explanatory variable on the dependent variable, holding other factors in the regression model fixed.

corresponding parameters to be estimated. ξ_i represents the time constant unobservable factors affecting fertilizer sales.

The effect of commercial fertilizer sales on quantity of subsidy fertilizer sales was also examined by applying OLS regression. The reduced form equation for the OLS regression was specified as follows:

$$Sub_{EPA/District} = Q_i\alpha + \vartheta_i \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots..\dots\dots\dots\dots.[21]$$

where $Sub_{EPA/District}$ represents the total quantity of subsidized fertilizer retailed at either EPA or district levels through the subsidy program in 2013/14 season. Q_i represents a vector of variables that affect subsidized fertilizer sales that include the volume of commercial fertilizer sales by an agro-dealer in 203/14 season, number of farm families, average fertilizer selling price and population density. α is corresponding parameters to be estimated. ϑ_i represents the time constant unobservable factors that affect subsidized fertilizer sales. It should be emphasized that these models were estimated at both the EPA and district levels in order to examine the factors influencing the volume of commercial fertilizer sales at different levels after accounting for the subsidy program.

3.3.2.1 Measurements of Variables used in Lognormal Hurdle Model

The dependent variable for the hurdle (1) is a latent (dummy) variable indexing entry in fertilizer market and the dependent variable for the hurdle (2) is total commercial fertilizer sales measured in kg. Commercial fertilizer sales is calculated as the total annual quantity of fertilizer an agro-dealer sold in 2013/2014 cropping season; hence a good indicator for agro-dealer's level of business performance in the fertilizer market. Measurements of factors that condition independent agro-dealers' decision to participate in the fertilizer market and its effect on the volume of commercial fertilizer sales are presented in the Appendix A (Table A-1 and Table A-2).

3.3.3 Theoretical Framework for Extent to which Subsidy Program is affecting Fertilizer Sales over Time

The extent to which the subsidy program affect commercial fertilizer sales can be determined by examining the long-run relationship between commercial fertilizer sales, subsidy sales and fertilizer selling prices over time. We assumed to have two stationary variables $ln(com)_t$ and $ln(sub_t)$ denoting volume of commercial fertilizer and subsidy fertilizer sales, respectively. The relationship between these variables over time was formulated as:

$$ln(com)_t = \delta + \theta ln(com)_{t-1} + \emptyset_0 ln(sub)_t + \emptyset_1 ln(sub)_{t-1} + \varepsilon_t \dots\dots\dots\dots\dots [22]$$

where $ln(com_{t-1})$ is previous period volume of commercial fertilizer sale and $ln(sub_{t-1})$ represents previous period volume of subsidy fertilizer sale. Equation [22] is an example of an autoregressive model and it is also known as dynamic model since it portrays the time path of the dependent variable in relation to its past value(s) (Gary, 2005; Ademe and Alemayehu, 2014). We assumed the error term, ε_t, is a white noise process, independent of $ln(com_{t-1}), ln(com_{t-2})$ and $ln(sub_t), ln(sub_{t-1})$. The above relation is referred to as an autoregressive distributed lag model. The interesting element in the model is that it describes the dynamic effects of a change in $ln(sub_t)$ upon current and future values of $ln(com_t)$. Taking partial derivatives, the immediate effect was derived as:

$$\frac{\partial ln(com_t)}{\partial ln(sub_t)} = \emptyset_0 \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots [23]$$

Equation [23] was referred to as the impact multiplier. Thus, an increase in $ln(sub)$ with one unit has an immediate impact on $ln(com)$ by $\emptyset_0$ units. The effect after one period was:

$$\frac{\partial ln(com_{t+1})}{\partial ln(sub_t)} = \frac{\theta\partial ln(com_t)}{\partial ln(sub_t)} + \emptyset_1 = \theta\emptyset_0 + \emptyset_1 \dots\dots\dots\dots.\dots\dots\dots\dots..\dots.[24]$$

and after two periods the effect was formulated as:

$$\frac{\partial ln(com_{t+2})}{\partial ln(sub_t)} = \frac{\theta\partial ln(com_{t+1})}{\partial ln(sub_t)} = \theta(\theta\emptyset_0 + \emptyset_1) + \emptyset_2 \dots\dots\dots.\dots\dots\dots.\dots.[25]$$

and so on. Equation [22] through [25] showed the effect of change in each of the explanatory variables, which were generated by having successive lags. Since the explanatory variables were more than two, the log-linear model for our problem was specified as follows:

$$ln(Com_t) = \beta_1 + \beta_2 ln(Com_{t-1}) + \beta_3 ln(Sub_t) + \beta_4 ln(FPr_t) + \mu_t \dots\dots[26]$$

where Com_t is total current quarterly commercial fertilizer sales, Com_{t-1} is total previous quarterly commercial fertilizer sales, Sub_t is total current quarterly subsidy fertilizer sales, FPr_t is average current quarterly aggregate fertilizer price of all types and μ_t is a random error which was assumed to be independent and identically distributed.

3.3.4 Empirical Model for Extent to which Subsidy Program is affecting Fertilizer Sales over Time

Waliullah *et al*. (2010) and Afzal *et al*. (2013) reported that the ARDL method applies general-to-specific modelling framework by taking sufficient number of lags to capture the data generating process. It estimates $(p + 1)^k$ number of regressions in order to obtain an optimal lag length for each variable (where p is the maximum lag to be used and k is the number of variables in the equation). The model is selected on the basis of different criteria such as Schwarz's Bayesian Information Criterion (SBIC), Akaike's Information Criterion (AIC) and Hannan and Quinn Information Criterion (HQIC). Afzal *et al*. (2013) reported that ARDL method can distinguish between dependent and explanatory variables and eradicate the problems that may arise due to the presence of autocorrelation and endogeneity. ARDL model is based on a single equation framework thereby permitting the cointegration relationship to be estimated by OLS once the lag order of the model is determined. Error Correction Model (ECM) is also drawn from ARDL approach to estimate long-run estimates (Waliullah *et al*., 2010; Afzal *et al*., 2013). Following Waliullah *et al*. (2010), the ARDL approach involved estimating equation [26] as follows:

$$\Delta\, ln(Com_t) = \beta_0 + \sum_{i=1}^{n-1} \beta_{1i} \Delta ln(Com_{t-i}) + \sum_{i=0}^{n-1} \beta_{2i} \Delta ln(Sub_{t-i}) +$$

$$\sum_{i=0}^{n-1} \beta_{3i} \Delta ln(Fpr_{t-i}) + \lambda_1 ln(Com_{t-1}) + \lambda_2 ln(Sub_{t-1}) + \lambda_3 ln(FPr_{t-1}) + \mu_t \dots \dots [27]$$

where n is the maximum number of lags in levels of the variables, Δ is the first difference operator, and β_0 is a drift component. The right hand side of the equation represents the explanatory variables in one lag in level, and in differences with $n-1$ lags for each variable, the parameters $\beta_{1i}, \beta_{2i}\ and\ \beta_{3i}$ represent the short-run dynamics of the model, where $i = 1,,, n$ is the corresponding short-run multiplier. The parameters $\lambda_1,\ \lambda_2,$ and λ_3 represents the long-run relationship. μ_t is residual terms. The null hypothesis of the model was:

$$H_0: \qquad \lambda_1 = \lambda_2 = \lambda_3 = 0$$

$$H_1: \qquad \lambda_1 \neq \lambda_2 \neq \lambda_3 \neq 0$$

Bounds test starts with testing the null hypothesis of no cointegration. The calculated F-statistics is compared with the critical value tabulated by Pesaran and Pesaran (2009). The null hypothesis of no long-run relationship is rejected if the test statistics exceed the upper critical value. Similarly, the null hypothesis cannot be rejected if the test statistic fell below a lower critical value. However, if the test statistic fell between these two bounds, the results become inconclusive. In the second step, upon finding evidence of a long-run relationship (cointegration) among the variables, the following long-run model is estimated:

$$ln(Com_t) = \lambda_0 + \sum_{i=1}^{n} \lambda_{1i} \ln(Com_{t-i}) + \sum_{i=0}^{n} \lambda_{2i} \ln(Sub_{t-i}) + \sum_{i=0}^{n} \lambda_{3i} \ln(FPr_{t-i}) + \mu_t \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots [28]$$

where n represent the optimal lags of the regressors (Com_{t-i}, Sub_{t-i} and FPr_{t-i}), λ_0 is a drift term, and $\lambda_{1i}, \lambda_{2i},$ and λ_{3i} are the long-run elasticities to be estimated. μ_t is random errors. The error correction model (ECM), which indicates the speed of adjustment back to long-run equilibrium after a short-run disturbance, is then estimated. The standard ECM involved estimating the following equation:

$$\Delta\ln(Com_t) = \beta_0 + \sum_{i=1}^{n-1} \beta_{1i} \Delta\ln(Com_{t-i}) + \sum_{i=0}^{n-1} \beta_{2i} \Delta ln(Sub_{t-i}) + \sum_{i=0}^{n-1} \beta_{3i} \Delta\ln(FPr_{t-i}) + \varphi ECM_{t-1} \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots [29]$$

where Δ is the first difference operator, β_{1i}, β_{2i}, and β_{3i} are the short-run parameters (where $i = 1,,,n$ is the corresponding short-run multiplier), and φ is the speed of adjustment toward the long-run steady state equilibrium. Diagnostic and stability tests are conducted, to ascertain the goodness of fit of the ARDL model. The structural stability test is conducted by applying the cumulative residuals (CUSUM) and the cumulative sum of squares of recursive residuals (CUSUMSQ) to the residuals of Equation [27] (Brown *et al.*, 1975).

3.3.4.1 Description of Variables used in ARDL Model

The dependent variable in the ARDL model was total quarterly commercial fertilizer sales of all companies in fertilizer industry over time. Fertilizer subsidy sales over time can affect commercial fertilizer positively or negatively; hence it is difficult to predict both the short and long run relationships between subsidy fertilizer sales and commercial sales because of crowding-in or crowding-out effects over time. Average quarterly fertilizer prices were hypothesized to have negative short and long run relationship with quarterly commercial fertilizer sales.

3.5 Data and Sampling Procedure

A simple random sampling method was used to select the districts. Three districts were selected in the Northern region (Rumphi, Mzimba and Nkhatabay), nine districts in the Central region (Dowa, Kasungu, Lilongwe, Nkhotakota, Ntchisi, Salima, Dedza, Mchinji and Ntcheu) and eight districts in Southern region (Thyolo, Zomba, Blantyre, Machinga, Chikwawa, Balaka, Chiradzulu and Mulanje). Global Positioning System (GPS) readings were collected to measure the distance between the agro-dealer and ADMARC/SFFRFM depot and develop the map in Figure 3.2 below.

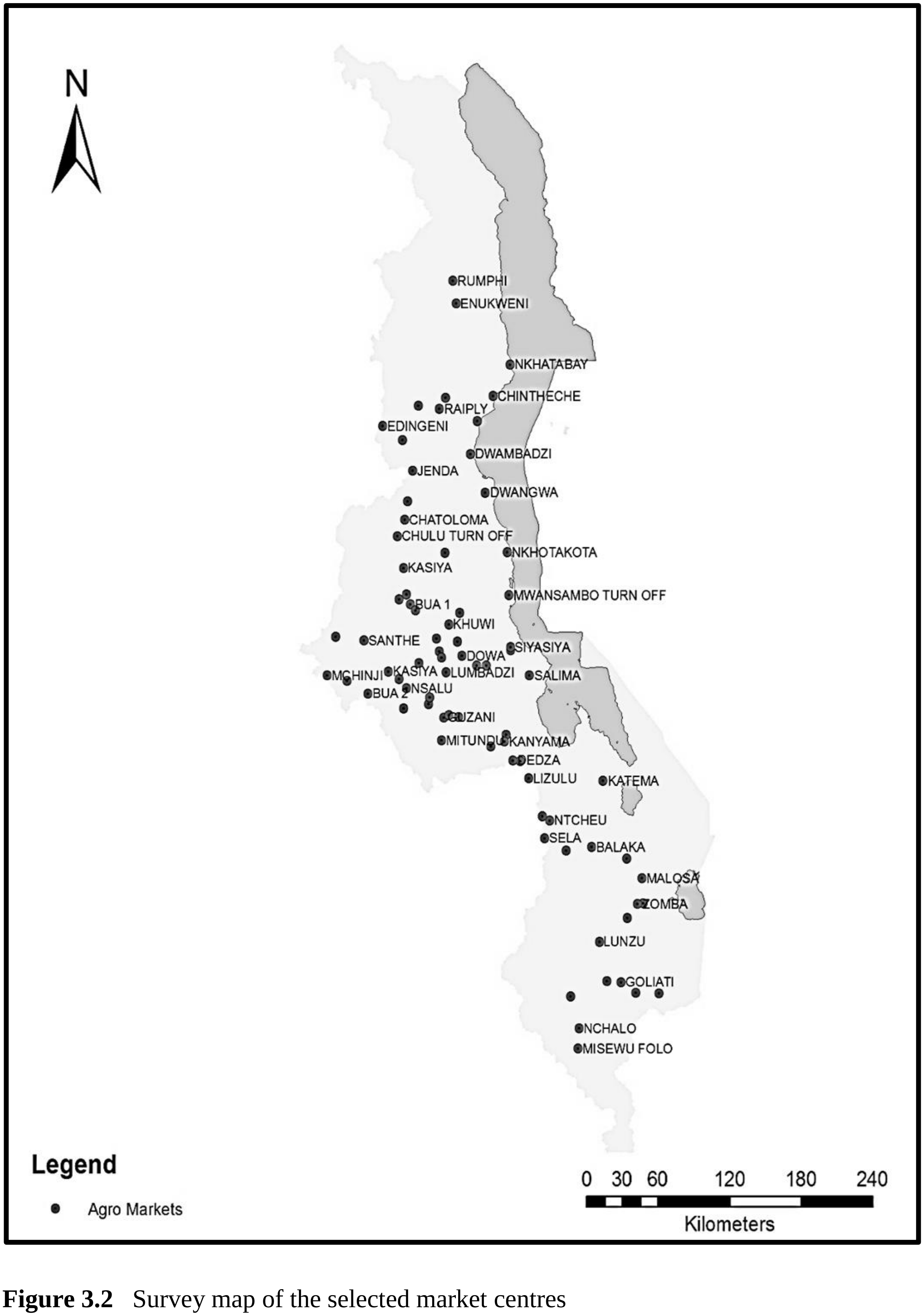

Figure 3.2 Survey map of the selected market centres

Following Edriss (2013), a sample size of agro-dealers was calculated using the formula:

$$q_s = \frac{Z^2(1-P)P}{e^2} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots [30]$$

where q_s is the sample size, P represents an estimate of the population proportion, Z is the z-value yielding the desired degree of confidence ($Z = 1.96$) and e represents the absolute size of the error in estimating population proportion that was permitted in this study (*i.e.* $e = 0.05$). According to National Statistical Office (2011), 21 percent (Population proportion) of the population in Malawi is involved in small scale business enterprise. Two hundred fifty five (255) agro-dealers were derived from the sample size formula. Nevertheless, the study accounted for a design effect of 2[6] due to the multistage cluster sampling implicit errors and it was expected that the selected districts are different from each other (*i.e.* the districts are internally heterogeneous in characteristics being studied). Due to the nature of the survey topic (*i.e.* some agro-dealers would be interested or not interested in the topic), it was anticipated that some agro-dealers would refuse to participate in the survey and some would not be available for the interview as they operate only during the peak period of the subsidy program; hence 18 percent was considered for the non-responses. The sample size was adjusted from 255 to 609 agro-dealers. The sample size is considered to be nationally representative of agro-dealers in Malawi. Independent agro-dealers were over-sampled because they are more heterogeneous than distributors (Dorward *et al.*, 2008; Fitzpatrick, 2012).

[6] Design effect of 2 is usually used for most variables unless the literature suggests otherwise (Edriss, 2013)

3.6 Sampling Design

The selected districts were considered as clusters and then agro-dealers were selected from each district using Proportional Probability Sampling (PPS) (See Table 3.1). PPS method ensured that districts with larger proportion have a proportionately greater chance of containing a selected cluster than small districts (*i.e.* the size of each cluster was taken into consideration). The advantage of this method is that it is self-weighting, which simplifies the analysis and improves the representativeness of the sample (Edriss, 2013).

The market centre where agro-dealers are operating was considered as the Primary Sampling Unit. Each market centre was selected using simple random sampling method in each sampled district. A complete simple random selection of independent agro-dealers was conducted within each selected market centre and agro-dealer semi-structured questionnaire was administered (see Appendix C). Similarly, fertilizer distributor retail outlets were randomly selected for the interview in locations where independent agro-dealers are operating using fertilizer distributor retail outlet semi-structured questionnaire (see Appendix D). A total of 431 independent agro-dealers and 178 retail outlets of fertilizer distributors[7] were interviewed across the country, representing a proportion of three independent agro-dealer to one retail outlet of distributors.

[7] *i.e.* Branch managers of Farmers' World, Export Trading, Nyiombo Investment, Transglobe, AGORA and Kulima Gold were interviewed.

Table 3.1 Total sample of agro-dealers per district

Region	Sampled Districts	Markets per District	Independent agro-dealers	Retail outlets of fertilizer companies	Sample per district	Proportion (%)
North	Mzimba	8	22	22	44	
	Nkhatabay	3		4	4	
	Rumphi	1	4	5	9	
Total North		12	26	31	57	9
Central	Dedza	5	57	10	67	
	Dowa	11	43	15	58	
	Kasungu	8	34	29	63	
	Lilongwe	18	63	26	89	
	Mchinji	6	41	20	61	
	Nkhotakota	3	9	8	17	
	Ntcheu	5	65	10	75	
	Ntchisi	3	13	5	18	
	Salima	2	5	3	8	
Total Central		61	330	126	456	75
South	Balaka	1	4	4	4	
	Blantyre	1	4		7	
	Chikwawa	3	13	1	14	
	Chiradzulu	1	3		3	
	Machinga	1	3	3	7	
	Mulanje	6	5	3	8	
	Thyolo	3	33	5	38	
	Zomba	6	10	5	15	
Total South		22	75	21	96	16
Total Sample		95	431	178	609	100

The data used in the study were collected through a survey conducted in the month of May and June, 2014. This time was considered ideal for data collection for two major reasons. Firstly, farmers start purchasing fertilizer soon after selling their surplus output mostly in April. This means that the season for fertilizer sales begins in April and end in March the following year. Secondly, subsidy program brings with it seasonal agro-dealers often in the month of November through February who simply want to benefit from cheap fertilizer. The scope of the study was in annual commercial sales of full time agro-dealers, therefore, the months of May and June were appropriate for data collection. A total of 609 agro-dealers were surveyed and the sample is considered nationally representative.

Initially, it was planned that government-run ADMARC and SFFRFM outlets should be surveyed. However, during the fieldwork it was observed that most depots were closed and others were temporarily opened during subsidy season. As a result, secondary data on quantity of subsidized fertilizer retailed at both Extension Planning Area and district level in 2013/14 season were collected from Logistics Unit (2013 Distribution Matrix). Another set of secondary data on number of farm families per Extension Planning Area and population density per district were obtained from the Ministry of Agriculture, Irrigation and Water Development, and National Statistical Office, respectively.

Another set of time series secondary data from 1998 to 2011 used in this study were obtained from several sources. Annual commercial fertilizer sales between 1998-2007 and 2008-2011 were sourced from the reports compiled by Dorward *et al*. (2008) and Kamchacha (2012), respectively. Annual subsidy fertilizer sales between 1998 and 2007 were obtained from the report compiled by Dorward *et al*. (2008) whereas the series from 2008 to 2011 came from the Logistic Unit reports. Quantities of fertilizer representing periods before FISP were quantities of fertilizer which include starter pack, TIP and APIP. Data on average commercial fertilizer prices between 1998 and 2004 were sourced from the report compiled by Kamchacha (2012) and additional data from 2005 to 2011 were obtained from Fertilizer Association of Malawi. The Proportional Denton procedure was applied to annual data to interpolate the annual series into a quarterly series in Stata (Baum and Hristakeva, 2001; Shittu *et al*., 2012; Fonzo and Marini, 2012).

3.7 Limitations of the Study

A major limitation of this study pertains to data used in both cross-sectional and time series model. The study recognizes the fact that some of the subsidized fertilizer was present at commercial retail outlets through leakage. However, the respondents were not able to disaggregate annual commercial fertilizer sales by source (*i.e.* whether an independent agro-dealer obtained fertilizer sold on the open market from commercial sources or from the subsidy program) and type. As a result, it was not possible to isolate the quantities of subsidized fertilizer that might have leaked to independent agro-dealers when estimating the effects of subsidy program on commercial fertilizer sales. In addition, it was also not possible to determine the effects by type of fertilizer. Further, the study did not capture seasonal participation of independent agro-dealers into fertilizer market. As a result, inference is made on full time agro-dealers. On the other hand, annual time series data available were aggregate total annual fertilizer sales by year. Similarly, it was not possible to disaggregate total annual fertilizer sales by type. Furthermore, the disaggregated annual quarterly data does not represent the actual quantities of fertilizer retailed per quarter; hence it was not possible to incorporate seasonality of the market and relationships by type of fertilizer. Despite these limitations, the analysis provides useful information in answering the research questions for this study.

CHAPTER FOUR

SOCIO-ECONOMIC CHARACTERISTICS OF AGRO-DEALERS

4.1 Introduction

This chapter gives the results of the socio-economic characteristics of the sampled agro-dealers as at the time of the survey. Statistical tests such as the t-test and the Chi-square test were used to test the significant difference of the socio-economic characteristics of agro-dealers. The results are categorized by type of agro-dealers (*i.e.* independent agro-dealers and retail outlets of major distributors). Characteristics of independent agro-dealers categorized by participation and non-participation in the fertilizer market is presented in the Appendix B (Table B-1 and Table B-2).

4.2 Agro-dealer Characteristics

4.2.1 Demographic Factors

Age of Independent Agro-dealer

The average age of independent agro-dealer was 37 years with a standard error of 0.497 (Table 4.1). This suggests that the majority of independent agro-dealers were young adults at the time of the survey. The significant t-test showed that the mean age of agro-dealers was not equal to zero.

Gender of Independent Agro-dealer

About 82 percent of the sampled independent agro-dealers were males and 18 percent were females (Table 4.2). This implies that there were more males participating in the input market than females.

Table 4.1 Descriptive statistics for continuous variables for participating agro-dealers and distributors in fertilizer market

Variable	**Independent dealer q=431**		**Distributor outlet q =178**		**T-test**
	Mean	**Std. Error**	**Mean**	**Std. Error**	**P-value**
Dependent variable					
Commercial Sales per agro-dealer (kg)	20249.77	2519.54	617809.40	247973.70	0.000
Independent variable					
Subsidized fertilizer retailed at EPA level (Mt)	945.39	20.91	947.07	31.14	0.965
Subsidized fertilizer retailed at district level (Mt)	7717.10	152.46	8033.60	245.74	0.267
Average age of independent agro-dealer (years)	37	0.497	____	____	0.000
Number of farm families per EPA (`000)	22.68	0.42	23.49	0.80	0.328
Population density per district (persons/km^2)	173.28	5.95	162.68	17.56	0.468
Number of other dealers at the market centre	8.10	0.30	4.22	0.12	0.000
Full time employees	0.89	0.07	____	____	0.000
Store size (m^2)	89.73	9.99	298.90	36.77	0.000
Experience in input market (years)	7.27	0.30	8.87	0.82	0.022
Experience in fertilizer business only (years)	5.95	0.30	8.87	0.82	0.000
Initial capital (MK)	177809.90	19763.91	____	____	0.000
Distance to ADMARC/SFFRFM (km)	1.12	0.09	0.51	0.04	0.000
Average fertilizer selling price (MK)	336.02	2.05	301.02	1.52	0.000

Table 4.2 Descriptive statistics for discrete variables for participating agro-dealers and distributors in fertilizer market

Variable	**Category**	**Independent dealer** **q =431** **Proportion**	**Distributor outlet** **q =178** **Proportion**	**Chi^2-test** **(P-value)**
Dependent variable				
Selling fertilizer	0= No	16.01	0.00	32.14
	1= Yes	83.99	100	(Pr=0.000)
Independent variable				
Education level of agro-dealer	0= Informal	23.90	____	____
	1= Formal	76.10		
Gender of independent agro-dealer	0= Female	18.10	____	____
	1= Male	81.90		
Selling maize seed	0= No	49.19	33.15	13.13
	1= Yes	50.81	66.85	(Pr=0.000)
Shop ownership	0= Store rented	83.99	100	32.14
	1= Store owned	16.01	0.00	(Pr=0.000)
Credit access	0= No	94.43	____	____
	1= Yes	5.57		
State of road connecting market centre	0= Feeder	19.03	9.55	8.31
	1= Tarmac	80.97	90.45	(Pr=0.004)
More than one selling point	0= No	82.60	____	____
	1= Yes	17.40		
Location of agro-dealer				
Northern region	1= North	6.03	17.42	20.512
Central region	2= Central	76.57	70.79	(Pr=0.000)
Southern region	3= South	17.40	11.80	

Note: the dashes in the table means that the variable does not apply to distributors

Education Level of an Agro-dealer

Table 4.2 shows that about 76 percent of independent agro-dealers had attended at least formal education at the time of the survey. This suggests that the majority of sampled agro-dealers were literate.

Experience in Input Market by Agro-dealers

The average number of years for independent agro-dealers in input market (*i.e.* selling fertilizer, seed, and chemicals) was about 7 years compared to about 9 years for retail outlets of major distributors. The means of independent agro-dealers and retail outlets of major distributors were significantly different at 1 percent level (Table 4.1). This suggests that distributor retail outlets have more experience in input market than independent agro-dealers, on average.

Experience in Fertilizer Business by Agro-dealers

In terms of selling fertilizer only, the average years of experience for independent agro-dealers was about 6 years, whereas for distributor retail outlets was about 9 years as at the time of the survey (Table 4.1). The mean difference was significant at 1 percent level. This suggests that distributor retail outlets were more experienced to fertilizer business than independent agro-dealers, on average.

4.2.2 Institutional Factors

Credit Access by Independent Agro-dealer

The results revealed that about 5.57 percent of independent agro-dealers have ever accessed credit (*i.e.* both formal and informal credit) to boost their businesses at the time of the survey (Table 4.2). This suggests that there is low access of independent agro-dealers to credit.

Distance between ADMARC/SFFRFM Depot and Agro-dealers

The average distance between an independent agro-dealer to ADMARC/SFFRFM depot was 1.12 km compared to 0.51 km for retail outlet of major distributors. The average difference was significant at 1 percent level (Table 4.1). This implies that distributor retail outlets were located closer to ADMARC/SFFRFM depots compared to independent agro-dealers.

State of Road Connecting Market Centre

The results showed that about 81 percent of independent agro-dealers were operating in market centres connected by tarmac road, whereas 90 percent of distributor retail outlets were located in market centres connected by a tarmac road (Table 4.2). The Chi-square tests shows that this difference was significant at 1 percent level. This implies that most retail outlets of major distributors were located in market centres that are easily accessible by tarmac road compared to independent agro-dealers.

Location of Market Centres for Agro-dealer

The results revealed that about 6 percent, 77 percent and 17 percent of the surveyed independent agro-dealers were located in the Northern, Central and Southern regions, respectively at the time of the survey (Table 4.2). On the other hand, about 17 percent of the distributor retail outlets were located in the Northern region, 71 percent in the Central region, and 12 percent in the Southern region. These differences were significant at 1 percent level. The location of agro-dealers by region revealed that the Central region was oversampled then followed by Southern and Northern region, on average.

Number of Farm Families per Extension Planning Area

The Extension Planning Areas where independent agro-dealers were operating had an average of about 22,678 farm families whereas in EPAs where distributor retail outlets were located had an average of about 23,494 farm families. However, the average difference is not statistically significant (Table 4.1).

Population Density per District

Independent agro-dealers were located in districts with population density of 173.28 persons/km^2 whereas retail outlets of major distributors were located in districts with population density of 162.68 persons/km^2, on average. However, mean difference was not significantly different (Table 4.1).

Number of other Agro-dealers at the Market Centre

The average number of independent agro-dealers within the market centre was about 8 whereas for retail outlets was about 4, representing a ratio of 2:1. The average difference was significant at 1 percent significance level (Table 4.1). This means that there were more independent agro-dealers than retail outlets of major distributors within the market centre at the time of the survey.

Average Fertilizer Selling Price by Agro-dealers

The results revealed that the mean value of a kg of commercial fertilizer was MK336 (US$0.85) for independent agro-dealer and MK301 (US$0.76) for distributor retail outlet. The mean difference was significant at 1 percent level (Table 4.1). This implies that independent agro-dealers charged a higher price per kg of commercial fertilizer compared to distributor retail outlets.

Subsidized Fertilizer Sales per Extension Planning Area and District Level

In 2013/14 season, the average quantity of subsidized fertilizer retailed in EPA in which independent agro-dealers were located was 945.39 Mt and 947.07 Mt for retail outlets of major distributors on average (Table 4.1). About 7717 Mt of subsidized fertilizer was distributed in districts where independent agro-dealers were located whereas about 8034 Mt of subsidized fertilizer was distributed in districts where retail outlets of major distributors were operating. It has to be taken into account that the volume of subsidized fertilizer was distributed in the months of November and December in 2013/14 season. However, the mean differences at both EPA and district levels are not significantly different.

4.2.3 Business Characteristics

Commercial Fertilizer Sales per Agro-dealer

Table 4.1 shows that the average volume of commercial fertilizer that was sold by an independent agro-dealer was 20,249.77 kg with a standard deviation of about 52,307 kg in 2013/14 season. During the same period, the retail outlet of major distributors sold 617,809.40 kg with a standard deviation of about 3,308,382 kg, on average. This shows that retail outlets of major distributors sold more quantities of commercial fertilizer than independent agro-dealers in 2013/14 season. The t-test showed that the means of commercial fertilizer sales of independent agro-dealers and retail outlet of major distributors were significantly different at 1 percent level.

Agro-dealers selling Fertilizer

Several of the agro-dealers in selected districts were either selling fertilizer or seeds and agro-chemicals. The Chi-square tests showed that about 84 percent of independent agro-dealers and all distributor retail outlets were selling fertilizer at the time of the survey (Table 4.2). The Chi-square tests shows that this difference was significant at 1 percent level.

Agro-dealers selling Maize Seed

At the time of the survey, about 51 percent of independent agro-dealers were selling maize seed only or together with fertilizers. In addition, about 67 percent of retail outlets of major distributors were selling maize seed (Table 4.2). This difference is significant at 1 percent level.

Store Size of Agro-dealers

At the time of the survey, the average size of the store operated by an independent agro-dealer was 89.73 m^2 compared to 298.90 m^2 for retail outlet of major distributor. The t-test showed that the mean difference was significant at 1 percent level (Table 4.1). This revealed that distributor retail outlets operate in big shops/stores compared to independent agro-dealers. This might further suggests that retail outlets of major distributors have adequate storage capacity for fertilizers than independent agro-dealers as fertilizer is bulky.

Shop Ownership by Agro-dealers

About 13 percent of the independent agro-dealers owned the stores/shops they were operating (Table 4.2). All major distributors were operating in rented stores/shops in various market centres at the time of the survey. This difference is significant at 1 percent level.

Independent Agro-dealers with more than one Selling Point

On average, about 17 percent of surveyed independent agro-dealers had more than one selling point within the market centre at the time of the survey (Table 4.2). This implies that few independent agro-dealers have capacity to increase the volume of commercial fertilizer sales.

Full Time Employees per Independent Agro-dealer

The average number of full time workers among independent agro-dealers was one. This suggests that most independent agro-dealers were selling commercial fertilizer at one selling point within an EPA or district at the time of the survey. Therefore, the size of independent agro-dealers' business was small-scale. The significant t-test showed that the mean number of full time workers was not equal to zero (Table 4.1).

Initial Capital for Independent Agro-dealer

The average amount of initial start-up capital for independent agro-dealer was about MK177, 809 (US$450)[8] with a standard deviation of about MK410, 309.50 (US$1038.76). The significant t-test showed that the mean value of initial start-up capital was not equal to zero (Table 4.1).

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[8] 1US$= MK395 as of May, 2014.

4.3 Correlation Analysis of selected Variables

A pair wise correlation was done to understand the linear relationships among key variables and the dependent variables for both participation decision and commercial fertilizer sales (outcome) models. Following sections present linear relationships among key variables and the dependent variables for both participation decision in fertilizer market and the volume of commercial fertilizer sales.

4.3.1 Participation Decision in Fertilizer Market by Independent Agro-dealers

Table 4.3 shows correlation analysis of variables that condition participation decision in the fertilizer input market. The decision to participate in fertilizer input market was found to be negatively and significantly correlated with the average age of the agro-dealer, distance between the agro-dealer and ADMARC/SFFRFM depot, selling maize seed, store ownership and location of the agro-dealer. In addition, the participation decision is found to positively and significantly correlated with the number of other agro-dealer at the market centre and initial start-up capital.

Table 4.3 Correlation analysis of variables that condition participation decision of independent agro-dealers

Variable	Participation in fertilizer market q =362	
	coefficient	**P-value**
Education level of agro-dealer =1	-0.0221	0.647
Gender of independent agro-dealer=1	-0.0080	0.8683
Average age of independent agro-dealer (years)	-0.1205	0.0123
Number of other dealers at market centre	0.0858	0.0753
Distance to ADMARC/SFFRFM (km)	-0.1482	0.0020
Selling maize seed=1	-0.1764	0.0002
Experience in input market (years)	-0.0583	0.2271
Initial capital (MK)	0.1133	0.0186
Credit access=1	0.0508	0.2924
Shop ownership =1	-0.1027	0.0330
State of road connecting market centre=1	0.0182	0.7067
Location of agro-dealer	-0.1097	0.0228

4.3.2 Commercial Fertilizer Sales by Agro-dealers

Table 4.4 shows correlation analysis of variables that influence commercial fertilizer sales conditional upon entry into fertilizer input market. The volume of commercial fertilizer sales by independent agro-dealers was found to be positively and significantly correlated with agro-dealer's experience in fertilizer market, store ownership, size of the store/shop, having more than one selling points and number of full time employees. On the other hand, the volume of commercial fertilizer sales was found to be negatively and significantly correlated with fertilizer selling price.

Table 4.4 Correlation analysis of variables that influence volume of fertilizer sales by agro-dealers

Variable	**Commercial sales (kg) by independent dealer**		**Commercial sales (kg) by distributor**	
	***q* =362**		***q* =178**	
	Coefficient	**P-value**	**Coefficient**	**P-value**
Log of subsidized fertilizer retailed at EPA level (Mt)	-0.0622	0.2375	-0.0302	0.6911
Log of subsidized fertilizer retailed at district level (Mt)	-0.0013	0.9802	-0.0320	0.6746
Number of other dealers at market centre	0.0814	0.1219	0.0001	0.9987
Average fertilizer selling price (MK/kg)	-0.1934	0.0002	-0.0495	0.5154
Experience in fertilizer business (years)	0.1063	0.0433	0.0211	0.7821
Number of farm families per EPA	-0.0067	0.8990	-0.0136	0.8584
Store ownership=1	0.1335	0.0110	____	____
Store size (m^2)	0.1832	0.0005	0.0138	0.8564
Distance to ADMARC/SFFRFM (km)	0.0531	0.3140	-0.0947	0.2123
More than one selling point=1	0.2101	0.0001	____	____
Full time employees	0.1146	0.0293	____	____
Location of agro-dealer	-0.0599	0.2553	-0.0075	0.9213

4.3.3 The Relationship between Quantity and Price of Fertilizer over Time

Table 4.5 depicts that commercial fertilizer sale was negatively and significantly correlated with subsidy fertilizer sale and average nominal fertilizer selling price over time at 1 and

10 percent levels, respectively. Subsidy fertilizer sale was found to be positively and strongly associated with average nominal price of fertilizer at 1 percent significance level.

Table 4.5 Correlation matrix of commercial and subsidy sales, and fertilizer price

Variable	**Commercial fertilizer sale (Mt)**	**Subsidized fertilizer sale (Mt)**	**Average nominal fertilizer price (MK/50kg)**
Commercial fertilizer sale (Mt)	1.0000		
Subsidized fertilizer sale (Mt)	-0.4446***	1.0000	
Average nominal fertilizer price (MK/50kg)	-0.2351*	0.8697***	1.0000

*, **, *** indicates that the corresponding coefficients are significant at the 10%, 5%, and 1% levels, respectively.

Figure 4.1 shows that the trend of quantity of subsidized fertilizer retailed increased while the quantity of commercial fertilizer sold declined between 1998 and 2012 period, on average. Substantial increase in subsidized fertilizer retailed and drop in commercial fertilizer sales occurred between 1998 - 2001 and 2005 - 2008. The trend of average nominal price of commercial fertilizer increased between 1998 and 2012 with major increase in 2008 and 2009. It can be depicted from Figure 4.1 that as the nominal price of commercial fertilizer increases, the quantity of commercial fertilizer sales decline and the quantity of subsidized fertilizer retailed increases over time.

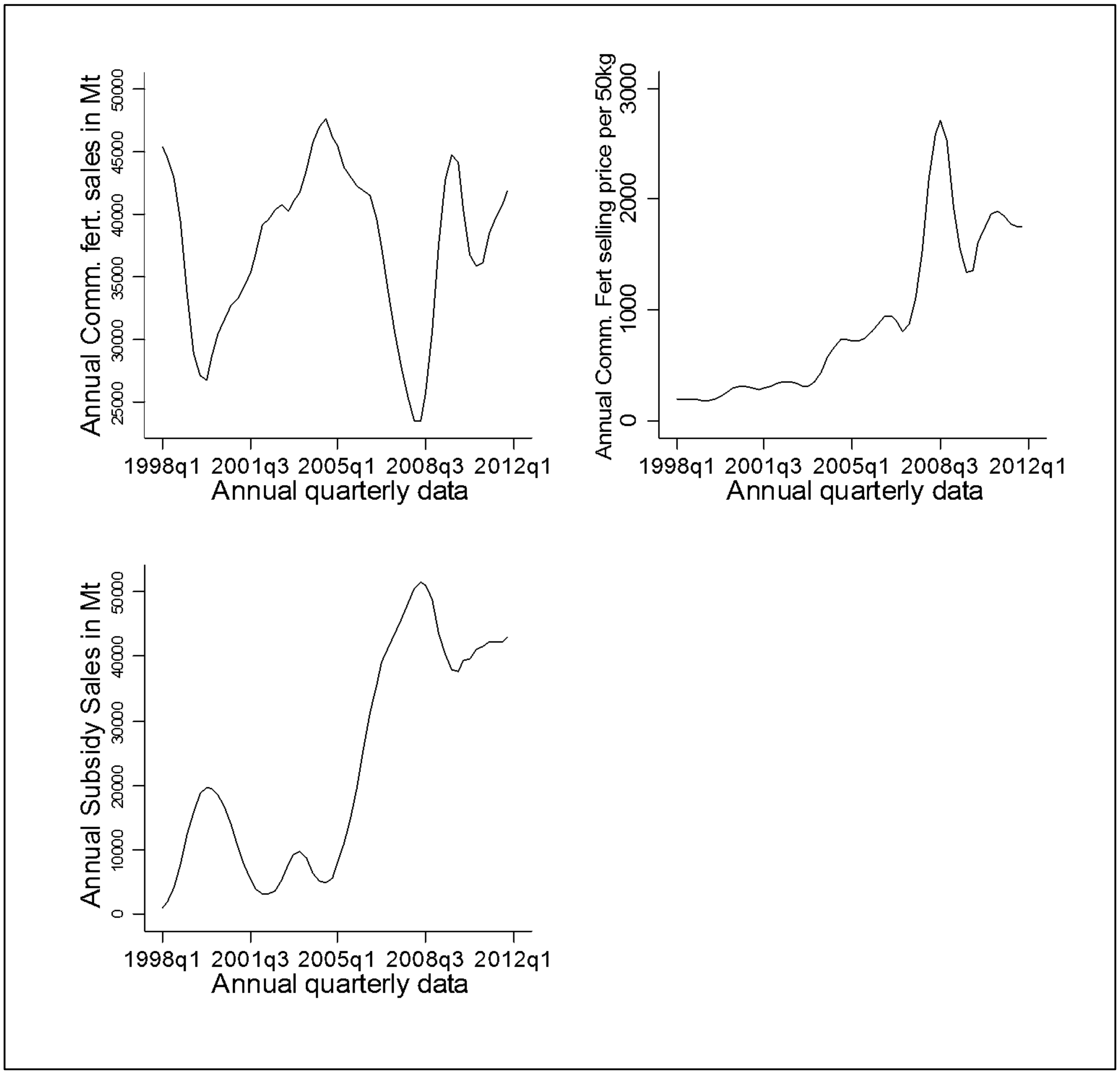

Figure 4.1 Quantities of commercial and subsidized fertilizer sales and nominal prices of commercial fertilizer over time

4.4 Concluding Remarks

The purpose of this chapter was to assess the socio-economic characteristics of agro-dealers. The results showed that retail outlets of major distributors sold more quantities of commercial fertilizer than independent agro-dealers in 2013/14 season. The majority of independent agro-dealers were young adults and literate. There were more males participating in the input market than females. It was also shown that there were more independent agro-dealers than retail outlets of major distributors within the market centre at the time of the survey. The average number of full time workers among independent agro-dealers was one implying that independent agro-dealers were operating on small-scale businesses.

The results also showed that distributor retail outlets operated in big stores compared to independent agro-dealers. Distributor retail outlets were more experienced to input market than independent agro-dealers. Distributor retail outlets were located closer to ADMARC/SFFRFM depots compared to independent agro-dealers at the time of the survey. Independent agro-dealers charged a higher price per kg of commercial fertilizer compared to distributor retail outlets. Few of the independent agro-dealers owned the stores/shops they were operating. Access of independent agro-dealers to credit was very low. Most retail outlets of major distributors were located in market centres that were easily accessible by tarmac road compared to independent agro-dealers. Few independent agro-dealers have capacity to increase the volume of commercial fertilizer sales. Finally, the correlation analysis revealed that some of the variables under consideration were correlated with the decision to participate in the fertilizer market and the volume of commercial fertilizer sales.

CHAPTER FIVE

ECONOMETRIC MODEL RESULTS AND DISCUSSIONS

5.1 Introduction

The previous chapter presented an analysis of agro-dealer socio-economic characteristics and correlation analysis of variables with the decision to participate in the fertilizer market and the volume of commercial fertilizer sales. This chapter presents empirical results on factors that condition independent agro-dealers' decision to participate in fertilizer market and its effect on commercial fertilizer sales using lognormal hurdle model. The analysis accounts for existence of subsidized fertilizer in the input market. This chapter, further, examines the long and short run relationships between subsidy fertilizer sales, commercial fertilizer sales and average commercial fertilizer price over time using ARDL model.

5.2 Determinants of Independent Agro-dealers' Participation in Commercial Fertilizer Market

Table 5.1 presents the first stage of lognormal model (probit model) of factors influencing participation of independent agro-dealers in commercial fertilizer market. The dependent variable is the latent (dummy) variable indexing entry in fertilizer market. The coefficients in column 2 are the conditional Average Partial Effects (APEs) obtained from the *margins* command in Stata. The *margins* command also computes the standard errors and *p*-values using the delta method. The results showed that age of independent agro-dealer has a negative relationship with participation in the fertilizer market. Thus, the probability of participation significantly decreases by 0.28 percent for every additional year an independent agro-dealer adds above the mean. This means that independent agro-dealers become risk averse as they get older and therefore, less inclined to invest in fertilizer business.

Table 5.1 Determinants of independent agro-dealers participation in commercial fertilizer market

Variables: ***Dummy variable indexing entry in fertilizer market***	Probit estimator		
	APEs	**Std. Errors**	**P-values**
Education level of agro-dealer =1	.0113487	.0278577	0.773
Gender of independent agro-dealer=1	.0265581	.0338806	0.535
Average age of independent agro-dealer (years)	-.0027555	.0015479*	0.056
Number of other dealers at market centre	.0010208	.0042546	0.810
Distance to ADMARC/SFFRFM (km)	-.0340731	.0142574**	0.029
Selling maize seed=1	-.1366505	.0469337***	0.002
Experience in input market (years)	.002437	.0030643	0.426
Log of initial capital (MK)	.0213058	.0083432***	0.009
Credit access=1	.0763322	.0730547	0.264
Store ownership=1	-.0362649	.0375303	0.379
State of road connecting market centre=1	.0392679	.0468112	0.413
Location of the agro-dealer			
2=Central region	.2459497	.0340987***	0.000
3=Southern region	.1618411	.0788412**	0.040
Observation 431	Log-likelihood = -163.896		

∗, ∗∗, ∗∗∗ indicates that the corresponding coefficients are significant at the 10%, 5%, and 1% levels, respectively; clustered standard errors at the EPA level; coefficients and p-values obtained using *margins* command in Stata.

The coefficient for distance between the independent agro-dealer and ADMARC/SFFRFM depot was negative (-3.4 percent) and significant at 5 percent level. This means that independent agro-dealers that were closer to ADMARC/SFFRFM depots were more likely to participate in fertilizer market compared to those that were far from ADMARC/SFFRFM depots. Thus, participation decision declines with increasing distance between the agro-dealer and ADMARC/SFFRFM depot. During the survey, it was learnt that around ADMARC/SFFRFM depots, there was pronounced input marketing activities taking place (*i.e.* buying and selling of seed, agro-chemicals and fertilizers) which in turn might have influenced independent agro-dealer's decision to participate in fertilizer market. The descriptive statistics in the previous chapter showed that the average distance between independent agro-dealers and ADMARC/SFFRFM depot was 1.12 km.

The results revealed that selling maize seed had a negative relationship with the decision to participate in the fertilizer market at 1 percent significance level. Thus, selling maize seed reduced the probability of participating in the fertilizer market by 13.7 percent for an independent agro-dealer. This might suggests that venturing into maize seed business does not provide the agro-dealer with fertilizer trade networks that reduce the costs of obtaining fertilizer trade information and searching for wholesale fertilizer suppliers which might facilitate entry into fertilizer market (Freeman and Kaguongo, 2003). This makes sense as maize seed in Malawi is supplied by seed growers whereas fertilizer is supplied by fertilizer major distributors. Therefore, there may be limited interaction between maize seed independent agro-dealers and fertilizer suppliers.

As expected, initial capital had a positive and significant relationship with the participation decision in the fertilizer market. This means that initial capital for independent agro-dealer increased the likelihood of participating in fertilizer market by about 0.02 percent. Fertilizer trade is capital intensive which impose entry barrier to trade in fertilizer market (Kherallah *et al*., 2000; Freeman and Kaguongo, 2003). The descriptive statistics in the previous chapter revealed that the amount of start-up capital for independent agro-dealers participating in fertilizer market was MK189, 958.50 (US$480) compared to MK114, 074 (US$289) for independent agro-dealers participating in seed and agro-chemical markets. Therefore, participation decision in fertilizer market increases with increasing capital.

The location of the agro-dealer had a positive relationship with the participation decision in the fertilizer market. The location the agro-dealer was operating represented the different agro-ecological zones. The coefficient for Central region was positive and significant at 1 percent level. This indicates that independent agro-dealers in the Central region were more likely to participate in fertilizer market than those in the Northern region. Similarly, the coefficient for Southern region was positive and significant at 5 percent level. Agro-dealers in the Southern region were more likely to participate in the fertilizer market than those in the Northern region. The result is consistent with Freeman and Kaguongo (2003) who found that participation decision in fertilizer market is location dependent.

The relationship between the decision to enter into fertilizer market and variables such as the gender of the independent agro-dealer, education level of independent agro-dealer, number of agro-dealers at the market centre, experience in input market, access to credit and the state of road connecting market centre were positive but not statistically significant. The relationship between the participation decision and store ownership was negative but also not statistically significant.

5.3 Determinants of Independent Agro-dealers' Commercial Fertilizer Sales upon Participation in Fertilizer Market

Before estimating the econometric models, normality test based on a test of skewness and kurtosis was applied to the dependent variable, volume of commercial fertilizer sales. The dependent variable, showed a strong positive skew. This necessitated transformation of the dependent variable because all of the models in this section rely heavily on the assumption of normality in the error terms. Without normality the property of consistency of the MLE fails to hold. A number of transformations to the dependent variable with zeros exist in literature in the presence of non-normality namely Box-Cox transformation (Jones and Yen, 2000; Moffatt, 2005; Martinez-Espineira, 2005), inverse hyperbolic sine (ihs) (Newman *et al*., 2001) and logarithmic transformation (Cameron and Trivedi, 2009). This study applied a logarithmic transformation to the dependent variable following Cameron and Trivedi (2009) because it normalizes the data and it is easy to implement and interpret the results.

The lognormal hurdle model assumes that the error term of the first stage probit model (hurdle 1) is uncorrelated with the error term of the second stage OLS regression (hurdle 2). This assumption was tested if it holds. The error term of the hurdle 1 was found to be positively associated with the error term of hurdle 2. However, the relationship was not statistically significant with a p-value of 0.2403. This implies that the assumption of independent and normally distributed error terms in hurdle 1 and hurdle 2 was maintained. Truncated OLS regression was then estimated to get parameters for the second hurdle measuring volume of fertilizer sales. The effect of participation in fertilizer market on the volume of commercial fertilizer sales was estimated at both EPA and district levels. The underlying estimated models passed diagnostic tests that included multicollinearity test using Variance Inflation Factor (VIF) and the Ramsey Regression Equation Specification Error test (RESET) for variable omission.

A lognormal tobit model was run first before estimating a second stage of lognormal hurdle (OLS) model. The dependent variable is the total volume of commercial fertilizer that was sold in 2013/14 season by independent agro-dealers. Table 5.2 presents results of factors influencing commercial fertilizer sales by an independent agro-dealer using tobit estimator (column 2 and 4) and OLS regression (column 3 and 5) at both EPA level and district levels. The coefficients in both lognormal tobit model and OLS regression are the Average Partial Effects (APEs) that were computed using the *margins* command in Stata. The standard errors and p-values were computed using the delta method.

How well the lognormal tobit model fitted the data was tested against the lognormal hurdle model. The restricted model was lognormal tobit model and the unrestricted more flexible model was the lognormal hurdle model. Each model was estimated with the same variables presented in Table 4.4 in previous chapter. At the EPA level, the log-likelihood for the lognormal hurdle model was -818.31 compared with a log-likelihood of -1058.47 for the lognormal tobit model. At the district level, the log-likelihood for the lognormal hurdle model was -814.77 compared with a log-likelihood of -1044.38 for the lognormal tobit model at the district level. Therefore, the lognormal hurdle model was the best fit for the data than the lognormal tobit model at both EPA and district levels. In addition, Durbin-Wu-Hausman specification test was applied to the lognormal tobit and OLS regression estimates. The null hypothesis that the data was modelled by lognormal tobit model was further rejected in favor of OLS regression model at 1 percent significance level with a Chi-square statistic of 163.52.

Table 5.2 Determinants of independent agro-dealers' commercial fertilizer sales

Variables: ***Dependent variable log of commercial fertilizer sales***	**Tobit estimator at EPA level q, =431**		**OLS estimator at EPA level q, =362**		**Tobit estimator at district level q, =431**		**OLS estimator at district level q, =362**	
	APEs	**Std. Error**	**APEs**	**Std. Error**	**APEs**	**Std. Error**	**APEs**	**Std. Error**
Log of subsidized fertilizer retailed at EPA level (Mt)	1.205139	.5812561**	-.1079091	.1987801				
Log of subsidized fertilizer sold at district level (Mt)	________	________	________	________	.7707709	.5083623	.0066232	.1675062
Number of other dealers at market centre	.0556852	.0467863	.0522467	.0221037**	.045767	.0296876	.0479114	.0173697***
Log of average fertilizer selling price (MK/kg)	.751323	1.629606	-2.235278	.6232939***	1.911156	1.606381	-1.707797	.7225099**
Experience in fertilizer business (years)	.2557654	.051788***	.0192602	.0190369	.2601197	.0572188***	.0254189	.0160638
Number of farm families per EPA	-.0590485	.0452838	.0133583	.0143602	________	________	________	________
Log of population density per district (persons/km^2)	________	________	________	________	2.258185	.5678187***	.6726737	.1860522***
Store ownership=1	-.2613301	.5607193	.7807628	.2090148***	.0290221	.5059273	.8267626	.2677203***
Log of store size (m^2)	.294263	.1240671**	.3573085	.0562959***	.2527717	.099806**	.3599004	.0634479***
Log of distance to ADMARC/SFFRFM (km)	-.1907218	.2143674	.0720493	.0629242	-.233508	.2525511	.0802812	.064932
More than one selling point=1	.6645782	.5689201	.7318876	.2728748***	.5282522	.527456	.7269319	.2019476***
Full time employees	.0087036	.1462941	.122169	.0498976**	.01457	.1822078	.1133363	.0480435**
Location of agro-dealer								
2=Central region	1.3968	.8482859	-.7267836	.3522642**	-.2745486	.7890801	-1.185723	.324998***
3=Southern region	-.7752398	1.162643	-1.451067	.4958664***	-3.266547	1.25359***	-2.228684	.4779278***
	Log-likelihood= -1058.47		Log-likelihood = -818.31		Log-likelihood = -1044.38		Log-likelihood = -814.77	

*, **, *** indicates that the corresponding coefficients are significant at the 10%, 5%, and 1% levels, respectively; clustered standard errors at the EPA level; p-values obtained by using *margins* command in Stata.

The results revealed that the number of independent agro-dealers at the market centre had a positive and significant relationship with the volume of commercial fertilizer sales at 5 and 1 percent significance level both at EPA and district levels, respectively (Table 5.2, column 3 and 5). The results mean that in market centres where the level of competition among independent agro-dealers was high, there was increased levels of commercial fertilizer sales taking place. Therefore, agro-dealers that were operating in market centres with high levels of competition sold more volumes of commercial fertilizers than those operating in market centres with low levels of competition.

The elasticity coefficient for price of commercial fertilizer had a negative and significant relationship with the volume of commercial fertilizer sales at 1 percent significance level at EPA level and 5 percent at district level. Thus, one percent increase in the price of commercial fertilizer in MK resulted in a decline in the volume of commercial fertilizer sales by about 2.24 percent at the EPA level and 1.71 at the district level. This makes economic sense as the quantity of goods demanded decline with increasing price. From the descriptive statistics in the previous chapter, the average fertilizer selling price per kg by independent agro-dealer was MK336 (US$0.85).

As expected, the elasticity coefficient for population density at the district level had a positive and significant relationship with the volume of commercial fertilizer sales. It had 1 percent statistical significance. Population density per district represents the potential market demand for commercial fertilizer. The market centres that were within districts with more numbers of persons per square km than others experienced increased levels of potential customers which eventually might have increased the volume of commercial fertilizer sales, c*eteris paribus*. This suggests that the volume of commercial fertilizer sales increases with the number of customers.

The results revealed that store ownership had a positive and significant relationship with the volume of commercial fertilizer sales both at EPA and district levels. The relationships are significant at 1 percent level. Store ownership had the potential to increase the volume of commercial fertilizer sales by about 78 percent at the EPA level and 83 percent at the district level. This might mean that independent agro-dealers who owned the shop/store might have increased the likelihood of attaining stability in the fertilizer market and developed long-term relationships with farmers which eventually resulted in increased fertilizer sales.

Similarly, elasticity coefficient for the size of the store had a positive and significant relationship with the volume of commercial fertilizer sales at 1 percent level at both EPA and district levels. This suggests that independent agro-dealers operating in big stores/shops were more likely to have enough space to keep large volumes of fertilizer as it is bulky. Therefore, this gave them more opportunities to stock increased volumes of commercial fertilizers which eventually translated into increased volume of commercial fertilizer sales compared to those that operated in small sized stores.

The results showed that having more than one selling point had a positive and significant relationship with commercial fertilizer sales. It had 1 percent statistical significance at both EPA and district levels. This means that independent agro-dealers with more than one selling point were more likely to increase their market share and reach more customers from different locations than those with one selling point. This eventually, translated into increased volume of commercial fertilizer sales compared to agro-dealers that were operating in one shop/store.

The proxy variable representing the size of business operation of an independent agro-dealer, the number of full time workers, had a positive and significant relationship with the volume of commercial fertilizer sales at 5 percent significance level. This means that independent agro-dealers that employed full time employees experienced high levels of commercial fertilizer transactions which was observed in increased levels of commercial fertilizer sales. This is consistent with Freeman and Kaguongo (2003) who found a significant positive relationship between the number of full time workers and fertilizer sales.

The location of the agro-dealer had a negative relationship with the volume of commercial fertilizer sales both at EPA and district levels. This suggests that independent agro-dealers in the Central and Southern regions sold less volumes of commercial fertilizer compared to those in Northern region. This is probably because huge quantities of subsidized fertilizer was retailed in the Central and Southern regions. This might mean that most farmers in these regions accessed the subsidized fertilizers which eventually reduced the demand for commercial fertilizer. As a result, independent agro-dealers in the Central and Southern regions sold less volumes of commercial fertilizer than those in the Northern region.

The relationship between the quantity of subsidy fertilizer retailed and the volume of commercial fertilizer sales was negative at EPA level and positive at district level. However, the relationships were not statistically significant. In addition, the relationship between the volume of commercial fertilizer sales with the numbers of years of experience in fertilizer business, number of farm families at EPA, and the distance between agro-dealer and ADMARC/SFFRFM depot were positive; but there were not statistically significant.

5.4 Factors Influencing Commercial Fertilizer Sales by Distributor Retail Outlets

Before estimating the OLS regression, normality test based on a test of skewness and kurtosis was also applied to the dependent variable, the volume of commercial fertilizer sales by retail outlet of major distributors. The dependent variable also showed a strong positive skew and the logarithmic transformation was applied to remedy the problem. Similarly, the underlying estimated model passed diagnostic tests that included multicollinearity test using VIF and RESET test for omitted variables. The factors that influence the volume of commercial fertilizer sales by retail outlets of major fertilizer distributors were estimated at both EPA and district levels.

Table 5.3 shows OLS regression results of factors that influence commercial fertilizer sales by distributor retail outlets at both EPA and district levels. The elasticity coefficients for log of subsidized fertilizer retailed was positive and significant at 10 percent level at the EPA level and 5 percent at the district level. For each additional Mt of subsidized fertilizer retailed was more likely to increase the volume of commercial fertilizer sales by 0.83 percent at the EPA level and 0.85 percent at the district level. This implies that subsidy fertilizer sales at both EPA and district levels promoted the volume of commercial fertilizer sales by fertilizer distributors. Majority of distributor retail outlets reported that most farmers that do not rely on subsidy fertilizer, purchase commercial fertilizers when cash is readily available from sales of other crops (May-September). Retail outlets of major distributors heavily depend on these purchases than those during subsidy seasons. Thus, agro-dealers are compensated for the decline in fertilizer sales during subsidy season by an overall increase in demand for fertilizer use. During the survey, it was also learnt that new actors such as Chanrai Fertilizer Company and Afriventure (Indian based companies) and Greenbelt Fertilizer Limited from Zambia had entered the fertilizer market and existing actors were expanding their geographic coverage.

The number of years of experience in fertilizer business had a positive and significant relationship with the volume of commercial fertilizer sales at the EPA level. The relationship is significant at 10 percent level. This makes economic senses as most distributors that have spent considerable number of years in the market centre have attained stability and developed long-term relationships with farmers. Eventually, this had resulted in increased volume of commercial fertilizer sales.

Elasticity coefficients for log of distance between distributor retail outlet and ADMARC/SFFRFM depot had negative and significant relationship with the volume of commercial fertilizer sales. The relationships have 10 percent statistical significance at EPA level and 5 percent at the district level. Thus, one percent increase in the distance between ADMARC/SFFRFM depot and distributor retail outlet in kilometers was more likely to reduce the volume of commercial fertilizer sales by 0.32 percent and 0.47 percent at EPA and district levels, respectively. This means that distributor retail outlets that are located closer to ADMARC/SFFRFM depots are likely to experience increased commercial fertilizer sales compared to those located far from them.

The results also revealed that the location of the agro-dealer had a negative relationship with the volume of commercial fertilizer sales. The regional dummy for Southern region was significant at 5 percent level at EPA level and 10 percent at district level. This means that distributor retail outlets located in the Southern region have reduced volume of commercial fertilizer sales compared to those in the Northern region. Similarly, this might rise from the fact that the Southern region retailed huge quantity of subsidized fertilizer compared to the Northern region. As a result, most smallholder farmers benefitted from the subsidy program which in turn translated into low demand for commercial fertilizers compared to farmers in the Northern region.

The relationships between the volume of commercial fertilizer sales and number of dealers at the market centre and population density per district were positive. However, the relationships were not significant. In addition, the relationships between the volume of commercial fertilizer sales and average fertilizer selling price and number of farm families were negative. Similarly, the relationships were not significant.

Table 5.3 Factors influencing commercial fertilizer sales

Variables: ***Dependent variable log of commercial fertilizer sales***	**OLS regression at EPA level**		**OLS regression at district level**	
	Coefficient	**Std. Errors**	**Coefficient**	**Std. Errors**
Log of subsidized fertilizer retailed at EPA level (Mt)	.8342623	.4390355*		
Log of subsidized fertilizer retailed at district level (Mt)			.8524529	.3137611**
Number of other dealers at market centre	.0169088	.0841858	.0241175	.0797587
Log of average fertilizer selling price (MK/kg)	-1.212001	1.515564	-1.172434	1.168469
Experience in fertilizer business (years)	.0104366	.00614*	.0075535	.0061097
Number of farm families per EPA	-.0187231	.0190197		
Log of population density per district (persons/km^2)			.2113384	.2525989
Log of distance to ADMARC/SFFRFM (KM)	-.3248515	.1632194*	-.4660561	.1691826**
Location of agro-dealer				
2=Central region	.1637378	.6622623	.4745618	.5377769
3=Southern region	-1.633513	.6716475**	-1.187472	.5733529*
Constant	12.867	8.860584	8.747125	6.857844
Observation 178	Adjusted R^2=19.2		Adjusted R^2=22.5	

Note: ∗∗∗ indicates that the corresponding coefficients are significant at the 1% levels, and 1% levels; clustered standard errors at the EPA level.

5.5 Effect of Commercial Fertilizer Sales on Quantity of Subsidy Fertilizer Sales

The dependent variable, volume of subsidized fertilizer retailed, did not pass normality test based on a test of skewness and kurtosis; hence the logarithmic transformation was applied. The estimated model passed multicollinearity test using VIF; but failed to pass RESET test for omitted variables. This suggests that there are other variables that influence subsidy fertilizer sales. The effect of commercial fertilizer sales on the quantity of subsidy fertilizer sales was examined at both EPA and district levels.

Table 5.4 examines the effect of commercial fertilizer sales on quantity of subsidy fertilizer sales at both EPA and district levels. The log of commercial fertilizer by independent agro-dealers had a positive and significant relationship with the quantity of subsidy fertilizer sales at 10 percent level at the EPA level. This might mean that the volume of commercial fertilizer sales by independent agro-dealers promote subsidy fertilizer sales at EPA level.

The coefficient for number of farm families was positive and had a significant relationship with subsidy fertilizer sales at 1 percent level for both independent agro-dealers and distributor retail outlets at EPA level. This makes sense as EPAs with more number of farm families were located more quantities of subsidized fertilizer than those EPAs with few number of farm families. Similarly, elasticity coefficient for population density had a positive and significant relationship with the volume of commercial fertilizer sales. Again this means that districts with more numbers of persons per square kilometer receive more quantities of subsidy fertilizers than those with less number of persons per square kilometer.

Table 5.4 Determinants of the quantity of subsidy fertilizer sales

Variables: ***Dependent variable log of subsidy fertilizer sales***	**Independent agro-dealer**				**Distributor retail outlet**			
	EPA level		**District level**		**EPA level**		**District level**	
	Coefficient	**Std. Error**	**Coefficient**	**Std. Error**	**Coefficient**	**Std. Error**	**Coefficient**	**Std. Error**
Log of commercial fertilizer sale (kg)	.0102962	.005189*	.0044058	.0046883	.023177	.0207971	.0486301	.0286581
Number of farm families per EPA	.0466862	.0084993***	______	______	.027927	.0066735***	______	______
Log of Average fertilizer selling price (MK/kg)	.0719528	.1870019	.1783632	.2492362	-.2251414	.3487653	-.1377646	.4401425
Log of Population density per district (persons/km^2)	______	______	.5228492	.2849667*	______	______	.3971224	.2816268
Location of the depot								
2=Central region	.0825956	.2590238	-.3890545	.3563918	.366467	.2451024	-.0930421	.4361621
3=Southern region	-.0425313	.3719415	-1.120032	.4610563**	.4365691	.2626584	-.5071353	.5329329
Constant	5.127637	1.103832***	5.650093	1.374989***	6.781003	2.073314***	7.318893	2.724436**
	Adj. R^2=57.0		Adj. R^2=37.6		Adj. R^2=53.2		Adj. R^2=22.1	

Note: ∗, ∗∗, ∗∗∗ indicates that the corresponding coefficients are significant at the 10%, 5%, and 1% levels; clustered standard errors at EPA (column 3 and 7) and district level (column 5 and 9).

Location of the ADMARC/SFFRFM depot for the Southern region had a negative and significant relationship with the volume of subsidy fertilizer sales. It had 5 percent statistical significance. This might mean that the Southern region sold low quantities of subsidy fertilizers compared to the Northern region. However, it should be emphasized here that determining the effect of commercial fertilizer sales on the quantity of subsidy fertilizer sales, requires further investigation as our model estimation suffered from variable omission.

5.6 Long and Short Run Relationships among Subsidy, Commercial Fertilizer Sales and Average Commercial Fertilizer Price over Time

An ARDL model was estimated to determine both the long and short run relationships among subsidy fertilizer sales, commercial fertilizer sales and average commercial fertilizer price over time. The estimation proceeded in three steps. First step was conducting a bounds test of cointegration, then estimation of long and short run relationships once cointegration was established and finally, conducting stability test of estimated parameters.

5.6.1 Cointegration Test

Augmented Dickey-Fuller (ADF) test was conducted to determine the existence of unit roots, although the ARDL framework does not require the pre-testing of variables. The unit root test help in determining whether or not the ARDL model should be used (Waliullah *et al.*, 2010; Nosier, 2012). Table 5.5 presents the unit root test results of the ADF test showing that there was a mixture of $I(0)$ and $I(1)$ of underlying variables. Commercial fertilizer sales (Com) and subsidy fertilizer sales (Sub) were integrated to the order of zero $I(0)$, while commercial fertilizer selling price (FPr) was integrated to the order of one $I(1)$.

Table 5.5 Unit-root test of residuals by Augmented Dickey-Fuller

Variables	Lag 1	Lag 2	Lag 3
lnCom	-5.202***	-2.660*	-1.899
ΔlnCom	-4.356***	-5.030***	-4.299***
lnSub	-2.652*	-1.194	-1.148
ΔlnSub	-5.122***	-4.567***	-3.653***
lnFPr	-1.595	-0.889	-0.874
ΔlnFPr	-5.587***	-6.326***	-5.237***

***, **, and * represents significant at 1%, 5% and 10%, respectively.

After determining that the underlying regressors were fractionally integrated, the long—run relationships were determined through the ARDL bounds testing. The ARDL bounds testing is a three-step procedure. In the first step, a lag order was selected on the basis of Schwarz-Bayesian criteria (SBC)[9], Akaike's Information Criterion (AIC) and Hannan and Quinn Information Criterion (HQIC) because the computation of F-statistics for cointegration is very sensitive to lag length. Using the *varsoc* command in Stata, the lag length that minimizes SBC, AIC, and HQIC was 2. Table 5.6 shows that the calculated *F*-statistic (*F*-statistic =4.37) was higher than the upper bound critical value at a 5% level of significance (3.625), using no intercept and no trend as reported by Pesaran and Pesaran (2009). This implies that the null hypothesis of no cointegration was rejected at 5% level

[9] SBIC works better with any sample size for quarterly data (Ivanov and Kilian, 2001; Torres-Reyna, 2012)

of significance. Therefore, there was a cointegration[10] relationship among the underlying variables.

Table 5.6 Bounds test for existence of long-run relationship

		Critical Values Bounds					
Calculated		**10%**		**5%**		**1%**	
F-statistic	**K**	**I(0)**	**I(1)**	**I(0)**	**I(1)**	**I(0)**	**I(1)**
F(9, 43)= 4.37	3	2.022	3.112	2.459	3.625	3.372	4.797

Critical values are obtained from Pesaran and Pesaran (2009) table CI case I; k is the number of regressors.

5.6.2 Long-Run Model

The empirical results of the long-run model are presented in Table 5.7. The optimal number of lags for each of the variables was ARDL (2, 0, 0) and selected based on the SBC, AIC, and HQIC. There was autocorrelation in residuals of the long-run model at the 1 percent level of significance. Cochran-Orcutt technique was used to correct residual autocorrelation. The DW statistic improved from 1.31 in the original model to 2.10 in the transformed model.

Table 5.7 shows that the estimated long-run elasticity coefficient of first lag of commercial fertilizer sales had a positive relationship with commercial fertilizer sales. The relationship

[10] Note that the cointegration relationship among the underlying variables does not imply unidirectional causality as in Engle and Granger cointegration two step procedure. However, it implies existence of a long-run relationship between commercial fertilizer sales and its determinants, subsidy fertilizer sales and average commercial fertilizer prices.

was significant at 1 percent level. This suggests that the previous quarter's sales of commercial fertilizer promote the current quarter's sales. The estimated long-run elasticity coefficient of second lag of commercial fertilizer had a negative relationship with commercial fertilizer sales at 1 percent significance level. This suggests that the current sales of commercial fertilizer were reduced by the second quarter's sales of commercial fertilizer.

Table 5.7 Long-run results of the ARDL approach

ARDL(2,0,0) selected based on Schwarz Bayesian Criterion

Dependent variable is LNCom

Variable	Coefficient	Standard Error	T-Ratio	P-value
$\mathbf{LNCom_{t-1}}$	1.497467	.0977191	15.32	0.000
$\mathbf{LNCom_{t-2}}$	-.7036181	.0916689	-7.68	0.000
$\mathbf{LNSub_{t}}$	-.0286019	.0128694	-2.22	0.031
$\mathbf{LNFPr_{t}}$	.0298859	.0139474	2.14	0.037
Constant	2.250598	.5080545	4.43	0.000

R^2= 0.9974 F-Statistics (4, 49)= 4617.86[0.000]

Adjusted-R^2= 0.9971 Durbin-Watson Stat= 2.10

The long-run elasticity coefficient of subsidy sales had a negative relationship with the volume of commercial fertilizer sales. The relationship was significant at 5 percent level. This means that every 1 percent increase in quantity of subsidized fertilizer was likely to reduce the volume of commercial fertilizer sales by about 0.03 percent. A long-run estimated elasticity of 0.03 percent was an overall measure of displacement (crowding-out effect).

The estimated long-run elasticity coefficient of average fertilizer prices had a positive and significant relationship with commercial fertilizer sales at 5 percent level. This means that increasing the average nominal price of fertilizer by 1 percent increases the volume of commercial fertilizer sales by about 0.03 percent. During the survey, it was observed that farmers purchase commercial fertilizer immediately after selling crop produce (*i.e.* month of May-September). As a result, a rise in nominal price of fertilizer might influence them to purchase enough commercial fertilizer for the forthcoming season (*i.e.* November-February) which might result in increased volume of commercial fertilizer sales over time.

5.6.3 Short-Run Model

Table 5.8 presents the results for ECM for commercial fertilizer sales. The underlying ARDL equation also passed all the diagnostic tests. The diagnostic tests were: (A) the Lagrange multiplier (LM) test of residual correlation, (B) the heteroscedasticity test based on the regression of squared residuals on square fitted values, (C) the Ramsey Regression Equation Specification Error Test (RESET) testing using the square of the fitted values to detect function misspecification due to either variable omission bias or incorrect choice of functional form, and (D) the Jarque and Bera (JB) normality test based on a test of skewness and kurtosis of residuals. The diagnostic tests suggest that the estimation of long-run coefficients and error correction model were free from serial correlation, heteroscedasticity and non-normality.

Table 5.8 Short-run results of ARDL model (Error Correction Model)

ARDL(2,0,0) selected based on Schwarz Bayesian Criterion				
Dependent variable is ΔLNCom				
Variables	**Coefficient**	**Standard Error**	**T-Ratio**	**P-value**
$\Delta \mathbf{LNCom_{t-1}}$	1.508841	.1209747	12.47	0.000
$\Delta \mathbf{LNCom_{t-2}}$	-.7674473	.1071282	-7.16	0.000
$\Delta \mathbf{LNSub_{t}}$	-.0390173	.0212092	-1.84	0.072
$\Delta \mathbf{LNFPr_{t}}$	-.0135279	.0448795	-0.30	0.764
$\Delta \mathbf{Constant_{t}}$	.0025209	.0046423	0.54	0.590
$\mathbf{ECM_{t-1}}$	-.5139715	.144086	-3.57	0.001
R^2= 0.8423		F-Statistics (4, 47)= 44.00[0.000]		
Adjusted-R^2= 0.8256		Durbin-Watson Stat= 2.1224		
Akaike Information Criterion= -18.063		Schwarz Bayesian Criterion =-17.3812		
$\chi^2 \mathbf{Arch} = \mathbf{2.167[0.1410]}$		$\chi^2 \mathbf{LM} = \mathbf{1.451[0.2284]}$		
$\mathbf{F_{Reset}} = \mathbf{0.80[0.5010]}$		$\mathbf{JB} = \mathbf{1.72[0.4229]}$		

Similarly, the short-run elasticity coefficients of the first and second lag difference of commercial fertilizer sales have positive and negative relationship with commercial fertilizer sales, respectively. The relationships were significant at 1 percent significant level.

The short-run elasticity coefficient of subsidy sales had a negative and significant association with commercial fertilizer sales at 10 percent level. Similarly, this means that every 1 percent increase in quantity of subsidized fertilizer reduced the volume of commercial fertilizer sales by about 0.04 percent. An estimate of 0.04 percent was an overall measure of displacement (crowding-out effect) in the short-run. The magnitude of displacement was higher in the short-run than in the long-run. The coefficient for average fertilizer price had a positive relationship with the volume of commercial fertilizer sales. However, the relationship is not significant.

The estimated short-run elasticity coefficient of lagged error correction term, ECM_{t-1}, had expected sign (negative) and was significant at 1 percent level. This established the long-run causal effect and confirmed the existence of cointegration (Afzal *et al*., 2013). Further, the negative sign of the coefficient of the ECM_{t-1}, validates the stability of the model (Pahlavani and Rahimi, 2009; Harvie and Pahlavani, 2007). Thus, there was causality in at least one direction. The coefficient of about -0.51 indicates that there was a high rate of adjustment of variables towards equilibrium. This implies that deviation from the long-term equilibrium in commercial fertilizer market was adjusted by 51 percent over each year (*i.e.* it took a considerable short time for the fertilizer market to return to its equilibrium once shocked).

The stability of ARDL model was examined by applying the cumulative sum (CUSUM) and cumulative sum of squares (CUSUMSQ) test on the recursive residuals (Brown *et al*., 1975). The CUSUM test makes use of the cumulative sum of recursive residuals based on the first set of n observations and is updated recursively and plotted against break points. For stability of the long-run as well as short-run coefficient estimates, the plot of the two statistics must stay within 5 percent significant level. If the plot of CUSUM statistics stays within the critical bounds of 5 percent significance level (represented by a pair of straight lines drawn at the 5 percent level of significance), the null hypothesis that all coefficients in the error correction model are stable cannot be rejected. If either of the lines is crossed, the null hypothesis of coefficient constancy can be rejected at the 5 percent level of significance. A similar procedure is used to carry out the CUSUMSQ test, which is based on the squared recursive residuals. Figure 5.1 shows a graphical representation of the CUSUM and CUSUMSQ plots applied to the error correction model selected by the SBC criterion. The CUSUM and CUSUMSQ plots were within the critical bounds, indicating significant structural stability. This means that the estimated long-run as well as short-run coefficients were stable over the period investigated.

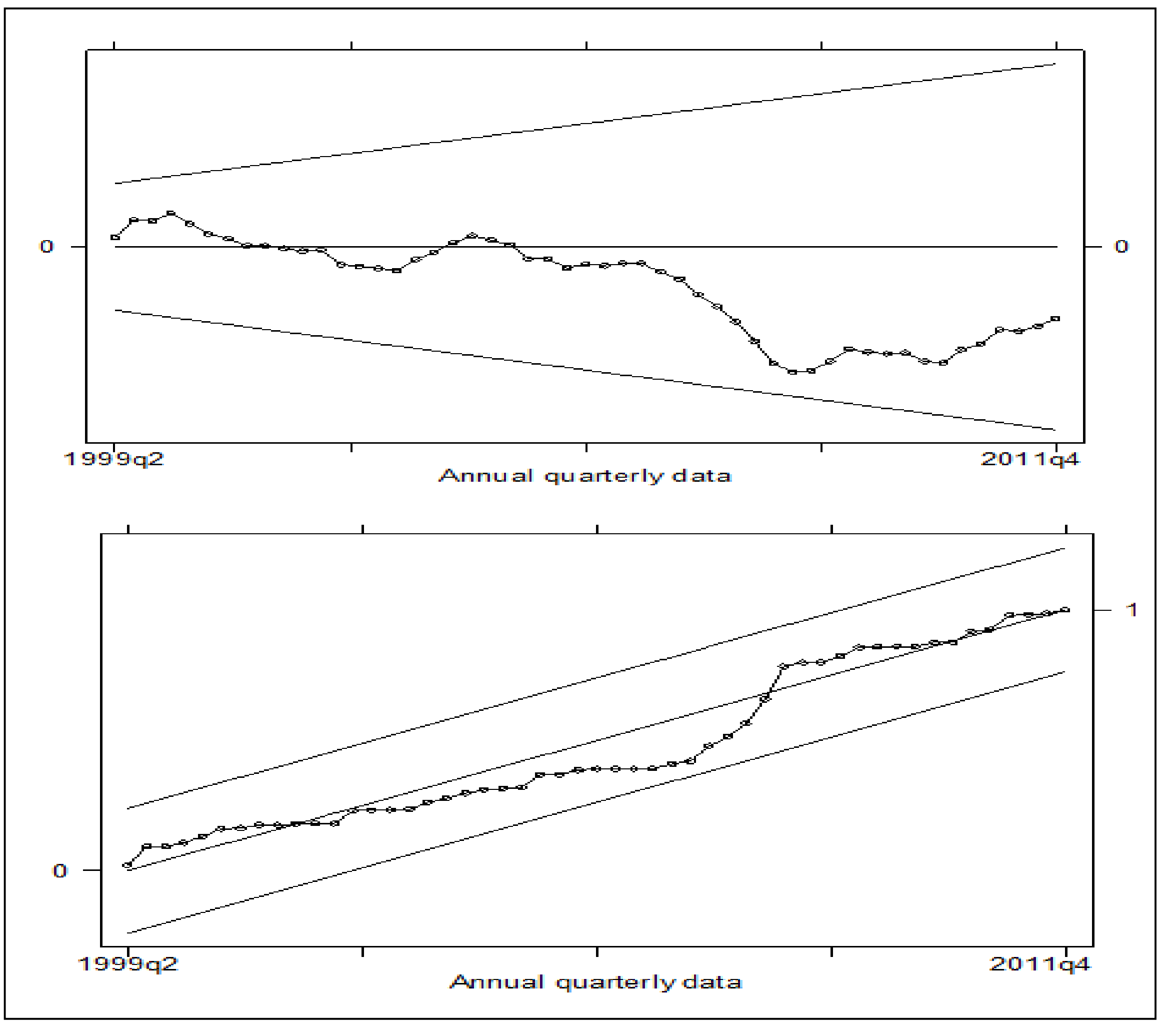

Figure 5.1 Plot of CUSUM and CUSUMSQ in the long-run model

5.7 Concluding Remarks

The purpose of this chapter was to assess the factors that influence independent agro-dealers decision to participate in the fertilizer input market and its effect on the volume of commercial fertilizer sales. In addition, the factors that influence commercial fertilizer sales by retail outlets of major distributors were also examined. The models were estimated at both EPA and district levels. Finally, the long and short run relationships among the volume of commercial fertilizer sales, subsidy fertilizer sales and the average nominal aggregate price of fertilizers were determined.

The first hurdle (probit model) results of the lognormal hurdle model showed initial start-up capital and location of the agro-dealer increase the likelihood of agro-dealers' decision to participate in the fertilizer market. Conditional upon participation, the second hurdle (OLS regression) revealed that the number of independent agro-dealers, population density per district, store ownership, size of the store, having more than one selling point, and the number of full time workers influenced commercial fertilizer sales. The OLS regression estimates of factors that influence commercial fertilizer sales by retail outlets of major distributors revealed that the volume of subsidized fertilizer retailed increased the volume of commercial fertilizer sales at both EPA and district levels.

The ARDL bounds testing approach showed that the volume of commercial fertilizer sales, subsidy fertilizer sales and the nominal price of commercial fertilizer were cointegrated. The estimated elasticity coefficients showed that the relationship between first lag of commercial fertilizer sales and the volume of commercial fertilizer sales was positive and significant in both long and short run. The relationship between second lag of commercial fertilizer sales and the volume of commercial fertilizer sales was found to be negative and significant in both long and short run. The relationship between the average nominal price of commercial fertilizer and the volume of commercial sales was found to be positive and significant in the long run. The estimated elasticity coefficients of the relationship between subsidy sales and the volume of commercial sales were found to be negative and significant in both long and short run. The estimated parameters were found to be stable over the period investigated.

CHAPTER SIX

CONCLUSION AND POLICY IMPLICATIONS

6.1 Summary

The study assessed how the subsidy program affected the commercial fertilizer sales by both fertilizer distributor retail outlets and independent agro-dealers. The study applied a lognormal hurdle model to identify factors that influence independent agro-dealers' fertilizer market participation and its effect on commercial sales using cross-sectional retail level data that was collected in twenty districts across the country. The OLS regression was estimated to determine the factors that influence the volume of commercial fertilizer sales by retail outlets of major distributors. The models were estimated at both EPA and district levels. Furthermore, the study applied ARDL framework to estimate long and short run association between commercial fertilizer sales, subsidy fertilizer sales and commercial fertilizer price over time using annual quarterly time series data from 1998 to 2011.

6.1.1 Socio-Economic Characteristics of Agro-dealers

The results showed that retail outlets of major distributor sold more commercial fertilizer than independent agro-dealers in 2013/14 season. The majority of independent agro-dealers were young adults and literate. There were more males participating in the input market than females. It was also shown that there were more independent agro-dealers than retail outlets of major distributors within the market centres at the time of the survey. The average number of full time workers among independent agro-dealers was one implying that most agro-dealers had one selling point.

The results also showed that distributor retail outlets operate in big stores compared to independent agro-dealers. Distributor retail outlets were more experienced to input market than independent agro-dealers. Distributor retail outlets were located closer to ADMARC/SFFRFM depots compared to independent agro-dealers at the time of the survey. Independent agro-dealers charged a higher price per kg of commercial fertilizer compared to distributor retail outlets. Few of the independent agro-dealers owned the stores/shops they were operating. Access of independent agro-dealers to credit was very low. Most retail outlets of major distributors were located in market centres that were easily accessible by tarmac road compared to independent agro-dealers. Few independent agro-dealers have strategies in place to increase the volume of commercial fertilizer sales. Finally, the correlation analysis revealed that some of the variables under consideration were correlated with the decision to participate in the fertilizer market and the volume of commercial fertilizer sales.

6.1.2 Determinants of Independent Agro-dealers Participation in Commercial Fertilizer Input Market

The first hurdle (probit model) results of the lognormal hurdle model showed initial start-up capital and location of the agro-dealer increase the likelihood of agro-dealers' decision to participate in the fertilizer market. The study further found that the likelihood of the participation decision in the fertilizer market decline with increasing age of the independent agro-dealer, distance between the independent agro-dealer and ADMARC/SFFRFM depot, and selling maize seed among independent agro-dealers.

6.1.3 Determinants of Independent Agro-dealers' Commercial Fertilizer Sales

Conditional upon participation in the fertilizer market, the second hurdle of the lognormal hurdle model revealed that the number of independent agro-dealers, population density, store ownership, size of the store, having more than one selling point, and the number of full time workers positively influenced the volume of commercial fertilizer sales by independent agro-dealers. The study also found that the volume of commercial fertilizer sales among independent agro-dealers declined with increasing the selling price of fertilizer. The volume of commercial fertilizer sales was also dependent on the location of the agro-dealer.

6.1.4 Determinants of Distributor Retail Outlets' Commercial Fertilizer Sales

The OLS regression estimates of factors that influence commercial fertilizer sales by retail outlets of major distributors revealed that the volume of subsidized fertilizer retailed increased the volume of commercial fertilizer sales at both EPA and district levels. This implies that subsidy fertilizer sales promote the volume of commercial fertilizer sales by fertilizer distributors. The volume of commercial fertilizer sales was found to increase with the number of years of experience in fertilizer business and decline with increasing distance between the store/shop of distributor retail outlet and ADMARC/SFFRFM depot.

6.1.5 Determinants of the Quantity of Subsidy Fertilizer Sales

The effect of commercial fertilizer sales on quantity of subsidy fertilizer sales at both EPA and district level was examined. Commercial fertilizer sales by independent agro-dealers were found to promote subsidy fertilizer sales at the EPA level. The quantity of subsidized fertilizer was found to increase with increasing number of farm families per EPA for both independent agro-dealers and distributor retail outlets, and population density per district.

Finally, the quantity of subsidy fertilizer sales were found to depend on the location of the ADMARC/SFFRFM depot. However, the model estimations suffered from variable omission which may necessitate further investigation.

6.1.6 Long and Short Run Relationships of Subsidy Sales, Commercial Fertilizer Sales and Average Fertilizer Price over Time

The ARDL bounds testing approach showed that the volume of commercial fertilizer sales, subsidy fertilizer sales and the nominal price of commercial fertilizer were cointegrated. The estimated elasticity coefficients showed that the relationship between first lag of commercial fertilizer sales and the volume of commercial fertilizer sales was positive and significant in both long and short run. The relationship between second lag of commercial fertilizer sales and the volume of commercial fertilizer sales was found to be negative and significant in both long and short run. The relationship between the average nominal price of commercial fertilizer and the volume of commercial sales was found to be positive and significant in the long run.

The estimated elasticity coefficients of the relationship between subsidy sales and the volume of commercial sales were found to be negative and significant in both long and short runs. This means that the subsidy program displaced commercial fertilizer sales by the private sector over the period under consideration. Every 1 percent increase in quantity of subsidized fertilizer was found to likely reduce the volume of commercial fertilizer sales by about 0.03 percent in the long run and by about 0.04 percent in the short-run. The magnitude of displacement was lower in the long-run than in the short-run. It was, further, revealed that the deviation from the long-term equilibrium in commercial fertilizer market was adjusted by 51 percent over each year. The stability of estimated parameters was examined by applying CUSUM and CUSUMSQ tests on the recursive residuals. Both the CUSUM and CUSUMSQ tests revealed that parameter estimates were stable over the period investigated.

6.2 Policy Implications and Recommendations

The study has established that the probability of independent agro-dealers to participate in fertilizer market increases with increasing initial start-up capital. Therefore, to promote participation of independent agro-dealers in fertilizer market there is need to support agro-dealers with start-up capital.

Independent agro-dealers should be promoted to open more selling points selling fertilizer in different locations as a strategy to increase market share. This will directly increase the volume of commercial fertilizer sales and indirectly reduce the distance that farmers travel to access fertilizer.

The study also found that retail outlets of major distributors located close to ADMARC/SFFRFM depots sold more quantities of commercial fertilizer than those far from these depots. Therefore, the Government should open more ADMARC/SFFRRM depots in areas that are not served by the private sector. This will also stimulate the establishment of private agro-dealers to serve smallholder farmers who may need smaller quantities of fertilizer that is supplied by small-scale agro-dealers.

Finally, the study found significant displacement of total commercial fertilizer sales over time both in the long and short runs. In order to develop a viable private input supply system, there is need for the Government to allocate and maintain a major share of fertilizer sales to the private sector as commercial fertilizer sales in Malawi are predictable.

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APPENDICES

Appendix A: Measurements of Variables used in Lognormal Hurdle Model

Table A-1 Measurements of variables used in the participation model

Variable	Type	Measurements
Dependent Variables		
Selling fertilizer=1	Binary	1=if agro-dealer sold fertilizer; 0 otherwise
Independent Variables		
Education level of an agro-dealer=1	Binary	Education of trader: 1=if agro-dealer attended formal education; 0 otherwise
Gender of independent agro-dealer=1	Binary	Gender of trader: 1=if an agro-dealer is male; 0 agro-dealer is female.
Age of independent agro-dealer (years)	Continuous	Age of an agro-dealer measured in number of years
selling maize seed=1	Binary	1=if agro-dealer sells maize seed; 0 otherwise
Distance to ADMARC/SFFRFM (km)	Continuous	Distance between agro-dealer and ADMARC/SFFRFM depots.
Number of other dealers at market centre	Continuous	Number of agro-dealers operating at the market centre within a radius of 500m
Experience in input market (years)	Continuous	Number of years an agro-dealer has in the input market
Initial capital (MK)	Continuous	Amount of initial capital for fertilizer business in MK
Credit access=1	Binary	1= if agro-dealer obtained credit for fertilizer business; 0 otherwise
State of road connecting market centre=1	Binary	1= if the market is connected by a tarmac road; 0 otherwise
Stored ownership=1	Binary	Ownership of the store: 1= if an agro-dealer owns store; 0 otherwise
Location of agro-dealer	Binary	Region the agro-dealer is operating either in Northern, Southern or Central region

Table A-2 Measurements of variables used in fertilizer sale model

Variable	Type	Measurements
Dependent Variables		
Commercial fertilizer Sales (kg)	Continuous	Annual commercial fertilizer sales in 2013/14 season (*i.e.* April 2013 to March 2014).
Independent Variables		
Subsidized fertilizer retailed at EPA level (Mt)	Continuous	Annual subsidized fertilizer retailed at an EPA level in 2013/24 season.
Subsidized fertilizer retailed at district level (Mt)	Continuous	Annual subsidized fertilizer retailed at District level in 2013/24 season.
Number of other dealers at market centre	Continuous	Number of agro-dealers at the market centre within a radius of 500m
Number of farm families per EPA	Continuous	Number of farm families at an EPA level. It is measured in `000.
Distance to ADMARC/SFFRFM (km)	Continuous	Distance between agro-dealer and ADMARC/SFFRFM depots.
Stored ownership=1	Binary	Ownership of the store: 1= if an agro-dealer owns store; 0 otherwise
Store size (m^2)	Continuous	The size of the store
Average fertilizer selling price (MK/kg)	Continuous	Average selling price of fertilizer in 2013/14 season during subsidy period.
Experience in fertilizer business (years)	Continuous	Number of years agro-dealer has been in fertilizer business
More than one selling point=1	Binary	1= if agro-dealer has more than one selling point; 0 otherwise.
Full time employees	Continuous	Number of people employed by an agro-dealer
Location of the agro-dealer	Binary	Region the agro-dealer is operating either in Northern, Southern or Central region

Appendix B: Characteristics of Participating and Non-participating Agro-dealers in Fertilizer Market

Table B-1 Descriptive statistics for continuous variables for participating and non-participating agro-dealers

Variable	**Participating agro-dealer n =362**		**Non-participating agro-dealer n =69**		**T-test**
	Mean	**Std. Error**	**Mean**	**Std. Error**	**P-value**
Subsidized fertilizer retailed at EPA level (Mt)	954.28	22.62	898.72	54.56	0.3305
Subsidized fertilizer retailed at district level (Mt)	7958.29	165.31	6451.74	359.13	0.0003
Average age of independent agro-dealer (years)	36.30	0.54	40.14	1.20	0.0123
Number of farm families per EPA (`000)	22.68	0.44	23.93	1.18	0.1928
Population density per district (persons/km^2)	177.17	6.87	152.86	8.83	0.1342
Number of other dealers at the market centre	8.34	0.33	6.87	0.73	0.0753
Full time employees	0.83	0.74	1.19	0.25	0.0745
Store size (m^2)	92.75	11.68	73.86	11.76	0.4889
Experience in input market (years)	7.11	0.33	8.09	0.68	0.2271
Initial capital (MK)	189958.50	22628.96	114074	33098.59	0.1594
Distance to ADMARC/SFFRFM (km)	1.00	0.09	1.72	0.27	0.0020

Table B-2 Descriptive statistics for discrete variables for participating and non-participating agro-dealers

Variable	**Participating dealer n =362**	**Non-participating dealer n =69**	**Chi^2-test (P-value)**
Education level of agro-dealer	75.69	78.26	0.2105 (Pr=0.646)
Gender of independent agro-dealer	82.61	81.77	0.0276 (Pr=0.868)
Selling maize seed	46.96	100	66.00 (Pr=0.000)
Shop ownership	14.36	24.64	4.55 (Pr=0.033)
Credit access	6.08	2.90	1.11 (Pr=0.291)
State of road connecting market centre	80.66	82.61	0.14 (Pr=0.706)
More than one selling point	17.40	17.39	0.00 (Pr=0.998)
Location of agro-dealer			
Northern region	5.25	10.14	18.5972
Central region	80.39	56.52	(Pr=0.000)
Southern region	14.36	33.33	

Appendix C: Independent Agro-dealer Questionnaire

MODULE A: TRADER IDENTIFICATION

01. DISTRICT :________________________
02. TA/TOWN :________________________
03. TRADER ID (FROM LIST) :________________________
04. NAME OF TRADER :________________________
05. NAME OF BUSINESS OPERATOR :________________________
06. PHONE NUMBER OF THE OPERATOR :________________________
07. POPULATION DENSITY IN STORE LOCATION (PERSONS/KM^2) :________________________
08. AVERAGE RAINFALL RECEIVED PER YEAR (MM) :________________________
09. AVERAGE MAIZE PRICE :________________________
10. STATE OF ROAD INFRASTRUCTURE AT THE MARKET CENTRE :________________________
11. DISTANCE TO ADMARC/SFFRFM (Km) :________________________

MODULE B: SURVEY STAFF DETAILS

01. NAME OF ENUMERATOR :________________________
02. DATE OF INTERVIEW :________________________
03. NAME OF FILED SUPERVISOR :________________________
04. DATE OF QUESTIONNAIRE INSPECTION :________________________
05. DATE OF DATA ENTRY :________________________

RECORD GENERAL NOTES ABOUT THE INTERVIEW AND ANY SPECIAL INFORMATION THAT WILL BE HELPFUL FOR SUPERVISOR AND DATA ANALYSIS

INTRODUCTION TO THE AGRO-DEALER TO BE INTERVIEWED

CONVEY THE FOLLOWING INFORMATION TO THE RESPONDENT:

Good morning/Afternoon. My name is ____________________________. Am coming from Lilongwe University of Agriculture and Natural Resources, Bunda Campus. The Centre for Agricultural and Development (CARD) at the University in collaboration with Purdue University is implementing a research project titled "Guiding Investments in Sustainable Agricultural Intensification in Africa (GISAMA)". The primary goal of this project is to improve the incomes and food security status of Malawian farmers and consumers through improving distribution and farmer adoption and use of modern farm inputs.

Your store was selected as one of those to which the questions will be asked. You were not selected for any specific reason. Simply your name was on a list of all of the agro-dealers in this area, and your name was chosen randomly.

I would like to ask the questions in this form to you as owner of the business. These questions will take few minutes to complete. All of your answers will be held in confidence. The answers which you might give me will only be used by CARD or under its supervision.

Before I start, do you have any questions or is there anything which I have said on which you would like any further clarification? May I proceed with interviewing you?

MODULE C: TRADER ROSTER

01. What agricultural inputs do you sell?

Fertilizer………………………….1

Seeds……………………………..2

Agro-chemicals…………………..3

Other (specify)…………………...4

02. If fertilizer, what type of fertilizer do you sell?

a. For maize
b. For tobacco
c. Other (specify)________________________________

03. If seed, do you participate in FISP seed subsidy?

Yes ………………………..1

No…………………………2

04. Do you sell other inputs or other goods in general?

Yes………………………….1

No…………………………...2

05. If yes, what are they?

06. Collect demographic and socio-economic indicators of the **trader** (If the business is run by an employee, probe for the details of the **owner of the business**)

Name of the owner of the business	Sex Male…..1 Female...0	How old is [Name]	Highest education qualification acquired by [Name] None……1 PSLC…...2 JCE……..3 MSCE…..4 Tertiary…5	Occupation or Employment 1. Farmer 2. Skilled employment 3. Unskilled employment 4.Government employment 5. Non-Government employment 6. Other business 7. Other (Specify)

07. Who is managing the store?

Owner…………………….…..1

Employee…………..……...2

Both……………………..….3

08. Is this enterprise jointly owned or not?

Yes………………………..1

No…………………………0 (if no skip to question 09)

09. How many individuals are co-owners of fertilizer enterprise? ______________________

10. Have you employed other people to assist with operationalization of the business?

Yes…………………………1

No………………………….0

11. If yes, how many people are full time workers in your business? ____________________

12. When was this enterprise started? ______________________________________

13. How many years have you been in fertilizer enterprise? __________________________

14. What is the size of business measure as square footage of store? ___________________________

15. How many agro-dealers are operating within a radius of 500m?_____________________________

16. What were the sources of starting-up capital for this enterprise?

Own savings……………………………………………1

Sale of assets……………………………………………2

Proceeds from another business………………………...3

Informal credit…………………………………………….4

Formal credit……………………………………………5

Other (specify)……………………………………………..6

Code

Formal	Informal
1. SACCO 2. BANK 3. Other institution	1. Relative 2. Neighbour 3. Local merchant 4. Money lender (Katapila) 5. Employer

17. How much was your starting capital (MK)?

____

18. Is this enterprise officially registered with

Registrar of Companies?	Malawi Revenues Authority?	Local Assembly?
Yes………….1 No…………..0	Yes…………1 No………….0	Yes…………………1 No………………….0

19. Are you a member of

Yes………………………………1

No………………………………0 (if no skip to question 23)

CNFA/RUMARK	AISAM	Other (specify)

Code

AISAM : Agricultural Input Suppliers Association of Malawi

CNFA : Citizens Network for Foreign Affairs

RUMARK : Rural Agricultural Marketing

20. As a member of AISAM/CNFA, have you ever received training on

Use of inputs to advise customers	Manage finance	Accessing market information	Others (specify)

21. Have you ever accessed loan/credit through AISAM/CNFA?

Yes……………………………………1

No……………………………………..0 (If no skip to question 12)

22. If yes, how did you use the loan/credit?

Increased fertilizer inventory………………...1

Increased business assets…………………….2

Opened a new shop in less served area………3

Other (specify)………………………………4

23. Do you provide advice to farmers (customers) on the appropriate use of fertilizer?

Yes…………………………………………………1

No…………………………………………………0n

24. What was the volume of fertilizer supplied on the market in kilograms

Type of Input	2013/2014	2012/2013	2011/2012	2010/2011	2009/2010	2008/2009
Fertilizer						

25. What was the unit cost of a kilogram of fertilizer in

Type of Input	2013/14	2012/13	2011/12	2010/11	2009/10	2008/09
Fertilizer						

MODULE D: ASSET OWNERSHIP

1. Do you own the following assets?

Asset	Ownership type	How many [Name] do you own	What is the age of this [Name] IF MORE THAN ONE ITEM, AVERAGE AGE	What is the value of [Name] if you were to sell today? (MK)
Store	1. Owned 2. Rented 3. Both			
Warehouse	1. Owned 2. Rented 3. None			
Lorry	1. Owned 2. Hired 3. None			
Weighing scale	1. Owned 2. Hired 3. None			
Desk	1. Owned 2. Rented 3. None			
Computer equipment & accessories	1. Owned 2. Hired 3. None			

MODULE E: FERTILIZER SALES

1. To whom do you mostly sell fertilizer?

    Small scale farmers only……………………...1

    Large scale farmers only……………………...2

    Small and large farmers……………………….3

    Other agro-dealers…………………………….4

2. In what quantities do you sell fertilizer?

    50kg bags only………………………………..1

    40-20kgs……………………………………...2

    20-10kgs……………………………………...3

    Any quantity demanded……………………....4

3. During the past 12 months, was this enterprise operational throughout the year?

    Yes………………………………1

    No……………………………….0

4. If so, what was the percentage of your sales from the stock?

    75-100% of the stock…………………….………...1

    50-75% of the stock…………………….………….2

    50% of the stock…………………………..………..3

    Below 50% of the stock …..………………………4

5. If not, why was the enterprise not in operation for the period indicated in 3 above?

    Lack of inputs……………..……………………..1

    Lack of credit…………………………………….2

    Lack of cash……………………………………...3

    Not profitable…………………………………….4

    Other (specify)…………………………………...5

6. What was the volume of [Type of input] sales in (Kgs)

Type of Input	2013/2014	2012/2013	2011/2012	2010/2011	2009/2010	2008/2009
Fertilizer						

7. What was the unit price of a kilogram of fertilizer in (MK)

Type of Input	2013/2014	2012/2013	2011/2012	2010/2011	2009/2010	2008/2009
Fertilizer						

8. During the 2013/2014 rainy season, what was the share of profits of total costs?

   Almost none……………………………1
   About 25%...2
   About 50%...…………………………...3
   About 75%...4
   Almost 100%..5

9. During the 2013/2014 rainy season, what was the total expenditure of this enterprise on

   If nothing was spent, record zero.

Purchase of fertilizer for sale (Inventory)	Transport	Fuel/oil	Search for marketing information	Electricity	Water	Insurance
MK	MK	MK	MK	MK	MK	MK

10. What is the price margin per kg of fertilizer (MK/kg)? ______________________________

11. Do you have other retail outlets in rural areas?

    Yes……………………………………………1
    No…………………………………………….0 (if no skip to 13)

12. If yes, do you incur additional costs on

Transport Yes…….1 No……..0	How much do you spend on transport? MK	Labour Yes…….1 No……..0	How much do you spend on labour MK	Store Yes…1 No….0	How much do you spend on renting the store? MK	Searching for marketing information? Yes…..1 No……0	How much do you spend on searching for market information? MK
Other (specify)							

13. Do you also buy out farmers' output at the end of the season?

Yes………………………………1

No……………………………….0

14. If yes, do you have some form of contract arrangement with farmers?

Yes…………………………1

No…………………………..0

15. Do you give inputs to farmers on credit?

Yes…………………………1

No…………………………..0

MODULE F: CONSTRAINTS TO FERTILIZER TRADE

1. Are the following constraints to your business?

Constraint	Yes…………..…1 No………………0
Access to credit	
Lack of fertilizer trade information	
Lack of fertilizer suppliers	
Lack of demand for fertilizer	
(Other specify)	

2. Is there any ADMARC/ SFFRFM depot that distribute subsidy fertilizer nearby?

   Yes…………………………………1

   No…………………………………..0

3. Have you been affected by subsidy program?

   Yes ……………………………..1

   No ………………………………0 (if no skip to question 10)

4. How have you been affected by subsidy program?

   Positively……………..1 (go to question 8)

   Negatively……………0 (proceed through 6 and 7)

5. If your business has been negatively affected by subsidy program, have you put strategies in place to maintain fertilizer sales?

   Yes……………………………1

   No……………………………..0 (if no skip to question 8)

6. What strategies have you put in place to maintain fertilizer sales?

7. If your business has been positively affected by subsidy program, have you put in place strategies to increase your market share/fertilizer sales

Yes…………………………..1

No…………………………...0

8. What strategies have you put in place to increase market share/fertilizer sales?

9. How has annual sales changed over time?

Today versus 5 years ago?	Today versus 10 years ago?
01. Sales have increased 02. Sales have decreased 03. Sales have remained constant	01. Sales have increased 02. Sales have decreased 03. Sales have remained constant

10. How has annual profitability changed over time?

Today versus 5 years ago?	Today versus 10 years ago?
01. Profits have increased 02. Profits have decreased 03. Profits have remained constant	01. Profits have increased 02. Profits have decreased 03. Profits have remained constant

11. Have you expanded or contracted business over

Last 5 years	Why?	Last 10 years?	Why?
01. Expanded 02. Contracted		01. Expanded 02. Contracted	

12. What about other agro-dealers in the area? Have they

Expanded?	Contracted?	Gone out of business?
01. Yes 02. No	01. Yes 02. No	01. Yes 02. No

13. Do you consider fertilizer business to be more profitable than any other input business?

Strongly agree …….……………………...1

Agree………………..……………………….2

Strongly disagree..…..……………………3

Disagree…………….………………………4

Appendix D: Distributor Retail Outlet Questionnaire

MODULE A: TRADER IDENTIFICATION

12. DISTRICT : ________________________________
13. TA/TOWN : ________________________________
14. NAME OF TRADER : ________________________________
15. NAME OF BUSINESS OPERATOR : ________________________________
16. PHONE NUMBER OF THE OPERATOR : ________________________________
17. POPULATION DENSITY IN STORE LOCATION (PERSONS/KM^2) : ________________________________
18. AVERAGE RAINFALL RECEIVED PER YEAR (MM) : ________________________________
19. AVERAGE MAIZE PRICE : ________________________________
20. STATE OF ROAD INFRASTRUCTURE AT THE MARKET CENTRE : ________________________________
21. DISTANCE TO ADMARC/SFFRFM (Km) : ________________________________

MODULE B: SURVEY STAFF DETAILS

06. NAME OF ENUMERATOR : ________________________________
07. DATE OF INTERVIEW : ________________________________
08. NAME OF FILED SUPERVISOR : ________________________________
09. DATE OF QUESTIONNAIRE INSPECTION : ________________________________
10. DATE OF DATA ENTRY : ________________________________

RECORD GENERAL NOTES ABOUT THE INTERVIEW AND ANY SPECIAL INFORMATION THAT WILL BE HELPFUL FOR SUPERVISOR AND DATA ANALYSIS

INTRODUCTION TO THE TRADER TO BE INTERVIEWED

CONVEY THE FOLLOWING INFORMATION TO THE RESPONDENT:

Good morning/Afternoon. My name is ____________________________. Am coming from Lilongwe University of Agriculture and Natural Resources, Bunda Campus. The Centre for Agricultural and Development (CARD) at the University in collaboration with Purdue University of United States of America is implementing a research project titled "Guiding Investments in Sustainable Agricultural Intensification in Africa (GISAMA)". The primary goal of this project is to improve the incomes and food security status of Malawian farmers and consumers through improving distribution and farmer adoption and use of modern farm inputs.

Your store was selected as one of those to which the questions will be asked. You were not selected for any specific reason. Simply your name was on a list of all of the fertilizer retail outlet in this area, and your store was chosen randomly.

I would like to ask the questions in this form to you as manager of the business. These questions will take few minutes to complete. All of your answers will be held in confidence. The answers which you might give me will only be used by CARD/Purdue University or under its supervision.

Before I start, do you have any questions or is there anything which I have said on which you would like any further clarification? May I proceed with interviewing you?

MODULE C: TRADER ROSTER

17. What agricultural inputs do you sell?

Fertilizer…………………………….1

Seeds……………………………….2

Agro-chemicals…………………..3

Other (specify)…………………...4

18. If fertilizer, what type of fertilizer do you sell?

a. For maize
b. For tobacco
c. Other (specify)________________________________

19. If seed, do you participate in FISP seed subsidy?

Yes ………………………..1

No…………………………2

20. Do you sell other inputs or other goods in general?

Yes………………………….1

No…………………………...2

21. If yes, what are they?

22. How many years have you been operating in this area as a fertilizer enterprise? ___________________________

23. What is the size of business measure as square footage of store? ______________________________

24. How many fertilizer distributer retail outlet are operating within a radius of 500m?________________________________

25. Do you provide advice to farmers (customers) on the appropriate use of fertilizer?

Yes………………………………………………1

No……………………………………………….0

26. What was the volume of fertilizer supplied on the market in (kgs)

Type of Input	2013/2014	2012/2013	2011/2012	2010/2011	2009/2010	2008/2009
Fertilizer						

27. What was the unit price of a kilogram of fertilizer in (MK)

Type of Input	2013/2014	2012/2013	2011/2012	2010/2011	2009/2010	2008/2009
Fertilizer						

MODULE D: ASSET OWNERSHIP

2. Do you own the following assets?

Asset	Ownership type	How many [Name] do you own	What is the age of this [Name] IF MORE THAN ONE ITEM, AVERAGE AGE	What is the value of [Name] if you were to sell today? (MK)
Store	4. Owned 5. Rented 6. Both			
Warehouse	4. Owned 5. Rented 6. None			
Weighing scale	4. Yes 5. No			
Desk	4. Yes 5. No			
Computer equipment & accessories	4. Yes 5. No			

MODULE E: FERTILIZER SALES

16. To whom do you mostly sell fertilizer?

Small scale farmers only……………………...1

Large scale farmers only……………………...2

Small and large farmers……………………….3

Other agro-dealers…………………………….4

17. In what quantities do you sell fertilizer?

50kg bags only………………………………..1

40-20kgs……………………………………...2

20-10kgs……………………………………...3

Any quantity demanded……………………....4

18. During the past 12 months, was this enterprise operational throughout the year?

Yes………………………………1

No……………………………….0

19. If so, what was the percentage of your sales from the stock?

75-100% of the stock…………………….………..1

50-75% of the stock…………………….………….2

50% of the stock……………………………….………..3

Below 50% of the stock Low…………………………4

20. If not, why was the enterprise not in operation for the period indicated in 3 above?

21. What was the volume of fertilizer sales in (Kgs)

Type of Input	2013/14	2012/13	2011/12	2010/11	2009/10	2008/09
Fertilizer						

22. What was the unit price of a kilogram of fertilizer in (Kgs)

Type of Input	2013/14	2012/13	2011/12	2010/11	2009/10	2008/09
Fertilizer						

23. During the 2013/2014 rainy season, what was the total expenditure of this enterprise on

If nothing was spent, record zero.

Transport	Fuel/oil	Search for marketing information	Electricity	Water	Insurance
MK	MK	MK	MK	MK	MK

24. What is the price margin per kg of fertilizer (MK/kg)? ______________________________

25. Do you have other retail outlets in rural areas?

Yes……………………………………1

No……………………………………0 (if no skip to question 13)

26. If yes, do you incur additional costs on

Transport Yes…….1 No……..0	How much do you spend on transport? MK	Labour Yes…….1 No……..0	How much do you spend on labour MK	Store Yes…1 No….0	How much do you spend on renting the store? MK	Searching for marketing information? Yes…..1 No……0	How much do you spend on searching for market information? MK
Other (specify)							

27. Do you also buy out farmers' output at the end of the season?

Yes………………………………1

No……………………………….0

28. If yes, do you have some form of contract arrangement with farmers?

Yes…………………………1

No…………………………..0

29. Do you sell inputs to farmers on credit?

Yes………………………….1

No…………………………..0

MODULE F: CONSTRAINTS TO FERTILIZER TRADE

14. Do you consider low demand for fertilizer as a constraint to your business?

Yes…………………………………1

No…………………………………2

15. Is there any ADMARC/ SFFRFM depot that distribute subsidy fertilizer nearby?

Yes………………………………….1

No…………………………………..0

16. If yes, what is the distance (km) to the depot from your store? ________________________

17. Have you been affected by subsidy program?

Yes ……………………………..1

No ………………………………0 (if no skip to question 10)

18. How have you been affected by subsidy program?

Positively……………..1 (go to question 7)

Negatively……………0 (proceed through 5 and 6)

19. If your business has been negatively affected by subsidy program, have you put strategies in place to maintain fertilizer sales?

Yes…………………………….1

No…………………………….0 (if no skip to question 8)

20. What strategies have you put in place to maintain fertilizer sales?

21. If your business has been positively affected by subsidy program, have you put in place strategies to increase your market share/fertilizer sales

Yes…………………………..1

No…………………………...0

22. What strategies have you put in place to increase market share/fertilizer sales?

23. How has annual sales changed over time?

Today versus 5 years ago?	Today versus 10 years ago?
04. Sales have increased 05. Sales have decreased 06. Sales have remained constant	04. Sales have increased 05. Sales have decreased 06. Sales have remained constant

24. How has profitability changed over time?

Today versus 5 years ago?	Today versus 10 years ago?
01. Profits have increased 02. Profits have decreased 03. Profits have remained constant	01. Profits have increased 02. Profits have decreased 03. Profits have remained constant

25. Have you expanded or contracted business over

Last 5 years	Why?	Last 10 years?	Why?
03. Expanded 04. Contracted		03. Expanded 04. Contracted	

26. What about other fertilizer distributer retail outlet in the area? Have they

Expanded?	Contracted?	Gone out of business?
03. Yes 04. No	03. Yes 04. No	03. Yes 04. No