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DETERMINANTS OF AGRICULTURAL PRODUCTIVITY IN MALAWI

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BSc (Agri. Econ), Malawi

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

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BUNDA CAMPUS

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DECLARATION

I, Shakira Phiri, 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.

Shakira Phiri

Signature_______________________________

Date ___________________\ _______________\ 2018

CERTIFICATE OF APPROVAL

We the undersigned, certify that this thesis is a result of the author's 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 oral examination held

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DEDICATION

The thesis is dedicated to my father Mr. Phiri and Uncle Dr. Phiri for the great inspiration and encouragement they have rendered towards me I will forever remain indebted to you.

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ABSTRACT

Agricultural productivity growth is a prerequisite for economic growth and poverty reduction as well as food and Nutrition security in agro-based economies such as Malawi. Malawi has been implementing several policies aimed at increasing agricultural exports as well as increasing food supply. The study assessed the determinants of agricultural productivity in Malawi. The study used time series data from1980-2015 and Autoregressive Distributed lag Model was applied. The study found out that in the short run an increase in the rainfall above the normal average by 1 percent will decrease productivity by about 0.55 percent; however the long run relationship is not significant. Another variable that is significant in the long run is expenditure to agricultural research, an increase in agricultural expenditure will increase productivity by 0.55 percent. In the short run, an increase in inflation will increase agricultural productivity by 0.15 percent however there is no significant relationship in the long run and this concurs with Olatunji et al. (2012).

Based on the findings the study recommends implementation of effective macroeconomic policies to manage inflation and devaluation of Kwacha, and increased expenditure to agricultural research.

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LIST OFABBREVIATIONS

APM	Automatic Pricing Mechanism
ARDL	Auto Regressive Distributed Lag
CAADP	Comprehensive Africa Agriculture Development Programme
FAO	Food and Agricultural Organisation
FISP	Farm Input Subsidy Programme
FRDP	Fiscal Restructuring and Deregulation Programmes
GIZ	German International Cooperation (Gesellschaft für Internationale) Zusammenarbeit)
GoM	Government of Malawi
GDP	Gross Domestic Product
ICT	Information Communication Technology
IMF	International Monetary Fund KPAs
KPAs	Key Priority Areas
LUANAR	Lilongwe University of Agriculture and Natural Resources
LDCs	Least Developed Countries
MDGs	Millennium Development Goals
MGDS	Malawi Growth Development Strategy
MEGS	Malawi Economic Growth Strategy
MPRSP	Malawi Poverty Reduction Strategy Paper

NES	Nation Export Strategy
NSO	National Statistical Office
PFP	Partial factor productivity
SAPS	Structural Adjustment Programs
SADC	Southern Africa Development Community
TFP	Total Factor Productivity
TIP	Target Input Subsidy
US$	United States Dollar

CHAPTER ONE

INTRODUCTION

1.1 Background

1.1.1 Global trends in Agricultural Productivity

Increasing agricultural productivity has been the world's primary agenda to ensure increased food supply to feed the growing population, Fuglie and Wang (2012). Comparisons of productivity across regions and countries mostly starts with comparing agricultural land and labour productivity, this is a method that was popularized by Hayami and Ruttan (1985). For the land and labour productivity the drivers have been intensive use of other inputs—such as fertilizers, machinery, energy and irrigation. A broader concept of agricultural productivity is total factor productivity (TFP), which is the ratio between total outputs of crops and livestock to total inputs—an aggregation of all of the land, labour, capital and materials used in production (Fuglie and Wang (2012).

Over the past 50 years, the highest levels of agricultural output per worker and per acre of agricultural land have been consistently achieved by industrialized nations. Currently, the world's highest yields—gross output of crops and livestock per hectare of land—are found in the developed countries of northeast Asia (Japan, South Korea and Taiwan), while the highest output per agricultural worker is in North America (the United States and Canada) and Oceania (Australia and New Zealand). Developing countries lag far behind, however in recent developments they have been slowly catching up. Developing countries are currently at levels achieved by industrialized nations in the 1960s, suggesting that large global productivity gaps still persist among countries, Fuglie and Wang (2012).

The global agricultural economy has remained relatively constant over the past decades with Total Factor productivity (TFP) averaging 2.7% per year in the 1960s and between 2.1% to 2.5% per year every decade since then. The agricultural yield growth, as measured by growth in total output per hectare of agricultural land, mirrored the output growth, remaining steady over the past 5 decades averaging to 2.1% annually. Table 1 illustrates the trends in global economy depicted in a number of measures.

Table 0.1 Summary of global agricultural productivity

Period	Gross Output	Total input	TFP	Output per worker	Output per area of crop land	Cereal yield area harvested
1961-1970	2.74	2.55	0.18	1.13	2.45	2.88
1971-1980	2.3	1.7	0.6	1.58	2.09	2.08
1981-1990	2.12	1.5	0.62	0.62	1.75	1.88
1991-2000	2.21	0.55	1.65	2	2.16	1.57
2001-2009	2.49	0.65	1.84	2.8	2.64	1.8
1971-1990	2.25	1.53	0.72	1.11	1.97	2.25
1991-2009	2.29	0.7	1.59	1.97	2.27	1.42

Source: Fuglie and Wang (2012)

Disaggregating these growth rates by global regions however depict a varied patterns with Total resources employed in agriculture in high income countries falling since around 1980; TFP growth offset the declining resource base to keep output from declining. TFP growth has remained robust overall, but has slowed in some countries like Australia and the UK. Labor productivity has been rising much faster than land productivity and average farm size has increased—agricultural labour has been falling more rapidly than land used in agriculture.

However the TFP growth in developing regions doubled between 1960-1990 and 1991-2009, from less than 1% to over 2% per year. Input growth has been slowing each decade but is still positive, enough to keep output growing at over 3% annually for each of the last three decades. Two large developing countries in particular, China and Brazil, have sustained exceptionally high TFP growth over the past two decades. Several other developing regions—including Southeast Asia, North Africa, and Latin America—also registered accelerated TFP growth in the 1990s or 2000s compared with previous decades. The major exception is Sub-Saharan Africa, where long-run TFP growth has remained below 1% per year, FAO FAOSTAT (2012).

Table 0.2 Regional differences in Agriculture

	1961-70	1971-80	1981-90	1991-00	2001-09
All Developing Countries	0.69	0.93	1.12	2.22	2.21
Sub-Saharan Africa	0.17	-0.05	0.76	0.99	0.51
Latin America & Caribbean	0.84	1.21	0.99	2.3	2.74
Brazil	0.25	0.6	3.02	2.62	4.03
Asia (except West Asia)	0.91	1.17	1.42	2.73	2.78
China	0.94	0.67	1.71	4.1	3.05
West Asia & North Africa	1.4	1.66	1.63	1.74	1.88
All Developed Countries	0.99	1.64	1.36	2.23	2.44
United States & Canada	1.25	1.67	1.31	2.18	2.24
West and Central Europe	0.58	1.44	1.43	1.25	1.98
Transition Countries (former USSR and E. Eur.)	0.57	-0.11	0.58	0.78	2.28
World	0.18	0.6	0.62	1.65	1.84

Source; Fuglie and Wang (2012)

1.1.2 Contributions agricultural productivity to food security

Food security is a major concern in global agriculture that needs a significant increase in order to be able to feed the expected growing world population. The projections show that feeding a world population of 9.1 billion people in 2050 would require raising overall food production by 70 percent between 2005/07 and 2050. Production in the developing countries would need to almost double. This implies significant increases in the production of several key commodities. Annual cereal production, for instance, would have to grow by almost one billion tonnes, meat production by over 200 million tonnes to a total of 470 million tonnes in 2050, 72 percent of which in the developing countries, up from the 58 percent today FAO (2014).

One way to feed an ever increasing world population is to increase the local and regional food supply of each and every country through improving agricultural productivity to achieve food security namely the availability of food in achieving sustainable food security. Furthermore, increasing productivity among small and marginal farmers can be an important instrument to guarantee food security in low income developing countries in the long-run (Pinstrup-Andersen and Pandya-Lorch, 1998). Furthermore, it can stimulate the development of rural non-farm activities hence improving access to food supply.

1.1.3 Agricultural Productivity in Sub Saharan Region

Agricultural productivity is central to the livelihood of most Africans. Two-thirds of the population of sub-Saharan Africa is rural, and the FAO counts nearly half of sub-Saharan Africa's rural population as "economically active" in agriculture. For some countries, such as Burundi, Rwanda, Uganda, and Burkina Faso, the rural population share approaches 85-90%, with 45-50% the total population counted as economically active in agriculture. Even among the most urbanized countries of sub-Saharan Africa, such as South Africa, one-third of the population remains rural.

In addition, up to 80% of Africa's poor live in rural areas, nearly all of whom work primarily in agriculture (World Bank, 2000). For these producer groups, agricultural productivity is the key determinant of welfare, and agricultural productivity growth is the key hope for poverty reduction (at least in the short- to medium-term). Non-farm rural employment, too, is often closely linked to agriculture -- either directly (as in the marketing of agricultural inputs and outputs), or indirectly (as in the provision of other services in rural markets).

The indirect benefits of agricultural productivity growth, in the form of lower food prices, are also critical to the welfare of Africa's rapidly expanding urban populations, the poorest of whom devote 60-70% of total expenditures to food (Sahn, et. al., 1997). From a macroeconomic perspective, as well, agriculture continues to play a central role in sub-Saharan Africa, accounting for 15% of total value added (20%, excluding South Africa).

Sub-Saharan Africa was largely bypassed by the Green Revolution that helped transform agriculture and reduce poverty in Asia and Latin America. This has been attributed to both adverse resource endowments (difficult climate and soils, lack of irrigation, etc.) and poor governing institutions and policies. Binswanger and Townsend (2000), who placed greater emphasis on poor institutions and policies than on adverse resource endowments in Africa, were optimistic that policy reforms enacted by many SSA countries in the 1980s and 1990s would improve agricultural growth.

Recently, in a wide ranging review of prospects for agricultural and rural development in the region, Binswanger-Mkhize and McCalla (2009) cite the reduction of armed conflict, improved macroeconomic management, the spread of democratic and civil-society institutions, stronger regional organizations, and increased foreign aid as further reasons for optimism about agricultural and economic development in SSA. Indeed, since the early 1990s, SSA’s rates of agricultural and economic growth have shown significant improvement over previous decades (Ndulu et al., 2007). However, it is not clear what is driving this growth.

According to FAO’s measure of gross agricultural output, agricultural production in SSA grew at an average annual rate of 2.6 percent between 1961 and 2008. Since 1991, agricultural growth has been higher, at 3.1 percent per year. During the 1970s, FAO gross agricultural output grew by only 0.78 percent per year, while real agricultural GDP rose by 2.49 percent per year. Production accounts for about three-quarters of agricultural output (with livestock products making up the other quarter.

The turnaround in a number of SSA countries from stagnant or declining agricultural TFP to positive growth since the mid-1980s corresponds with evidence that new agricultural technologies were becoming more widely adopted in SSA around this time. Despite these successes, national investments in agricultural science and technology have remained weak in SSA, limiting countries' capacities to adapt and disseminate more technologies to local farmers (Eicher, 1990; Pardey, Roseboom, and Beintema, 1997; Beintema and Stads, 2011). Compared with Asia and Latin America, adoption rates for new crop varieties and other technologies remain low in SSA (Evenson and Gollin, 2003).

1.1.4 Regional efforts to address agriculture issues

Several commitments at global and regional levels have been made to address challenges of low agricultural productivity and food insecurity. At the global level, the most prominent commitments include; the 1996 World Food Summit which was reinstated by the November 2009 Summit and renewed the commitment of the international community to ensuring food for all through increasing agricultural productivity; the Millennium Declaration which specifically sets the objective of halving the proportion of the world's poor and hungry people by the year 2015; the Paris Declaration on Aid Effectiveness re-confirmed by the Accra Agenda for Action; the UN Reform, and L'Aquila Food Security Initiative that announced a goal of mobilizing US$20 billion over a period of three years for increasing G8 assistance to Agriculture and Food Security (GAFS).

There have also been numerous commitments at a regional level from as far back as the 1980s such as the Lagos Plan of Action for the Economic Development of Africa and in the early 1990s in the African Economic Community initiative. Some of the more recent ones include;

The Maputo Declaration on Food Security (2003) with the "commitment to the allocation of at least 10 percent of national budgetary resources to agriculture and rural development policy implementation within five years";

The Sirte Declaration on Agriculture and Water (2004), geared toward addressing the challenges in implementing integrated and sustainable development on agriculture and water in Africa;

Endorsement of NEPAD / CAADP in 2005 with the aim to increase agriculture growth rates to 6 percent per year, and to sustain over time; the Abuja Declaration on Fertilizer for the African Green Revolution by which the AU Member States resolved to increase fertilizer use from 8.0 kilograms to 50.0 kilograms of nutrients per hectare by 2015; and

the Sharm El-Sheik Declaration on the High Food Prices in 2008 as the AU Assembly committed to reduce by half the number of undernourished people in Africa by 2015, eradicate hunger and malnutrition in Africa and take all necessary measures to increase agricultural production and ensure food security in Africa, in particular through the implementation of AU-NEPAD CAADP and the 2003 AU Maputo Declaration.

The Comprehensive Africa Agriculture Development Program (CAADP) of the New Partnership for Africa's Development (NEPAD) was developed with a specific goal of ensuring attainment of average annual growth rate of 6 percent in agriculture. This is because agricultural growth has powerful leverage effects on the rest of the economy. To achieve this goal, CAADP directs investment to four mutually reinforcing ‘pillars’: (i) extending the area under sustainable land management and reliable water control systems; (ii) improving rural infrastructure and trade-related capacities for improved market access; (iii) increasing food supply and reducing hunger; and (iv) agricultural research, technology dissemination and adoption. Each of these pillars incorporates policy, institutional reform and capacity building (CAADP, 2006).

1.1.5 Agricultural Productivity in Malawi

1.1.5.1 Agricultural productivity growth rate in Malawi

Generally, the performance of the agricultural sector in Malawi has been unsatisfactory. The poor performance of the agricultural sector in Malawi is mostly attributed to the low levels and growth rates in productivity. Labour productivity in the agricultural sector has stagnated at below US$170 which is lower than the SADC Low income average which currently stands at more than US$350 and is also significantly lower than the SADC and SADC middle income countries where labour productivities stand currently stand at above US$1088 and US$1880 respectively.

The land productivity in Malawi has been increasing since the 2000-2003 period, although such an increase has been very slow. The average land productivity in Malawi stands at about US$ 155 which, although higher than the SADC Low income average, is significantly lower than the SADC average which stands at around US$270 per hectare and SADC Middle income averages which stand at more than US$470 in recent year, Matchaya et al (2014).Table 1.3 shows agricultural productivity of various commodities for a selected period. Productivity growth has been relatively unstable in many crops, there was a declining productivity in the 2000-2005 period in both maize and rice production. In fact, most of the crops show negative rates of productivity growth in the 2000-2005 periods, with the exception of beans and tea.

Table 0.3 Summary of Productivity for various commodities

Commodity	**1970-79**	**1980-84**	**1985-89**	**1990-94**	**1995-99**	**2000-05**
Maize	2.74	-0.06	0.27	23.94	18.48	-5.67
Rice	3.43	14.67	2.97	-0.08	6.47	-7.79
Cassava	0.37	-7.32	-6.97	11.92	10.19	32.21
Sorghum	0.08	13.47	3.06	24.80	29.17	-0.93
g/nuts	-0.82	1.02	-5.69	18.18	19.46	-4.53
beans	0.01	0.09	0.43	-0.49	-6.08	1.54
Pulses	-0.05	-0.38	-0.65	-0.92	-0.99	-0.49
Cereals	2.57	0.16	0.32	22.15	18.14	-5.99
tobacco	7.86	5.51	3.64	5.88	-8.84	-1.41
Tea	5.45	3.32	1.35	-0.24	0.70	4.50
Average	2.16	3.05	-0.13	10.51	8.67	1.14

Source: Matchaya et al (2014).

The agricultural growth rate has been fluctuating recently as well as depicted below with highest growth rate registered in 2006 and lowest in 2012

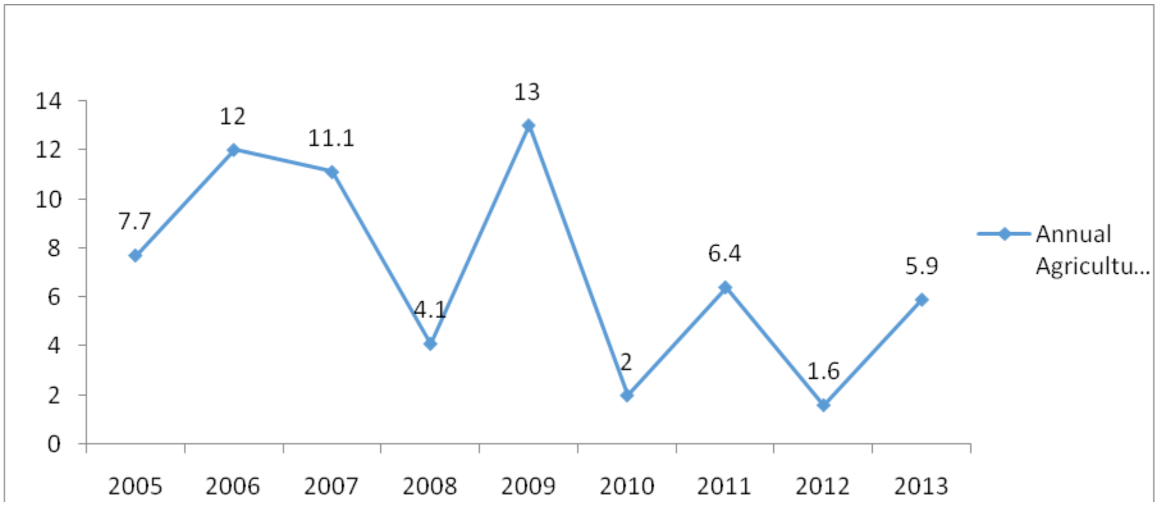

Figure 1.1 Historical trend for agricultural growth rate

Source: Matchaya et al (2014).

1.1.6 Land Issues in Agriculture

In Malawi the total area under cultivation is estimated at 2.2-2.5 million hectares, of which more than 90 percent is in small farms. It is estimated that the potential for agricultural land is about 4.7 million hectares suitable for rained, dimba, or wetland cultivation, irrigated land, and plantations plus 0.9 million ha of grassland. This means that about half of Malawi's land area can be cropped, of which only about half is currently under crops (GoM, 2009).

1.1.6.1 Land tenure systems

In Malawi the land acquisition, rights and control of land can be categorised as customary, public and private land. The most common system for smallholder farmers is actually customary land. In the customary land system the land is considered traditional and communal as such individuals have usufructs rights where they can cultivate or use the land, however, the ownership is still communal (Nothale, 1982). It is argued that the lack of ownership has affected the land utilisation and land productivity as the land is considered insecure. Malawi has operated without a comprehensive policy on land matters for a long time. The present land holding system is a product of colonial history and settlement patterns, agricultural policies of the one-party era, and recent demographic trends. All these have contributed to the problems that currently affect land tenure and utilisation (MLPPS, 2002).

Public land refers to land occupied, used, or acquired by the Government or any other land, which is neither customary nor private. Private land refers to land owned, held, used, or occupied under a freehold title, a leasehold title, or a certificate of claim, which is registered as private land. Customary land is by far the most common form of tenure in Malawi and accounts for 69 per cent of the country's total land and this is where most of the smallholder farmers are located (Government of Malawi, 2001).

The inheritance of customary land in Malawi is not catered for under statutory law but follows the customary law. Land is transferred predominantly through inheritance from relatives and marriage is one of the means to land access (Kishindo, 2004). Two customary systems of inheritance, the matrilineal and the patrilineal systems can be distinguished in Malawi. Under a matrilineal system, chieftaincy is handed down through the female line and so is land. Under this system, women's rights to customary land tend to be primary. Under the matrilineal system of marriage, a man's rightful heirs to his land are his sister's children (Pachai, 1978). This system characterises land transfers within the central and southern regions (Ng'ong'ola, 1982; Pachai, 1978). Under the patrilineal system, land is transferred from fathers to sons. It is in a way a mirror image of the matrilineal one where the powerful figure is the man other than the woman.

The land productivity in Malawi has been increasing since the 2000-2003 period, although such in increase has been very slow. The average land productivity in Malawi stands at about US$ 155 which, although higher than the SADC Low income average, is significantly lower than the SADC average which stands at around US$270 per hectare and SADC Middle income averages which stand at more than US$470 in recent years. Malawi therefore has to improve land productivity and the key is in policies that seek to yields and value of crops in general (Matchaya et. al., 2014).

1.1.7 Labor issues in Agriculture

Malawi is currently experiencing rapid population growth that in turn puts pressure on the state to find quick options for job creation. While African countries like Malawi consider large human population as a challenge to development, Asian countries like China have used the same phenomena to fast truck their development agenda. Investment in human capital through education and vibrant public health service delivery system has potential to turn the so called mess into mass production through innovation and hard work. According to Malawi Labor Force Survey (MLFS) conducted in 2013, about 80%

of the Malawi labour force is employed and agriculture provides employment to about 64% of this labour force (NSO, 2014). This means that only 16% work in non-agriculture sectors. The largest formal employer remains the state which in one way or another suggests the infancy of the industrial sector. Tourism and mining are examples of developing sectors of the economy. In the MLFS, a person is employed if, during the reference period, the person did some work (even for just one hour) for pay, profit or family gain, in cash or in kind or was attached to a job or had an enterprise from which she/he was 'temporarily' absent during this period for such reasons as illness, maternity, parental leave, holiday, training, industrial dispute payment. Using this definition unemployment rate in Malawi was estimated at 20%. This definition excludes people of working age who worked on their own land to produce crops for family consumption, not sale and for less than 48 hours in the reference period. As reported in IHS3, about 85 percent of households in Malawi are engaged in agricultural activities such that 84 percent of households are engaged in crop production whilst 44 percent do rare livestock. It is further noted that 43 percent of households engaged in agricultural activities are engaged in both livestock raring and also crop cultivation (NSO, 2012). Much as the reported proportions are different but one strong message is that the majority of Malawians depend on agriculture for their livelihoods.

1.1.8 Child labor in agriculture

One of the criticisms leveled against Malawi agriculture sector is child labour. There appears to be a very thin line between activities that minors do to assist their parent or learn how certain farm operation are done and economic activities that qualify as child labour. The problem is much bigger among the rural farming communities. What one society view as child labour, may not be viewed as such in another community. Child Labor Survey 2002 defined working children as the ones aged 5-17 who are involved either in economic or non-economic activities (NSO, 2004). This survey found that 30% of Malawi children are affected with child labour. In urban areas they are engaged in domestic activities or housekeeping while in rural areas they are 52% work in agriculture. The problem is worse in the Northern region but reduces with education. Most of the children were working either in family farm or in their own homes, assisting parents or guardians in production of food and housekeeping activities. As a result most of the working children were referred to as unpaid family worker. There has been tremendous improvement in reduction of child labour in Malawi.

1.1.9 Agriculture Labor

Labor is a critical input and perhaps a major constraint in the agricultural sector where mechanization remains a dream in color far from its realization. Human labour is the most important input to mobilize other inputs in the production process (Sharma, 2013). The Malawi Labor Force survey conducted in 2013 showed that agriculture provides employment to about 64% of the Malawians mostly those living in rural areas. These include those that worked on their own farm or off farm. However the compensation for the supplied labour so low that most of the people employed in agriculture lives below the poverty line. Productivity of agricultural labour is a key to improvement of livelihoods of the rural farming population. Unlike developing Sub-Saharan countries, developed countries experience high agriculture (land and labour) productivity due to rapid technological advancement (Chavas, 2008). This has contributed to welfare improvement for their farmers and economic growth. According to (Matchaya, Nhlengethwa, & Chilonda, 2014), productivity in the Malawi agricultural sector has stagnated at below US$170 per year which is lower than the SADC Low income average which currently stands at more than US$350. Explanation of the low productivity is very wide. Agricultural productivity among the households engaged in task-contracted casual labour and female-headed households may not be explained by the level of family labour inputs alone. Factors such as the paucity in working capital to purchase inputs play an important role in determining the levels of productivity (Takane, 2008).

The types of labour used in agricultural production can be broadly classified into two categories called family labour and hired labour but of these, family labour remains the main source of agriculture labour (Takane, 2008). Many smallholder farmers carry out all crop and animal production activities using unpaid family labour alone. Since Malawi agriculture is dependent on rainfall, crop production is also seasonal, these results into a large variation in agricultural labour demand through the year with peak periods falling between November of one year and February of the following year. During labour peak periods farmers face labour shortages to the extent that some of the production activities are not done in time, not done properly or even not done at all. Crops are sensitive to such hiccups in husbandry practices. On the other hand, they have surplus labour in the rest of the months. Valuable time is left unused in agricultural production. This creates room for labour intensive technologies like irrigation to be practices during the dry season.

In times of labour shortage some agricultural households supplement their family labour with hired labour (Bedemo, Getnet, & Kassa, 2013). This labour is supplied by other people at a wage. The peak periods also coincide with critical food shortages in the country. It is therefore not uncommon to observe households that supply wage labour while facing labour shortage. The proportion of the Malawi labour force engaged in crop and livestock production remain very large. However, Matita and Chirwa (2011) reported that agricultural productivity in sub-Saharan African countries like Malawi is very low and farmers face low-productivity trap.

1.1.10 Gender disparities in agriculture labor

Most agricultural land operations are inefficient and require high labour input unless appropriate machinery is used. It is not surprising, therefore, that smallholder farmers especially female-headed households have labour shortages and this affects their productivity. In terms of economic sectors, men and women are involved in the agricultural sector to the same extent, but women still have limited access to, and control over production factors such as land, agricultural inputs and technology. For this reason, women are particularly in subsistence agriculture, growing mainly food crops where earnings are low, whilst men are involved in cash crop production with high earnings (Ministry of Labour, 2009).

1.1.11 Government expenditure on Agriculture

Since implementation of FISP, the Government of Malawi has allocated more than 10.0% of the total budget towards agriculture annually, which indicates Malawi’s compliance to the 'Maputo Declaration on Agriculture and Food Security' to spend 10.0% of national budgets on agriculture development. The number of beneficiaries varies from 0.8-1.7 million farm families every year. Despite of increased cost of inputs and logistics the selling price of maize has remained constant. This has led to reduced investment in other agricultural subsectors such as extension and research and development (CISANET, 2012).

Table 0.4 Historical trends in agriculture expenditure

Commodity	**Pre reform**	**Reform period**			**Post period**	**Reform**
	1970-79	1980-84	1985-89	1990-94	1995-99	2000-5
Agriculture Share in Budget %	32.15	24.83	10.8	11.17	8.98	6.13
Agriculture Budget($m)	21.30	43.98	29.05	41.90	36.12	37.48
Recurrent budget($m)	8.39	21.69	18.52	30.56	26.66	22.17
Development Budget ($m)	12.91	22.29	10.54	11.34	9.46	15.31
Agriculture spending/capita($)	4.03	6.88	3.85	4.77	3.51	3.21

Source: CISANET (2012)

1.1.12 Current Government expenditure

In the budget of 2014/15 Malawi allocated about 142 Billion Malawi Kwacha, almost 19.1% of the total budget, to the agricultural sector which was the highest allocation in the budget. Out of the sum about 50.8 billion was allocated to Farm Input Subsidy

Program which targeted 1.5 Million small holder farmers. The actual expenditure however was increased to 59.7 Billion Kwacha due to exchange rate fluctuations. About 2.0 Billion Malawi Kwacha was allocated to improve production of Legumes. The developmental budget was estimated at 74.1 Billion Malawi Kwacha. The budget allocation was constrained due to withdraw of donor support following the cash gate scam (MoF, 2014). In the 2015/16 the government reduced the FISP allocation to 41.5 Billion Malawi Kwacha however the actual expenditure was estimated at 63.9 Billion Malawi Kwacha. The government reduced allocation to legume production as well to 1 Billion Malawi Kwacha. The total budget allocation to agriculture sector was around 133.7 Billion Kwacha (MoF, 2015)

In the 2016/17 fiscal year the government allocated about 198.5 billion Malawi kwacha to the agricultural sector. The FISP program was allocated 31.4 Billion Malawi Kwacha whilst 35.5 billion Malawi Kwacha was allocated to purchase food following the food crisis which affected the country. About 117.5 billion were allocated to various projects such as ASWAp, Shire Basin Management among others. Of this amount 115.9 Billion Malawi Kwacha from developmental partners and only 1.6 billion came from local resources (MoF, 2016). The 2017/18 budget has reduced allocation to agriculture about 192.0 billion Malawi Kwacha which represent about 15.5 percent of the total budget expenditure. The development budget has been estimated at 62.0 Billion Malawi Kwacha whilst about 17.6 billion Malawi Kwacha has been allocated to large scale irrigation projects through Green Belt Authority.

1.2 Problem Statement

Malawi is one of the least-developed countries in the world where the incidence of poverty is relatively high. The Human Development Index for, which is a combination of three sub-indices covering wealth, health and education, ranked Malawi lowly at position 153 out of 169 countries surveyed in 2010 and from 2015 and 2016 data it is ranked 170 out of 188. On the other hand, the country estimates based on the national poverty line showed that 40 percent of the populace earn/spend less than the threshold in 2012 and based on IMF (2017) report about 50.7 percent earn/spend less than the threshold and 25 percent is in extreme poverty which means the population is becoming poorer and poorer.

Agriculture still remains the main engine for economic growth and development for the country. With the most the people living in rural areas and depend on agriculture for meeting their daily necessities as well as for their livelihood, poverty reduction and food security efforts in Malawi have to put significant emphasis on improving agricultural productivity growth.

Increased agricultural productivity is one of the most important tools to end extreme poverty and hunger. Increased productivity necessitates growth in the sector leading to creation of employment, increased income and increased food consumption and enhanced nutrition for the population. However, Malawi is experiencing low productivity stemming from challenges such as: (i) adverse weather conditions, (ii) poor and unimproved crop varieties, (iii) poor crop management practices, (iv) insects, pests and diseases, (v) technology barriers, (vi) environmental externalities and technology adoption, (vii) increasing population pressure on land, (viii) poor and declining soil fertility, (ix) institutional challenges and macroeconomic factors Phiri et al (2012).

Feeding the ever growing Malawi population adequately would require rapid increased agricultural productivity. Malawi population is growing rapidly with a 3 percent annual growth rate and a net increase of 1 person per 58 seconds. By 2020 the population is estimated to hit 20.2 Million.

It is against this background that the research provided in-depth understandings study on the sources and the extent the factors propels agricultural productivity growth.

1.3 Justification

The findings of the study contribute significantly to development of National Agricultural Investment Plan which takes more consideration of the National Agricultural policy and National Export strategy. The policy forms an arch in agricultural related investment such as strengthening of institutional arrangements and public infrastructure. Additionally, the study will contribute to guiding stakeholder engagement, through Public Private Dialogue Forum, on agricultural commercialization project which is facilitated by Ministry of Agriculture, Water and Irrigation Development and Ministry of Industry, Trade and Tourism.

The study contributes to solving problem of low productivity as it provides basis for a policy space in addressing the problem. Furthermore, the study contributes to a pool of literature especially on addressing productivity in Malawi as it provides an in depth study unlike most research that provide a descriptive analysis.

1.4 Main objective

The main objective of the study is to assess the determinants of Agricultural productivity in Malawi.

Specific objectives

- To assess if economic, social and climatic factors affect agricultural productivity in Malawi.
- To identify long run determinants of agricultural productivity in Malawi.

Research question

- Do social, economic and climatic factors affect agricultural productivity in Malawi in Malawi?
- Do social, economic and climatic factors affect agricultural productivity in Malawi in Malawi in the long run?

Hypothesis

Inflation, rainfall, exchange rate, research expenditure, labour and agricultural subsidies do not affect agricultural productivity in Malawi

CHAPTER TWO

Literature review

2.1 Agricultural development theories

Staatz and Eichr (1998) summarized the change in perspective of agricultural development focus was to determine the existing interactions between agriculture and non-agricultural sectors in the overall economic growth. In the 1970s and 1980s the focus was to develop theoretical and empirical understanding of rural economy and to re-examine the role of agriculture in the economy. In the 1990s the focus was on the rural economy and the link to world markets as well as the role of institutions existing in an economy to growth of the agricultural sector.

Barret (2009) observed that the perspective was on broader development agenda. On the macro perspective research focused mostly on developing new empirical depth and policy impact of two dimensions which are (1) the dynamic role of the rural non-farm economy and linkages between the farm sector and the macro economy during the structural transformation; and (2) the political economy of agricultural policy and how the policies evolve.

Lewis model (Ranis, 2004) recognizes the role of agriculture by depicting a two sector world of Industry and agriculture. The model focuses more on structural transformation whereby it is assumed that in the initial phase more labour is employed in the agricultural sector, labour is a variable resource in limited supply and land is a fixed resource. The agricultural sector production reaches diminishing returns at some cut off point and the wages start to decline thereby forcing the workers to reallocate their labour to industrial sector which experiences higher wages and marginal product. The model therefore places agricultural sector at a focal point for economic growth.

Harris-Todaro (1970) main innovation was to introduce the notion that intersectoral labour reallocation is affected not only by the intersectoral wage gap but also by the probability of obtaining a formal sector job. They accepted the idea of institutional interventions in determining the level of the non-agricultural urban unskilled real wage, arising from union,

Fields (1975), closer to Lewis' basic model, pointed out that there were three choices for migrants: a formal sector job or open urban unemployment, plus a third possibility, a job in the urban informal sector, which Lewis had already pointed to. Just as in agriculture, he stated that very few urban residents can afford to be openly unemployed and rely on usually non-existent unemployment insurance. Instead, just as in agriculture, they fall back on family sharing, while working at low levels of productivity, i.e., they are the urban underemployed.

Among other extensions we would count the work by Ranis and Stewart (1999), which differentiates among two urban informal sub-sectors, a V-goods sub-sector which is dynamic and tied by subcontract to the urban formal sector, and an informal sponge sub-sector which was the focus of both Lewis and Fields. Lewis' model also had implications for income distribution, very much in line with Kuznets' (1955) early contribution to the subject.

Kuznets' structural analysis, as the economy moves from agriculture to manufacturing to services, implicitly also adopted a dualistic model. His reasons for anticipating an initial worsening of income distribution was that, as labour shifts from an equally distributed agricultural to a less equally distributed non-agricultural sector, this leads to a worsening of the overall distribution until wages rise in a one-sector world. This makes it very much akin to Arthur Lewis' view, which also has distribution likely to be worsening as long as wages are depressed, i.e., before the Lewis turning point is reached.

Neither Lewis nor Kuznets can be said to have taken into account the possibility that the employment effects of low wages during the early reallocation process can, in fact, lead to an increase in the wage bill and a functional distribution favouring labour, which can lead to an improvement in the family distribution of income—see the experience of Taiwan, for example. It is nevertheless clear that the Lewis model had substantial influence on subsequent work on the relationship between growth and equity.

Johnston and Mellor (1961) model links agricultural development to the role it performs and it states that the means by which agriculture is to develop is closely related to the functions it performs. They further categorized the functions as follow; (a) meet a rapidly growing demand for agricultural products associated with economic development (essentially a wage goods argument); (b) increase foreign exchange earnings by expanding agricultural exports; (c) supply labour to the non-agricultural sector; (d) supply capital, particularly for its own growth, for overheads and for secondary industry; and (e) serve as a market for industrial output.

The agricultural development strategy follows from these objectives; the initial dominance of agriculture in the economy; the inevitable relative decline of agriculture with economic development; and the restraint imposed by diminishing returns given the relatively fixed land area on which most agricultures operate. The basic prescription for agricultural development under the circumstances was 'expansion of agricultural production based on labour intensive, capital-saving techniques relying heavily on technological innovations'.

We also recognized a substantial period for 'establishing the preconditions for such growth' and a much later period, emphasizing 'expansion of agricultural production based on capital-intensive, laboursaving techniques'. Because the key intervening period 'requires an environment in which the possibility of change is recognized and accepted, and in which individual farmers see the possibility of personal gain, from technological improvement', it followed that in the preconditions phase agricultural growth - structures and patterns 'improvements in land tenure are likely to be the most essential requirement'. In agricultural development, emphasis was given to 'nonconventional inputs' to complement the existing land, labour and capital resources. Explicitly noted are the large numbers of trained people needed by institutions for agricultural research, extension, supply of purchased inputs, particularly seed and fertilizer, and other institutional facilities.

Schultz (1964) Third, T.W. Schultz (1964) stressed the need for an “agrarian revolution,” or higher productivity through technical change in agriculture. He emphasized the importance of human capital, especially the education of rural workers, in facilitating productivity growth, and governments' failure to provide appropriate policy environments (Schultz 1975, chapter 7, 1978)

2.1 Empirical review

2.1.1 Global studies

The decomposition of sources of growth in global agricultural output indicated that contributions came from the following factors (i) growth in land and water (irrigation), (ii) intensification of other inputs per unit of land, and (iii) TFP. Over these 50 years, total inputs grew at about 60% as fast as gross agricultural output, suggesting that improvement in TFP accounted for about 40% of total output growth. Furthermore, TFP's contribution to output growth grew over time, and by the most recent decade (2001-2009), TFP accounted for about three-quarters of the growth in global agricultural production. The rate of expansion in natural resources used—land and water—has slowed slightly over time, while the rate of growth in input intensification—the amount of labour, capital and materials per hectare of land—has fallen sharply. The source of increase in agricultural yield—output per hectare of agricultural land—has shifted markedly from input intensification to improvement in TFP, Fuglie and Wang (2012).

The single most important factor separating countries that have successfully sustained long-term productivity growth in agriculture from those that have not is their national capacity in agricultural research and development (R&D). Countries that have built national research systems capable of producing a steady stream of new technologies suitable for local farming systems are generally the ones that have achieved the higher growth rates in agricultural TFP (Evenson and Fuglie, 2011). Evidence reported in the chapters of Fuglie, Wang, and Ball (2012) finds that international and inter-state spill overs of agricultural knowledge are important sources of productivity growth, and that an important role of local R&D is facilitating the "capture" of these spill overs. Local R&D is often critical for adapting technologies developed elsewhere into useable technologies for local farming systems. Being actively engaged with foreign or international research institutions significantly raises returns to national agricultural research. While public-sector investments in agricultural R&D exhibited a slowing rate of growth in the 1980s and 1990s, the most recent evidence suggests that at least in developing countries this trend has reversed (Bientema et al. 2012). In high income countries, some of the stagnation in public agricultural R&D spending has been offset by greater R&D investment by the private sector, although the willingness of the private sector to invest in agricultural R&D may in turn be dependent on continued advances in publicly-funded fundamental sciences (Fuglie et al. 2012)

Furthermore, R&D, new econometric evidence from the Fuglie, Wang, and Ball (2012) volume has identified a number of other factors that have contributed to cross-country differences in agricultural TFP. This can broadly be characterized as the "enabling environment" for the dissemination of new technologies and practices. These factors include policies that improve economic incentives for producers, stronger rural education and agricultural extension services, and rural infrastructure that improve access to markets. At the same time, economically disruptive "shocks," such as armed conflict and human or animal diseases—HIV/AIDS in Africa and avian flu in Asia—have seriously depressed agricultural productivity growth in some countries. Having a more favourable enabling environment compliments but does not substitute for research. Improving on these enabling factors raises the return to investments in agricultural R&D.

2.2.2 Studies focusing on Agricultural productivity in Sub-Saharan Region

In particular, African governments have been hesitant about making genetically modified crops available to their farmers (Paarlberg, 2008). African farmers also continue to face more discriminatory policies than farmers in other global regions (Anderson and Masters, 2009), policies that lower economic incentives to invest in agricultural production and modern inputs. In addition to weak research systems and low incentives, many farmers in SSA are hindered by poor infrastructure, civil unrest, and the spread of HIV/AIDS (Binswanger-Mkhike and McCalla, 2009). While investments in agricultural research provide an obvious mechanism for TFP to grow through technological change, other factors influence incentives for agricultural investment and technology adoption. Economic policies, rural infrastructure, farmer education and health, access to extension and credit services, secure land tenure, and the presence or absence of peace and security influence farmers' access to new technologies and markets, returns to savings and investments, and incentives to allocate resources to the most profitable enterprises.

Block (1994) was the first to report a recovery of aggregate agricultural TFP in sub-Saharan Africa during the 1980s, a result confirmed by a number of subsequent studies. Block attributed up to two-thirds of this recovery to investments in agricultural R&D and to macroeconomic policy reform. Frisvold and Ingram (1995) provide an early growth accounting exercise for land productivity, concluding that most of it (up to 1985) resulted from increased input use (labour, in particular). Thirtle, Hadley, and Townsend (1995) highlight the role of policy choices, finding that an index of real agricultural protection played a significant role in explaining TFP growth in African agriculture for the 5 period 1971-86.

Lusigi and Thirtle (1997) highlight the role of agricultural R&D in explaining TFP growth in Africa. They also highlight the role of increasing population pressure in driving increased agricultural productivity in Africa. Chan-Kang, et. al. (1999) focused on the determinants of labour productivity in a cross-country African setting. They recommended land per unit of labour to be an important determinant of labour productivity. Fulginiti, Perrin, and Yu (2004) estimated agricultural TFP growth for 41 sub-Saharan African countries from 1960 to 1999, finding an average TFP growth rate of 0.83% per year, and confirming the finding from Block (1994) of an acceleration of the agricultural TFP growth since the mid-1980s. Their analysis concentrates on the role of institutions in explaining this growth. They conclude that former British colonies experienced greater rates of TFP growth, while former Portuguese colonies experienced lower rates. They also found negative effects for political conflicts and wars, and positive effects resulting from political rights and civil liberties. Three more recent papers conclude this review.

Nin-Pratt and Yu (2008) reconfirm the acceleration of African agricultural TFP growth since the mid-1980s. They find, however, a negative average growth rate of agricultural TFP (- 0.15% per year) from 1964 to 2003, casting the recovery period as making up for negative productivity growth during the 1960s and 70s. Specifically, Nin-Pratt and Yu find that average TFP growth fell at the rate of -2% per year from the mid-1960s to the mid-1980s, then grew by 1.7% per year between 1985 and 2003. They, too, highlight the role policy change in explaining this reversal in performance. In particular, they find that an indicator of reforms associated with structural adjustment played a positive role. In addition, they find that agricultural productivity in East and Southern Africa benefited from the end of internal conflicts, and that agriculture in 6 West Africa benefited from the devaluation of the CFA franc. They also provide suggestive evidence of the positive effect of investments in agricultural R&D. Alene (2010) also focuses on the contributions of R&D expenditures to productivity growth in African agriculture. In contrast to the average TFP growth rate reported by Nin-Pratt and Yu (2008), Alene finds an average TFP growth rate of 1.8% per year for the period 1970- 2004 (a difference that he attributes to an improved estimation technique). Alene finds strong positive effects of lagged R&D expenditure on agricultural productivity growth, arguing that rapid growth in R&D expenditures during the 1970s helped to explain strong productivity growth after the mid-1980s, while slower growth of R&D expenditures in the 1980s and early 1990s led to slower productivity growth since 2000. Alene (2010) also notes a 33% annual rate of return on investments in agricultural R&D in Africa.

Most recently, Fuglie (2010) examines agricultural productivity growth in sub-Saharan Africa from 1961 to 2006. His findings are mixed. While he reports an increased rate of growth in agricultural output during the 1990s and early 2000s, Fuglie finds that most of this growth in output is explained by expanding crop land rather than improved productivity. Fuglie (2010) stands out in this literature for his critical assessment of the standard data sources, for which he proposes various corrections. In contrast to previous studies, Fuglie does not find a general recovery of agricultural productivity in recent decades. For the period 1961-2006, he reports an average TFP growth rate of 0.58% per year, with the lowest rate occurring during the 1970s (- 0.18% per year), and the highest rate occurring during the 1990s (1.17% per year). Thus, recent estimates of the rate of agricultural TFP growth in Africa differ widely, though there is a general consensus surrounding a decline in productivity during the first two 7 decades following independence and a recovery during the past two decades. These studies applied different methodologies to essentially the same data set, which may explain some of the conflicting findings cited above. As described below, the methodology applied in the present study differs from all of the studies cited above.

This approach is based on underlying assumptions of econometric estimation of production through production function (Primal) or the cost function is based approach (dual) (Antle and Capalbo, 1988). The approach determines the level of output given the price of inputs such as labour and capital as well estimate the increase in the level of output with the change in level of inputs. The general production can be specified as follows

$$\ln Q = \alpha_0 + \alpha_t T + \Sigma_{i=1} \alpha_i \ln X_i + (1/2)\Sigma_{i=1}\Sigma_{j=1} \gamma_{ij} \ln X_i \ln X_j + \Sigma_{i=1} \phi_{it} \ln X_i T + (1/2)\phi_{tt} T^2$$

Where Q is an aggregate output index, T is a time trend representing technological change and Xi is a quantity index of input category i. For theoretical consistency, symmetry and hometheticity are imposed. Many researchers use the Cobb-Douglas function, despite the fact that it imposes some assumptions about technology, such as unitary elasticity of substitution.

The application of endogenous growth theory using econometric approaches has focused on cross-country comparisons of the entire economy. These new growth models have been able to explain growth better than the old growth models. Using data from 1960 to 1985 for 98 countries, Mankiw, Romer and Weil (1992) augment a Solow model with a human capital variable to examine international variation in per capita GDP in three categories of countries (non-oil, intermediate and OECD). Even with a restrictive Cobb-Douglas functional form, they are able to capture about 80 percent of the variation in GDP among non-OECD countries. Using cross-section data from 98 countries on growth between 1960 and 1985, Barro (1991) incorporates both a human capital measure and population growth (arguing that raising the cost of children reduces fertility rates and increases investment in both physical and human capital). Barro finds that the returns to physical capital investment are positive but inelastic; a one-percent increase in the ratio of investment to GDP increases real growth in GDP by less than one percent. Levine and Renelt (1992) examine the average annual growth between 1960 and 1989 of 119 countries using an augmented Solow model to explore institutional and regional factors affecting growth. Using a simple linear regression model, their findings concur with Barro's that both human capital and fertility are important.

2.3 Studies focusing on specific indicators

2.3.1 Labour input

Enu & Attah-Obeng (2013) set out to establish the macro determinants of agricultural production in Ghana for the period 1980 to 2011. The study used a Cobb-Douglas production function and ordinary least squares estimation technique to analyze the data. Agricultural output was the dependent variable. Labour force, real GDP per capita, inflation, and real exchange rate were the independent variables. The study found that apart from inflation all the other factors that is Labour force, inflation, real exchange rate, real GDP per capital, were significant in determining agricultural productivity.

Anyanwu (2013) carried out a study on agricultural productivity determinants in Nigeria.He formulated an econometric model to analyze his data as follows: Q = F(X1, X2, X3……X12, e)

Where, Q is the aggregate agricultural productivity and X1, X2, X3 TO X12 are farm size, labour input, expenditure on planting material, non-farm income, capital input, expenditure of fertilizer, number of crops in the mixture, distance to the market, level of education of the farmer, age of the farmer, size of households, experience of the farmer and e is the error term. That study found farm size, labour input, expenditure on planting material, non-farm income, capital input, the number of crops in the mixture, distance to the market, the level of education of the farmer, experience of the farmer were statistically significant determinants of aggregate agricultural output. Labour despite having a negative coefficient was statistically significant.

Ahmad (2012) sought to find out what determines the growth of agricultural productivity in Pakistan. The study employed autoregressive distributed lag model. The period considered in the study was from 1965 to 2009. From the study, it was concluded that in the short run and the long run fertilizer input, human capital, and agricultural credit were significant. The area under crop was found to be insignificant in the short run as well as the long run.

Abugamea (2008) in estimating the long-run relationship between agricultural production to variables like cultivated land, labour force and capital (purchased input cost) the study employed Johansen-Granger cointegration procedures. The study found a significant negative relationship between capital and agricultural production. Over a long period, the cost of inputs impacted agricultural production negatively. Additionally, the study found a positive correlation between labour force and agricultural production. Error Correction Model (ECM) was used to check for short-run dynamics, which indicated clearly that capital and labour were the main determinants of agricultural productivity in Palestine.

Odhiambo *et al.* (2004) studied sources and determinants of agricultural growth and productivity in Kenya between 1965 and 2001. The study used growth accounting procedure to determine the respective factors followed by econometric technique to analyze the factors. The study concluded that 90% ofagricultural sector growth is accredited to factor inputs; land, capital, and labour. Labour by itself contributed 48% of agricultural growth. The study further established that factors which affect agricultural productivity include; climate, trade policy in Kenya and government expenditure on agriculture.

Ekborn (1998) employed Cobb-Douglas production function with agricultural productivity as the dependent variable. The independent variables used were labour input, materials, physical resource endowment, human capital and physical capital investment. The results from ordinary least square regression indicated that soil conservation quality, the cost of agricultural inputs and labour availability were positively correlated to agricultural productivity and statistically significant. Farm size and distance from key resources and major infrastructures such as water and roads were negatively correlated to agricultural productivity and were statistically significant. Soil capital investments, capital assets, access to credit, off-farm nonagricultural income also contributed positively to productivity.

Schultz's (1963) classic work attributed between 21 to 23 percent of the growth in U.S. income, between 1929 and 1957, to education of the labour force. Contemporaneously, Griliches (1963) focused on minimizing the unexplained portion of growth in U.S. agriculture by adjusting labour for quality, using education. When he included research and extension expenditure as an input to production, he found that virtually all the "unexplained" growth could be explained by economies of scale, R&D and labour quality changes. Romer (1986) and Lucas (1988) provide theoretical grounds for human capital being the driving force behind economic growth.

Jamison and Lau (1982) explored the role of farmer education and extension on farm efficiency. They found that farmer education and extension were not only important to enhancing production on Thai, Korean and Malaysian farms, but that there was an interaction effect between education and extension. In contrast, they found physical capital had an insignificant impact on production and profits. On the other hand, some researchers are finding evidence that returns to education are low, especially for those who stay in agriculture. In their summary of the findings on the determinants of rural poverty for six country studies based on econometrically estimated income equations, Lopez and Valdes (2000) conclude that the return to education in farming is surprisingly small in most cases. An increase in one year in the average level of schooling raises per capita annual income of the family by less than US$ 20 per person in most cases. The main contribution of education in rural areas appears to be to prepare young people to emigrate to urban areas and towns.

Using an econometric approach, Nehru and Dhareshwar (1994) examined sources of TFP growth in 83 industrial and developing countries for the period 1960-1990. They found that human capital formation was three to four times more important than raw labour in explaining output growth. Using human capital as a separate variable, they found that the countries with the fastest growing economies have based their growth on factor accumulation (human capital, labour and physical capital), not growth in efficiency or technology.

2.3.4 Real exchange rate

Brownson *et al.* (2012) set out to establish evidence-based relationship between value of agricultural GDP as a ratio of total GDP and macroeconomic variables; inflation rate, nominal exchange rate, external reserves, interest rates, savings, real GDP per capita, index of energy consumption, index of agricultural production, index in manufacturing production, non-oil exports and average industry capacity utilization rate, in Nigeria. Real exchange rate affects both prices for inputs which are imported and output prices for outputs which are exported.

In the short run and long run, the empirical results revealed that; there was a positive relationship between nominal exchange rate, capacity utilization rate of the industry and agricultural productivity. There was a significant negative relationship between agricultural productivity and inflation rate, external debt, real total exports, and external reserves.

The study recommended that relevant economic policies should be formulated and implemented so as to increase investment in the agriculture so as to increase the percentage of agricultural output in the total exports of the country. The country's economy should be diversified to ensure that the country is not solely dependent on the oil sector. There should be efforts to drastically reduce external debt. Also, an incentive program should be put in place to promote industrialization so as to enhance production and ensure capacity is fully used and consequently encourage backward integration. Policies to ensure inflation rates are stabilized should be implemented. All these are critical to promoting agricultural productivity.

2.3.5 Trade

Trade policies and the overall trade environment have been found to affect agricultural growth. There have been empirical studies done to link trade policies and agricultural growth (e.g. Ram Rati, 1985; Tybout, 1992; Edwards, 1992; Mwega, 1995; Onjala, 2002). There exist the two popular views on the link between agricultural growth and trade policies the first view which is advanced by researchers in the late 1980s and earlier 90s with trade liberalisation being the popular agenda in many economies. Researchers such Ram Rati (1985) and Havrylyshyn (1990), among others, believed that an increased outward trade affects economic growth though specialisation in commodities of comparative advantages and intensification affects, economies of scale associated with availability of larger markets and rapid technological advancement. It is also further argued that trade encourages innovation which results increased productivity growth.

Trade can also influence agricultural growth through foreign exchange market. There are two hypotheses in terms of analyzing the relationship between exchange rate and agricultural growth. The first hypothesis is the exchange rate sheltering which state that a depreciation of real exchange rate leads to reduction in growth of domestic productivity since it cushion the domestic producers from foreign competition. This usually led to reduction of the domestic producers' incentives to be innovative and endeavour into productivity enhancement investments.

2.3.6 Inflation

Olatunji et al. (2012) employed Granger causality method and descriptive statistics in the analysis agricultural production and inflation in Nigeria. From the study, the variation in the agricultural output (the inventory change) resulted in changes in inflation for the years 1970 to 2006. Agricultural output and inflation rate are directly related. Moreover increase in agricultural output from the preceding year resulted in an increase in the inflation rate. The study indicated that there is variation in both trends of agricultural output and rate of inflation. The study recommended that policies should be put in place to ensure surplus agricultural output is absorbed in order to ensure stability in food prices and inflation rates.

Oyinbo et al. (2012) used descriptive and inferential statistics in the analysis of the trends of inflation, agricultural productivity, and economic growth. The study used time series data. There was a one-way relation between agricultural productivity and economic growth. There was one-way causality between inflationary trend and agricultural productivity. However, there was no causality between trends in the inflation rate and economic growth. The study thus recommended that inflation should be maintained at single digits by the Central bank of Nigeria.

2.3.7 Government Expenditure on Agriculture

Benin et al. (2009) carried out a study on agricultural productivity and public expenditure in Ghana. The results from the different zones differed marginally. The study used household production data and public expenditure data. From the study health, education, roads and supply of public goods and services in relation to agriculture had a significant impact on agricultural productivity.

From the study, a unit increase in agricultural public spending resulted in a 0.15percent increase in agricultural labour productivity. The benefit-cost ratio of public spending on agriculture was 16.8. Spending on rural feeder roads followed with a benefit-cost ratio of 5. Health followed at a distant third. However, formal education had a negative effect on agricultural productivity. This could be connected to more skilled labour which is associated with more educated people, being allocated away from farms.

Selvaraj (1993) analyzed how variation in government expenditure affected growth in agriculture sector in India. Agricultural development had relied significantly on financing by the government for a long time. Over the years, the share of agriculture spending out of the public finance has been declining. This can be attributed to the economic reforms, milestones achieved in agriculture, as well as industrialization. This trend, however, affects the performance of agricultural sector negatively. The study used time-series data. The results of the study clearly demonstrated the importance of government expenditure on agriculture. Reduction in the portion allocated to agriculture has adverse effects on performance of the agricultural sector. There was an inverse relationship between fluctuation in government expenditure in agriculture and agricultural sector growth.

Mutuku (1993) studied the impact of government expenditure and the structural adjustment programmes on the agricultural sector. He noted that agricultural output can be increased through land use intensification which includes the use of hybrid crops, farm machinery, and use of fertilizers to improve soil productivity as well as improved animal husbandry practices. He also noted that small-scale farmers account for a significant percentage of the total agricultural output. The infrastructure needed to raise agricultural productivity is a public good provided by the government via government expenditure. Adequate government expenditure to the agricultural sector would fast track agricultural development. The study found that instability in government expenditure adversely affects agricultural sector performance.

Public policy and budgetary decisions regarding infrastructure also have a profound effect on agricultural production. A serious conflict arises with structural adjustment reforms. Budget cuts in public services often accompany market reforms. While fiscal restraint may be required to stabilize the economy in the short run, cuts in human capital development, public R&D, and infrastructure have a detrimental long-term effect on productivity growth. Policy makers need to choose carefully to mitigate the deleterious impacts of budget cuts on future growth.

Using an econometric approach, Jayne et al. (1994) demonstrated the complementarity of public policies and public investments in facilitating the use of new technology. They point to the sharp decline in public investments and growth in Zimbabwe during the 1980s. Pal (1985) underscores the complementarities of public policy towards investment in irrigation technology and private variable input use.

The importance of policy reform is increasingly viewed as fundamental for agricultural productivity gains. Liberalizing markets so prices can send proper signals to producers is the fundamental objective of structural adjustment programs in developing countries and policy reform in economies in transition. Assigning property rights is viewed as a means of promoting development through the efficient and responsible use of resources (North, 1994) and therefore underlies the distribution of capital in economies in transition, land reform and most land policy. Block (1994) discusses the complementarities of economic reform and technical change, but cautions that policy reform offers a one-time effect.

An example of the relation between policy reform and productivity is the implementation of China's "responsibility system" (RS) in 1980-81, which linked productivity to material reward, resulted in increased crop yields "for every major crop" (Wiens, 1983). McMillan, Whalley and Zhu (1989) calculated that in response to the RS and price reforms, output in the Chinese agricultural sector increased by over 61 percent between 1978 and 1984. They attribute 78 percent of the increase to the RS and 22 percent to higher prices for crops. They calculate the RS increased productivity in agriculture by 32 percent. Lin (1992) calculated that 42 to 47 percent of the growth in agricultural output was attributable to the RS during the same period.

In another example, price reforms in Egypt implemented in 1986 resulted in increased wheat and maize yields from 1987 to 1993. Rice production increased by 62 percent, while yields increased by 42 percent (Khedr, Ehrich and Fletcher, 1996). Bevan, Collier and Gunning (1993) contrast the performance of agriculture in Kenya and Tanzania. In Kenya where there was little intervention production of food and cash crops increased by 4.6 and 5.5 percent per annum, respectively. In Tanzania, where policies controlled prices and taxed export crops, agricultural production stagnated until policy reforms were instituted in 1984.

Using an econometric approach to estimate TFP for the United States dairy industry 1972-1992, Lachaal (1994) examined how protectionist policies in the form of direct subsidies to agriculture reduced productivity growth in the United States dairy industry. Lachaal showed that government subsidies encouraged using materials at the expense of feed and raised the cost of production by 1.8 percent for each 10 percent increase in subsidy. The subsidy policy was the source of technical inefficiency, creating biases that distorted factor usage.

2.3.8 Climate/ rainfall

Ayinde et al. (2011) carried out a study in Nigeria on how changes in climate affected agricultural productivity. The study used descriptive and co-integration model approach to analyze time series data. The study concluded that during the period from 1981 to 1995, there was a steady and high rate of agricultural productivity. However, during the period from 1996 to2000, the rate was very low. It was observed that the amount of rainfall and temperature had fluctuated in the later period

Agricultural productivity and annual rainfall results from Augmented Dickey-Fuller unit root test were not stationary but became stationary after the first differencing. Temperature (annual), however, was stationary at its level. Temperature change was negatively related to agricultural productivity. However, rainfall change was positively related to agricultural productivity. The study also revealed that previous year's rainfall had a negative effect on the productivity of the current year. The study thus recommended that to increase and sustain agricultural productivity there was a need to encourage innovations and technologies that are environmentally sensitive so as to mitigate fluctuations in the climatic conditions.

Kumar & Sharma (2013) used an econometric model and the regression analysis which revealed that extreme climate variation adversely affects the quantity and value of production for majority of the crops. This indicates that food security is greatly threatened for most of the small scale farming households. This is because agricultural productivity and food security are interrelated. The study also generated food security index which revealed that it was also adversely affected by the climatic fluctuations.

Edame et al (2011) noted adverse climate change is a major threat to food security in the21st century. Agriculture is very sensitive to climate change. Since the world population is growing agricultural production should also increase to ensure food security. To successfully boost food security, agricultural productivity needs to be boosted.

Malawi has about 3 million hectares of cultivatable agricultural land, but more than 99 per cent of agricultural land remains under rain-fed cultivation. Malawi, like many Southern African countries, is experiencing increasing climate variability which results into poor crop yields or even total crop failure due to drought and floods (CARLA, 2011). The rain-fed nature of smallholder farming makes agricultural production prone to such adverse weather conditions (Government of Malawi, 2010). Since the good performance of the economy is directly linked to performance of the agriculture sector, the national development strategies in Malawi have emphasized the importance of the growth of the agricultural sector in the fight against poverty, since most of the poor are currently engaged in the agricultural sector and mostly involved in subsistence agriculture (Muhome-Matita and Chirwa, 2011). Over-dependence on rain fed agriculture makes the country vulnerable to climate-related shocks culminating in low agricultural production and productivity. For example, the country has been experiencing low agricultural production from 2011 to 2013 due to unreliable rainfall patterns, erratic rains, dry spells, pest and diseases, droughts and floods. This depressed economic growth and development in the country.

Climate change is among other challenges that have emerged to be of great importance to agricultural production. Malawi being an agro-based country has a policy framework that guides agricultural production including other supporting policies. The role that climate plays in agriculture in the economies that depend on the rain fed agriculture production cannot be underestimated. Malawi like many developing countries depend heavily on climate as such to some extent output is influenced by rainfall. The association of productivity to climate explains the wide regional variability in productivity. It is also to a large extent explains shocks in the agricultural production as well as food security in Malawi. In Malawi not only does it affect the output it also influences the shifting in strategies. Initiatives such as the Green Belt Initiative and several irrigation projects are being undertaken by the government to overcome the negative impact the climate change has had on the economy.

The government of Malawi developed the National Adaptation Programs (NAPA) under UNFCCC to address impacts of climate variability (EAD, 2006). The policy interventions are in line with the government priorities as outlined in the Malawi Growth and Development Strategy II (MGDS II, 2011-2016) and the 2010-2012 Bank's Interim Country Strategy Paper (ICSP). Moreover, Adaptation actions under NAPA are mostly ranked and advocated for because they improve agricultural production and rural livelihoods (CARLA, 2012). In this context, Malawi has put in place several measures and strategies to deal with the adverse effects of extreme climatic events. The Department of Disaster, Relief and Rehabilitation was established to handle extreme weather and other natural disasters.

2.3.9 Research expenditure

Research increases availability of technology hence agricultural R&D expenditures are used as a proxy for agricultural technological change. However, the development of technology does not always result in its adoption. In some cases this may be because the technology being developed is not appropriate, that is, it does not meet the needs of agricultural producers. Hence, researchers focus on public expenditure as an explanatory variable in TFP growth. Additionally public research has been shown to lead private research (Chavas and Cox, 1992).

Several caveats arise in focusing on public R&D to explain growth in agricultural TFP. Public R&D expenditures are used as proxy for R&D results, yet there is not an exact correspondence between expenditures and technology. Even when technology is produced, researchers may have different goals than farmers, e.g. yield maximization rather than profit maximization or risk minimization or improvement in commercial crops rather than staple crops. Additionally, when an appropriate technology does result, the process of technology adoption in agriculture is widely recognized as one that occurs over many years in which some adopt quickly and others wait for extension or the results of their neighbours to convince them to adopt.

Bearing this in mind, researchers have found that public investment in developing and extending agricultural technology is justified by the high rates of return to such investment. In a survey of studies on Asia, Pray and Evenson (1991) found rates of return to national research investment from 19 to 218 percent, returns to national extension investment from 15 to 215 percent and returns to international research investment of 68 to 108 percent. A report of the Taskforce on Research Innovations for Productivity and Sustainability indicated that the returns to research, though variable, were always high, from 22 to 191 percent. Using an index number approach to calculate TFP for several crops in India, Rosegrant and Evenson (1992) and Evenson and McKinsey (1991) used econometric analysis to identify sources of growth in TFP. Rosegrant and Evenson (1992) found that public research accounted for 30 percent of growth and extension for about 25 percent, with rates of return for each respectively of 63 percent and 52 percent. Evenson and McKinsey (1991) found that public investment in India in research accounts for over half of growth, while extension contributes about one-third and infrastructure accounted for very little growth. They calculated internal rates of return of 218 percent for public research, 177 percent for public extension and 95 percent for private research expenditures in India.

Block (1994) compareds econometric estimates of TFP for Sub-Saharan Africa between 1963 and 1988. He uses three different methods of aggregating agricultural output: official exchange rates, purchasing power parity and wheat units. He finds that one-third of the growth in agricultural TFP in Sub-Saharan Africa is due to research expenditures. In India, Rao and Hanumantha (1994) attribute continued growth in agriculture, despite a sharp decline in physical capital formation, to better utilization of existing infrastructure, fertilizer and high yielding varieties.

While the returns to research are high, the technology is not always adopted. For example, high yield varieties (HYV) of wheat and rice have been introduced on less than one-third of the 423 million hectares planted to cereal grains in the Third World.

Specifically, in Asia and the Middle East 36 percent of the grain area was HYV, 22 percent in Latin America and one percent in Africa (Wolf, 1987). This implies there is much potential for increasing agricultural productivity using existing technology. However, the use of HYV requires increased use of fertilizer, but external debt in Latin America and poverty and inadequate water supply in Africa have made fertilizer use and hence HYV unprofitable. Jahnke, Kirschke and Lagemann (n.d.) also attributed low adoption of HYV in Africa to lack of appropriate technology development and few extension services directed to women. Additionally, non-traditional crops have rarely been the focus of improved varieties or technology and potential exists to develop them to increase agricultural production.

2.4 Theoretical Review

Economists originally limited themselves to examining the roles of labour and physical capital in economic growth. The failure to adequately explain growth led them to examine the roles of other factors and to develop endogenous growth theory. Investment in infrastructure has been cited as an important source of growth in agriculture (Jayne et al., 1994). However, Ferreira and Khatami (1996) claim that economic literature has not reached a consensus on the direction of causality between infrastructure and development. Nor can investment be viewed in isolation of policy reform which has been shown to be a vital stimulus of production (Auraujo Bonjean, Chambas and Foirry, 1997; Lachaal, 1994; Lin, 1992; McMillan, Whalley and Zhu, 1989; Wiens, 1983); as have institutions (North, 1994). Public investment in forms of human capital: education, extension, training and technology research have also been shown to increase productivity (Antholt, 1994; Beal, 1978; Evenson and McKinsey, 1991; Pray and Evenson, 1991; Pardey, Roseboom and Craig, 1992; Rosegrant and Evenson, 1992).

Nelson (1964 and 1981) recognized that there are important interactions between capital formation, labour allocation, technical progress and productivity. This calls into question whether the growth due to physical capital can be separated from growth attributed to other inputs. Unless a production technology is a fixed Leontief process, there is always some degree of substitutability among categories of inputs. However, since inputs are not perfect substitutes, the lack of adequate investment can slow down production growth. Estimates of the elasticity of substitution in agriculture between hired labour and capital equipment vary from 0.32 in the short run (Brown and Christensen, 1981) to 1.78 percent (Lopez, 1980) in the long run.

Most measures of TFP incorporate inputs and physical capital, leaving human and social capital, technology, institutions, infrastructure and policy to "explain" growth in TFP. Social and human capital is the on-farm human elements that mediate how policy, technology, institutions and infrastructure affect input and physical capital use. Human capital directly affects whether and how technology will be adopted. Technology choice in turn, affects the inputs and physical capital used. That is, technology is embodied in the types of inputs and how they are used. Social capital affects access to physical capital (e.g. land directly or through land titling and loans) and variable inputs (e.g. through credit or cooperatives).

In general, researchers have estimated TFP and then focused on how one or several of these factors might be driving its growth (Antle, 1983; Nehru and Dhareshwar, 1994; Evenson and McKinsey, 1991; Rosegrant and Evenson, 1992). Usually, they have done so using the change in TFP as a dependent variable in a regression with explanatory variables that represent measures of technology, human capital and policy (which are not easily quantifiable or assignable in constructing the production indices). In the following sections, policy is divided between budgetary policies that affect investment in R&D and infrastructure, political and economic policies and political stability.

Total factor productivity (TFP) divides the value of output and the value of inputs used. Partial factor productivity (PFP) is often used as TFP are tough to formulate as it is difficult to value all inputs when markets are not operating optimally.

Auto Regressive Distributed Lag Model

To establish the individual or joint contribution of inputs to output it is necessary to establish a function. Since the study used historical data series to estimate the parameters the time characteristics can be decomposes as $Yt = X_1t + X_2t + \cdots X_nt + U_t$ with mean E (YT) = 0 and covariance Cov (Yt, Yt-1). For any period t, the difference between the least squares fit Ýt and the actual value Yt is the residual term Ut. That is if the residual is substantial we will examine $Yt = \alpha Y_{t-1} + U_t$ where α represent the strength of the residual correlation and error term Ut and this model is valid if α< 1.

Generally the stochastic model can be specified as

$Yt = \alpha 1Y_{t-1} + \alpha 2Y_{t-2} \ldots\ldots + \alpha nY_{t-n} + U_t$ and this function can be expressed compactly as a polynomial $(1 - \alpha 1L - \alpha 2\ L^2\ \ldots\ldots - \alpha n\ L^n)Yt = U_t$ where L shows the lagged operator.

The models was used because the series were not stationary at the same order and were differenced to become stationary and furthermore the model was used because it takes into account any cointegration relationships among variables.

2.4.2 Overview of literature

From the above literature, some studies have employed Cobb-Douglas production function with agricultural output as the dependent variables while the independent variables varied in different studies. This study employed the Auto Regressive Distributed Lag Model with the independent variables being: labour force, climate/rainfall, real exchange rate, government expenditure and inflation. Research in the agricultural sector has and continues to be carried out. This can be attributed to the significant role agricultural sector plays in the economy, especially in the developing economies. Since agricultural sector continues to be a very significant sector of the Malawian economy, there is need for vigorous and extensive research so as to provide updated data to enable the relevant authorities to formulate policies and programmes which are up to date and relevant to the current trends. This study, therefore, serve the purpose of expanding the body of literature available to enable policy makers to formulate relevant policies.

Research gaps

Further research needs to be done on individual determinants of agricultural productivity so as to have an in-depth understanding of the contribution of individual factors without aggregating them in a study.

CHAPTER THREE

METHODOLOGY

This chapter explains data collection methods and tools, defines the theoretical frameworks specify the empirical model.

3.1 Data collection

The study used secondary data from different sources. The sources include Food and Agricultural Organization, World Bank and locally from National statistics office. The study used time series secondary data from 1980 to 2013. World Bank as well as FAO compiles data on macro variables in all countries annually.

3.2 Research design

This study applied quantitative research design where empirical data was analyzed. The general definition of productivity presented in this paper includes multiple possible combinations of measures of output and especially inputs. The broadest productivity metric, applied to all sectors of economic activity, combines value added as a measure of output with an indicator of labour input. While the resulting measure of value added per worker is a partial productivity ratio in that it uses only one type of input, i.e. labour, it allows for ready comparison across sectors and countries.

3.3 Theoretical framework

A production function describes the technical relationship that transforms inputs (resources) into outputs (commodities) resources) into outputs (commodities). A general way of writing a production function is

$$Y = F(x_1, x_2 \ldots\ldots x_n)$$

Where y is an output and $x_1, x_2 \ldots\ldots x_n)$ is array of inputs. In order to find productivity

generally a Total Factor of Productivity (TFP). TFP divides the value of output and the value of inputs used. However historically, economists have used and developed productivity measures which are based on the relationship between one or more outputs relative to a single key input, such as an acre of farm land or an index of farm labour input. These indicators are called partial factor productivity indicators. The most common partial productivity index economy-wide is a labour productivity measure. The usefulness of a labour productivity measure for an industry varies depending upon the importance of the labour input in that industry. As such Partial factor productivity (PFP) is often used as TFP are tough to formulate as it is difficult to value all inputs when markets are not operating optimally. PFP is given by physical output (Q) over physical factor input (X) that is (Y=Q/X). To establish the individual or joint contribution of inputs to output it is necessary to establish a production function. The general neoclassical production function: Y = F (X1, X2, X3,….Xn) or Y = AKαLβ where Y is the output level, Xs are the inputs; A, α & β are positive constants; K & L are capital and labour input respectively. A is the total factor productivity, α & β are capital and labour elasticities respectively. The factors are constant and determined by the available technology (Koutsoyiannis, 2006).

The Cobb-Douglas production function is of degree one if $\alpha + \beta = 1$. Productions function of degree one has constant returns to scale. If $\alpha + \beta < 1$ then the production function exhibits decreasing returns to scale. If $\alpha + \beta > 1$ the production function exhibits increasing returns to scale. The value of α and β will determine what degree of returns to scale a Cobb-Douglas production function can exhibit. Since the values of α and β are not limited, Cobb-Douglas production function can exhibit any degree of returns to scale (Koutsoyiannis, 2006).

However eliminate the bias in Cobb-Douglas production function; the equation can be transformed by taking the logarithms of both sides. Function can be written as $\ln Y = \ln A + \alpha \ln K + \beta \ln L$. Generally, Cobb-Douglas production function can be generalized to many inputs to take the following function; Q = Πni = 1 Xβii . This function can exhibit any degree to scale depending on the value of summation of βi. In this study, the Xs are labour force, climate (rainfall), real exchange rate, government expenditure and inflation.

The logical basis for choosing Cobb-Douglas production function is based on the fact that it is relatively simple and convenient to specify and interpret. Moreover, application of Cobb-Douglas production function has been found applicable in similar settings to this one. For instance, (Enu & Attah-Obeng, 2013), (Ekborn, 1998) and (Muraya 2014Agricultural productivity (Y) was regressed against; labour force (L), rainfall(R), real exchange rate (E), Subsidy (G) and inflation (I).

3.4 Conceptual Framework

Figure 3.1 depicts a graphical depiction of the growth decomposition. The height of the bars indicate the growth rate of real output. Growth in real output can be attributable to raising yield per hectare (intensification and this yield growth itself is decomposed into input intensification (i.e., more capital, labor and fertilizer per hectare of land), and TFP/PFP growth, which reflects the efficiency with which inputs are transformed into outputs. Improvements in TFP/PFP are driven by technological change, improved technical and allocative efficiency in resource use, and scale economies. The decomposition of output growth into these components is both intuitively appealing and has direct policy relevance; input intensification is strongly influenced by changes in resource endowments and relative prices, whereas TFP growth is strongly influenced by long-term investments in agricultural research and extension services, education, and infrastructure, and improved resource quality and institutions(USDA, 2018).

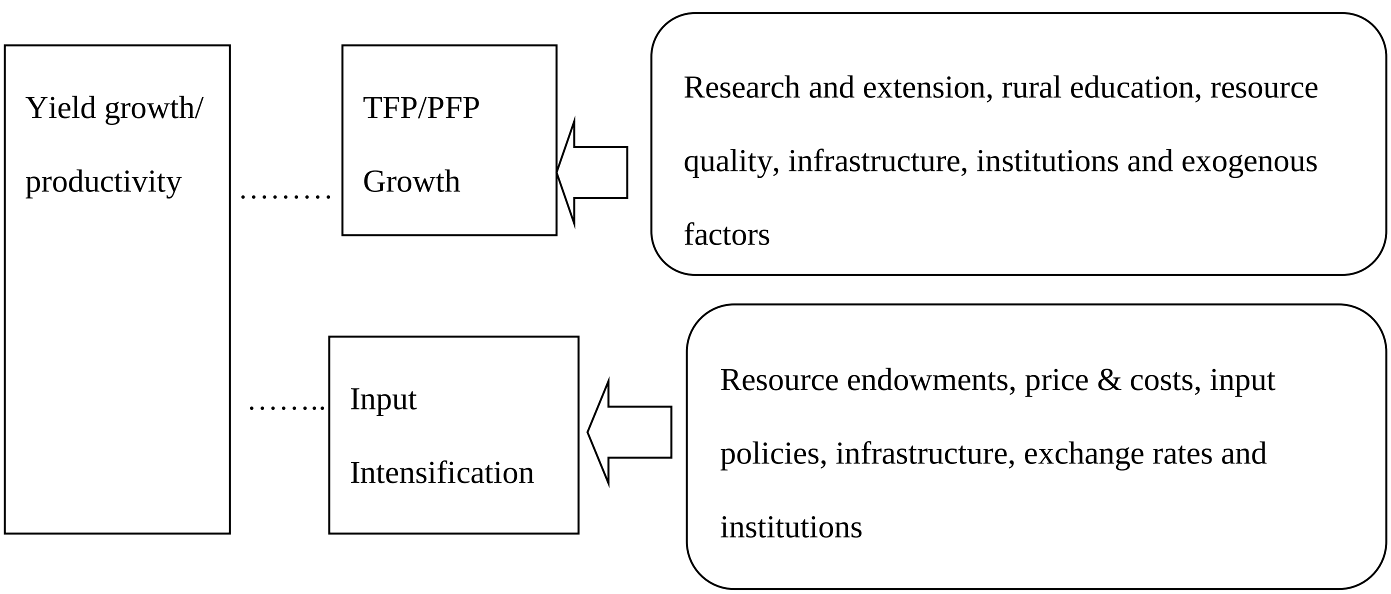

Figure 3.1 Conceptual framework

Source USDA, Economic Research Service

Model Specification

$$lnYt = \alpha + \alpha 1(lnLt)_{t-1} + \alpha 2(lnRt)_{t-1} + \alpha 3(lnGt)_{t-1} + \alpha 4(lnRE)_{t-1}$$
$$+ \alpha 5(lnEt)_{t-1} + \alpha 6(lnIt)_{t-1} + U_t$$

Where,

Yt is agricultural productivity measured as agriculture value added per worker

Lt is labour force measured in terms of percentage of farming population growth rate at time t

Rt in the rainfall measured in terms of annual rainfall in Malawi at time t

Et is the real exchange rate measured as real effective exchange rate at time t

Gt is a dummy variable for government agricultural subsidy at time t

It is the inflation rate measured using annual consumer price index

RE is research expenditure measured as a percentage of GDP at time t

µt is the random error term.

3. 4 Definition of variable

3.4.1 Labour Force (L)

The labour force is proxied by percentage of agricultural labour force. The relationship between labour force and agricultural productivity is expected to be negative. This is due to the pressure on the agricultural land with an increase in population.

3.4.2Inflation (I)

Inflation is the sustained general increase in price levels of goods and services. Inflation is measured in terms of consumer price index over time. When we consider the prices of outputs, the relationship between price level and agricultural productivity is expected to be positive. When inputs are considered the relationship between price levels and agricultural productivity is expected to be negative.

3.4.3Rainfall (RF)

Rainfall is a variable indexed by total annual rainfall in Malawi.Rainfall is used to represent climatic factors as a determinant of Agricultural productivity. With the variations of rainfall patterns over the years it is an indication of weather variability. The variable is an index of average annual rainfall. From theory, a positive relationship is expected between rainfall and agricultural productivity.

3.4.3Real exchange rate (E)

The real exchange rate is the purchasing power of a currency relative to another currency. In this project, it is used as a policy variable to bring in the effect of a country's macroeconomic and trade policies. The real exchange rate is a macro price and affects both the prices of imported inputs and tradable outputs. The relationship between exchange rate and agricultural productivity is rather uncertain.

3.4.4Government expenditure in agriculture (G)

This is used to represent government direct involvement in agriculture. From theory, we expect a positive relationship between government expenditure on agriculture and agricultural productivity. This is attributed to increased investment by the government in the agricultural sector from input subsidies which all contribute positively to enhancing agricultural productivity.

3.4.5Agricultural productivity (Y)

Agricultural productivity proxied by agriculture value added per worker is a measure of agricultural productivity. Value added in agriculture measures the output of the agricultural sector less the value of intermediate inputs. Agriculture comprises value added from forestry, hunting, and fishing as well as cultivation of crops and livestock production. This is the dependent variable in the model.

3.4.6 Data processing and Analysis

This study employed the Autoregressive Distributed Lag Model method to estimate the parameters of the model. To test the statistical significance of the parameters the study employed t-test. T critical value (from t distribution table) and t-statistic were compared at 5% level of significance. When the magnitude of t-statistics is great the more reliable the value of the coefficients are to predict the dependent variable. When the magnitude of the t-statistics are close to zero the less reliable the value of the coefficients are to predict the dependent variable.

We tested for autocorrelation which is detected by using the Durbin-Watson statistic. If the value of the DW statistics lies between 1.5 to 2.5, this indicates that there is no problem of autocorrelation (Shim et al, 1995).

CHAPTER FOUR

RESULTS AND DISCUSSION

This section presents results from the analysis of the date for the research. The first section shows descriptive analysis of the variables used in the research followed by model estimation

4.1 Descriptive summary

The table below summarizes the variables used in the study; the mean exchange rate was 361 Malawi Kwacha per US$ with the maximum of 564 Malawi Kwacha per US$. The standard deviation of 146. 43 Malawi Kwacha per US$ is greater than the mean showing a greater variation of the exchange rate. The mean annual rainfall was 857.74 mm with minimum of 611 mm and maximum of 1138mm. These figures concur with the metrological findings that the average rainfall varies from location to location and from season to season however the figures vary from 725 mm to 2500 mm. The value added per worker shows minimal variation of 73.9 US$ with the mean value added per worker of 361. 33 US$ and a maximum of 463.46 US$

Table 0.1 Summary of Variables

Variable	**Mean**	**Standard Deviation**	**Min**	**Max**
Labour	78.31	4.49	69.9	83
inflation	20.37	14.62	7.41	83.32
Real exchange rate	95.11	146.43	0.812	564
Value added	361.33	73.91	211.98	463.46
Research	1.16	0.4	0.6	1.9
Rainfall	857.74	121.20	611.19	11.38

The figure below shows a historical trend of inflation; the inflation rate has been fluctuating with a minimum 0f 7. 4 percent in 2010. Inflation in 1995 soared due to low rainfall which affected many parts of the country, the inflation reached about 83.32 percent however a maximum of 93 percent was registered in that year. The inflation rate declined to around 37 percent in 1996 and stabilized to around 9 percent in 1997 inflation rate also peaked in 1999 and later the rate increased steadily from 2011 to 2013

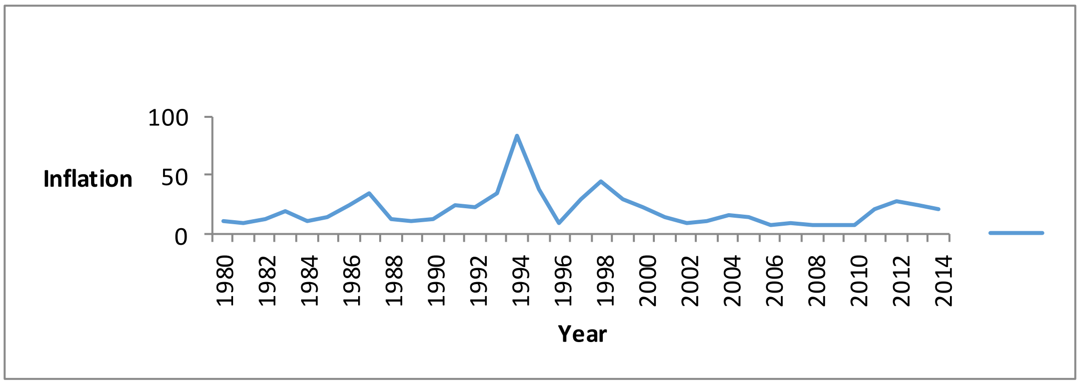

Figure 0.1 Historical trend of inflation rate

Rainfall patterns have been fluctuating, receiving mostly normal to below average rainfall the years 1992, 1994, 1998, 2005 were characterized by low rainfall while earlier years are most characterized by normal to above average such as 1980, 1989. The linear shows that Malawi is receiving less and less rainfall.

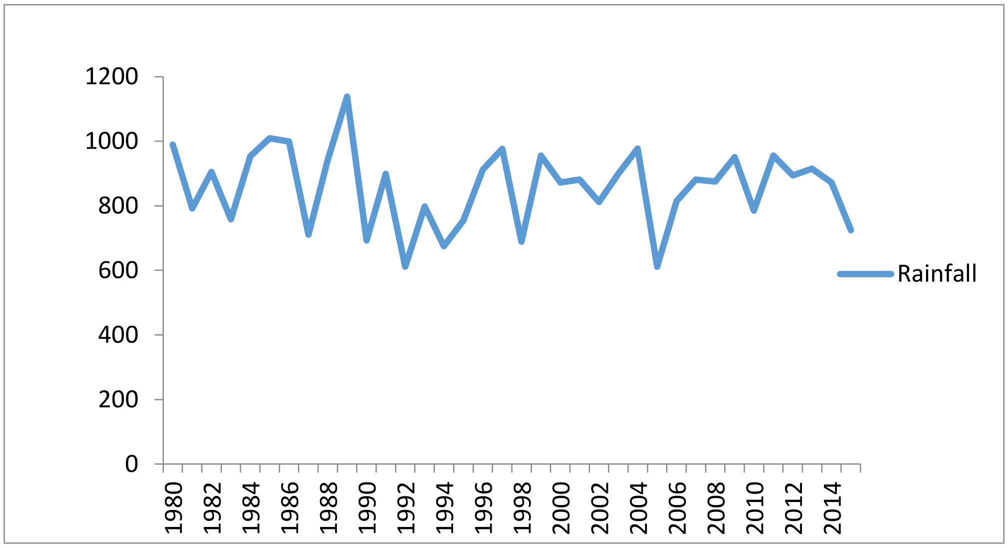

Figure 0.2 Historical trend rainfall

Agricultural value added per worker has been fluctuating as well with 1991 and 1993 with lower rates of 212 and 228 US$ respectively. Higher rates were registered in 1999 and 2003 of 463 and 454 US$ respectively however these could not be sustained and declined to 380 US$ in 2005.

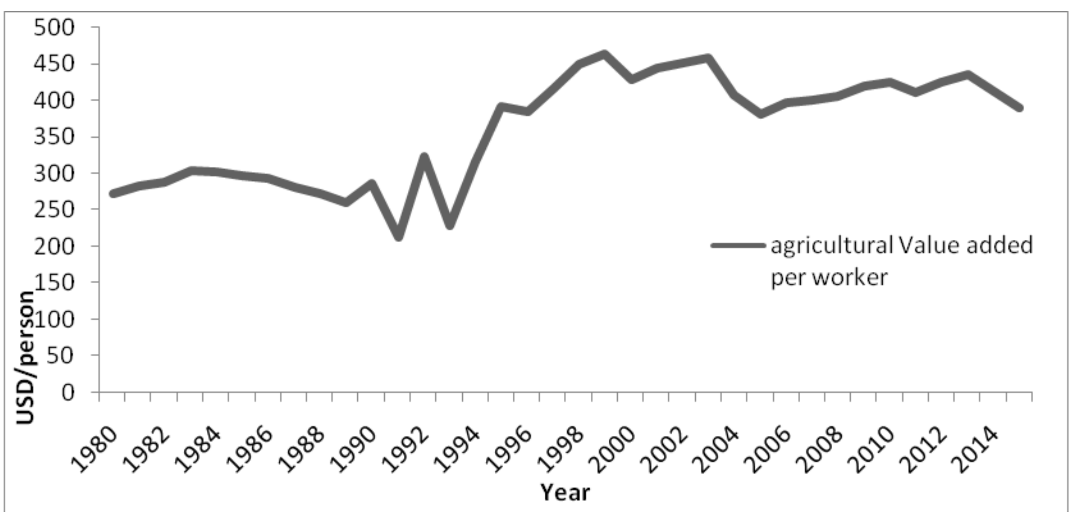

Figure 0.3 Value added per worker

The Malawi Kwacha has been losing value against the dollar over time. The exchange rate went from 59.5 Malawi Kwacha per US$ in 2000 to 564 Malawi kwacha per US$ in 2015. Sadly the percentage of research expenditure has remained almost constant with a maximum of 1 percent of GDP spent on research and development over the 2 decades.

4.2 Diagnostic tests

The study used partial autocorrelation function and autocorrelation function graphs to determine if there is auto correlation. Limiting the output to 16 observations, the ACF and PACF plots indicates a non-decaying spike of spikes in the correlogram graph of subsidy, exchange rate and research. Using a clearer ACF and PACF plots with a 95% confidence band (Bartlett's method) show that inflation, rainfall are not auto correlated however indicate that there is auto correlation in labour and agricultural value added per worker.

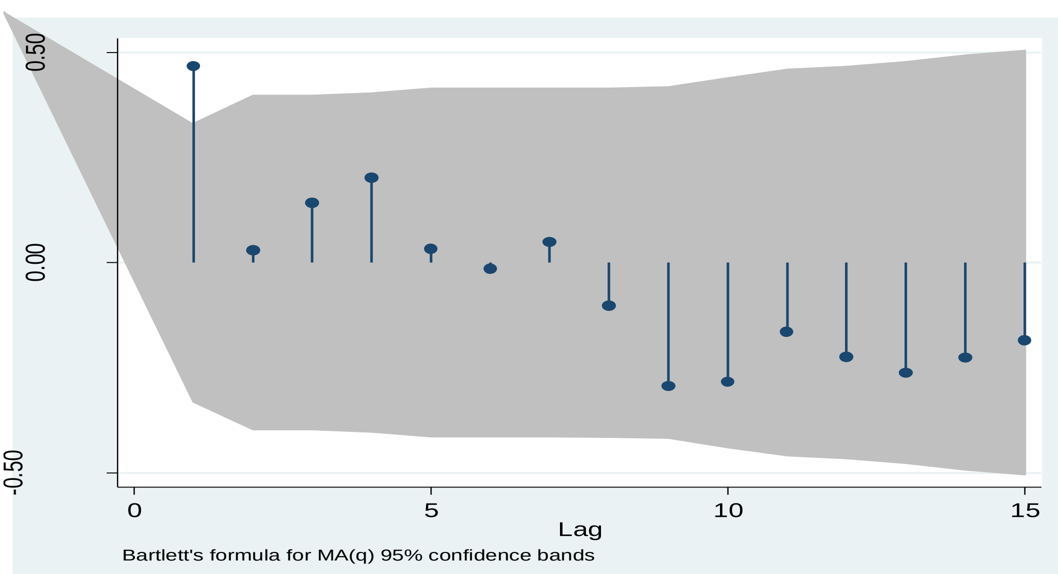

Figure 0.4 ACF of inflation

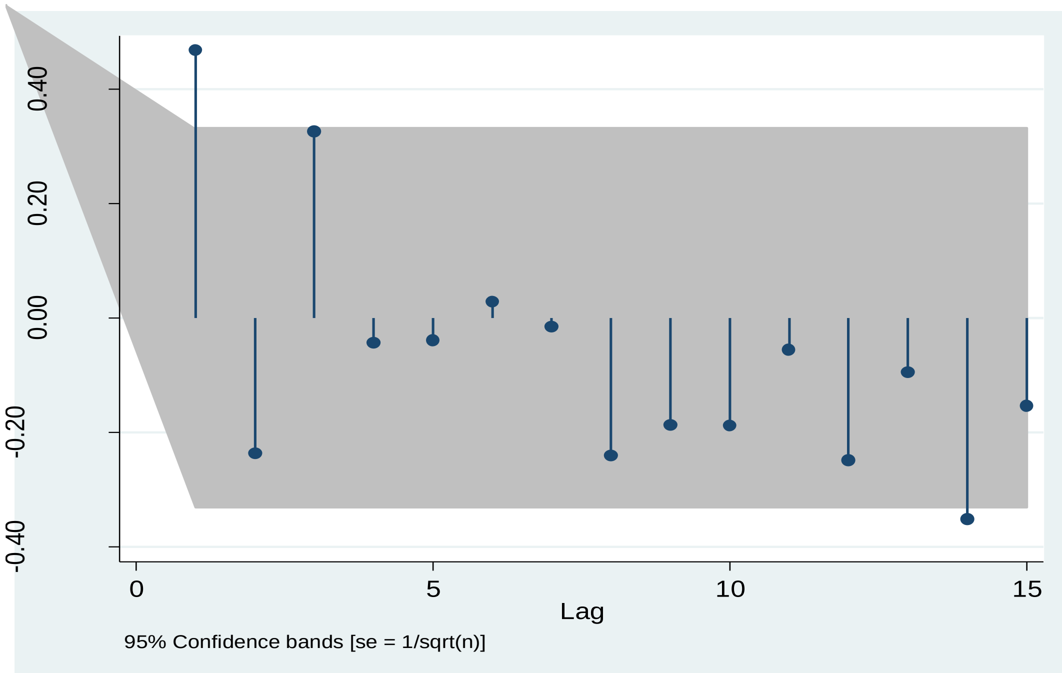

Figure 0.5 PACF of inflation

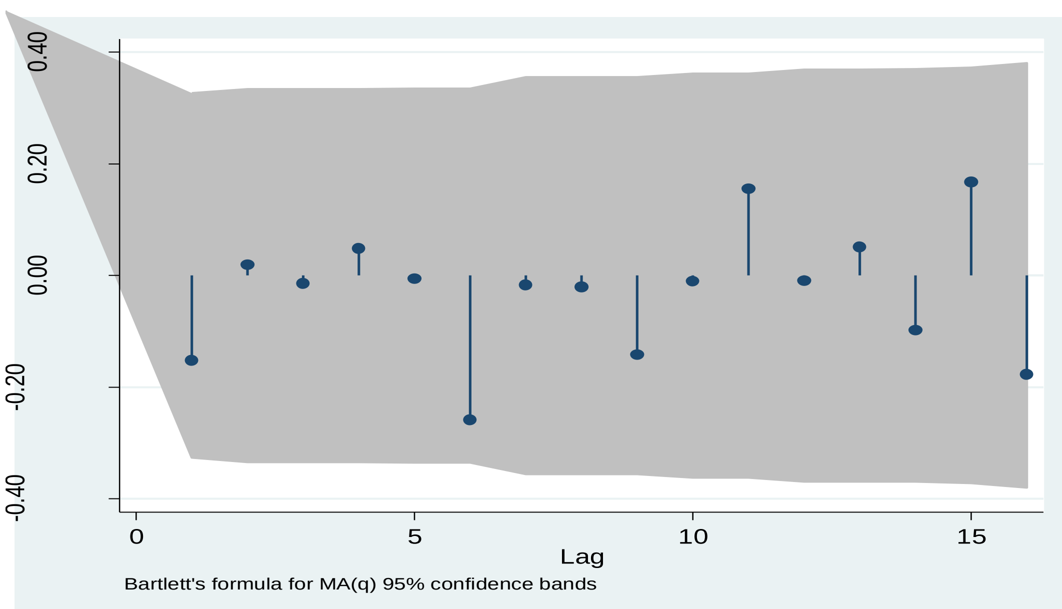

Figure 0.6 ACF for rainfall

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LAG	AC	PAC	Q	Prob>Q
1	0.9167	0.9444	32.843	0.0000
2	0.8333	0.0000	60.784	0.0000
3	0.7500	-0.0000	84.102	0.0000
4	0.6667	0.0000	103.1	0.0000
5	0.5833	0.0000	118.12	0.0000
6	0.5000	0.0000	129.52	0.0000
7	0.4167	0.0000	137.71	0.0000
8	0.3333	0.0000	143.14	0.0000
9	0.2500	0.0000	146.3	0.0000
10	0.1667	0.0000	147.76	0.0000
11	0.0833	-0.0000	148.14	0.0000
12	0.0000	0.0000	148.14	0.0000
13	-0.0833	-0.0000	148.56	0.0000
14	-0.1667	0.0000	150.29	0.0000
15	-0.2500	-0.0000	154.36	0.0000
16	-0.3333	0.0000	161.96	0.0000

Figure 0.7 Correlogram for subsidy

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:rgram research
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AC	PAC	Q	Prob>Q
0.6352	0.6460	13.358	0.0003
0.5766	0.3545	24.757	0.0000
0.5244	0.3298	34.536	0.0000
0.4088	0.1862	40.707	0.0000
0.4408	0.3188	48.169	0.0000
0.3377	0.1371	52.732	0.0000
0.2718	0.2858	55.815	0.0000
0.1617	0.1728	56.956	0.0000
-0.0329	-0.1852	57.006	0.0000
-0.0030	0.0305	57.006	0.0000
0.0463	0.4064	57.114	0.0000

Figure 0.8 Correlogram for research

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. corrgram exchange
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LAG	AC	PAC	Q	Prob>Q	-1 0 1 [Autocorrelation]	-1 0 1 [Partial Autocor]
1	0.8105	1.1644	25.676	0.0000		
2	0.5764	-0.7400	39.044	0.0000		
3	0.3974	1.2532	45.591	0.0000		
4	0.3130	-0.0799	49.778	0.0000		
5	0.2869	2.1266	53.41	0.0000		
6	0.2520	-0.7778	56.306	0.0000		
7	0.2129	1.2592	58.444	0.0000		
8	0.1827	1.1441	60.074	0.0000		
9	0.1452	-0.4307	61.143	0.0000		
10	0.1022	-0.3918	61.692	0.0000		
11	0.0625	3.6770	61.906	0.0000		
12	0.0217	1.8922	61.933	0.0000		
13	-0.0180	8.3960	61.952	0.0000		
14	-0.0519	3.5952	62.119	0.0000		
15	-0.0903	2.5310	62.65	0.0000		
16	-0.1258	-22.3924	63.732	0.0000		

Figure 0.9 Correlogram for real exchange

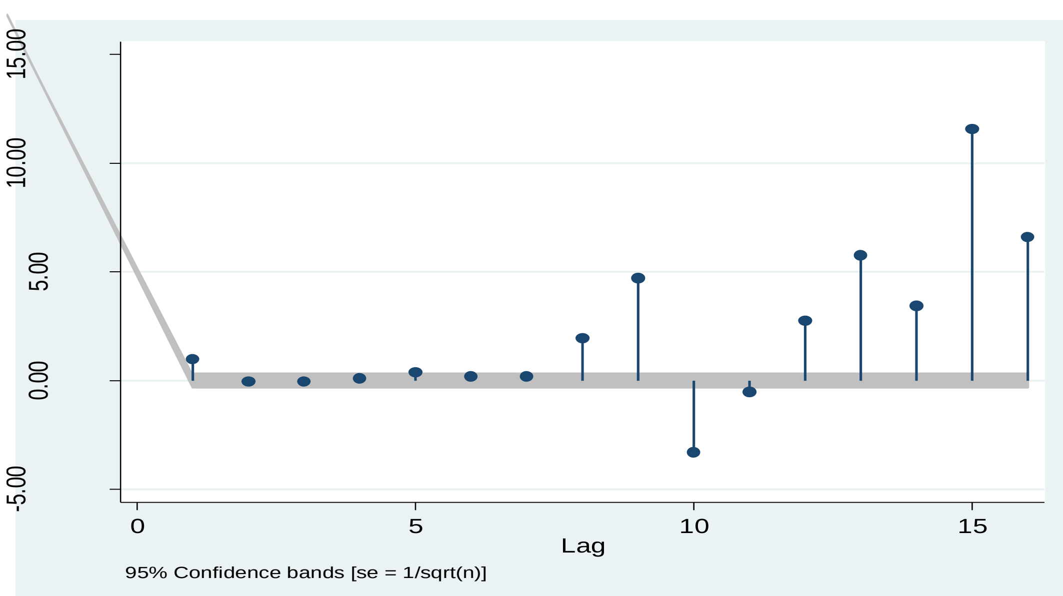

Figure 4.10 PACF for labour

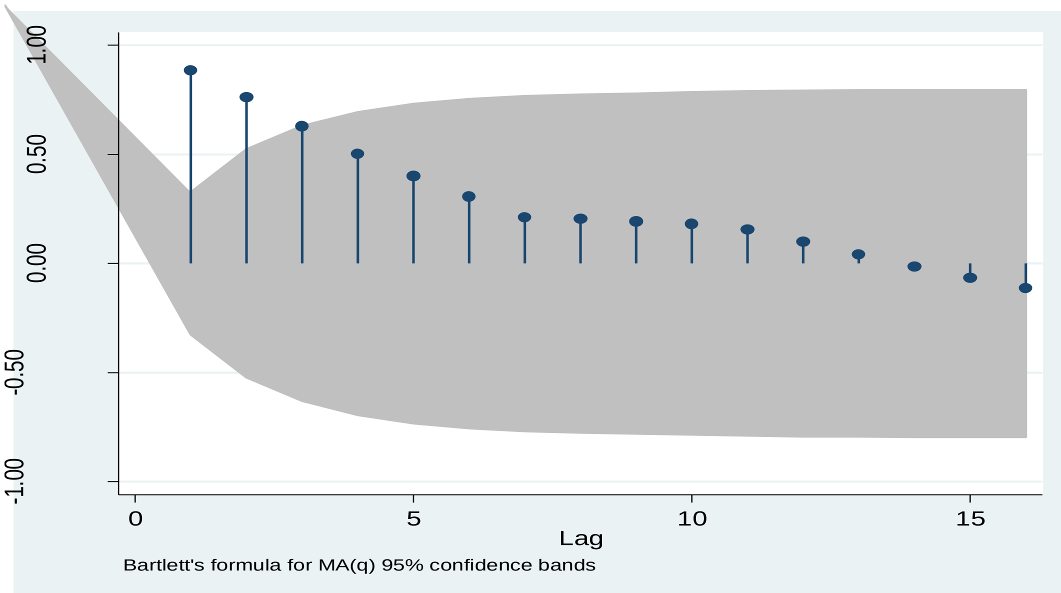

Figure 4.11 ACF for labour

Testing the residuals shows that there is no serial correlation between the independent variables and the Durbin Watson test concurs with the Breusch Godfrey test.

Table 0.2 Breausch Godfrey Test

Lags	**Chi2**	**df**	**Prob> Chi**
1	1.239	1	0.2657

Durbin Watson test: Durbin –Watson d-statistic (7, 30) = 1.63

4.2 Test for stationarity

The study compared the findings from an Augmented Dickey fuller test to test for stationarity. Stationarity condition assumes that the variance of Ut tends to a limiting value (Constance variance) rather than increasing without limit as time t gets large (Edriss). These methods were chosen because of presence of serial auto correlation.

Table 0.3 Augmented Dickey Fuller test

Variable	T-statistic	95% critical value	P-value	Difference	95%critical value	P-value	I(0)
Rainfall	-6.721	-2.972	0.000				(0)
Subsidy	-0.971	-2.972	0.7637				(0)
inflation	-3.431	-2.975	0.0099				(0)
Labour	-0.195	-2.972	0.9392	-5.468	-2.975	0.000	(1)
Exchange rate	3.844	-2.972	1.000	-4.470	-2.980	0.0002	(2)
Value added	-1.778	-2.972	0.3912	-8.988	-2.975	0.000	(1)
Research	-2.522	-2.989	0.1102	-8.513	-2.992	0.000	(1)

4.3 Choice of Lags to fit in the model

The Model compared Akaike Information criterion and the Schwartz Bayesian criterion to specify the number of lags that best fit to the data. Both the criterion adds lags in a regression until they add little explanatory power relative to the statistical “cost” of reducing degrees of freedom. From the table it indicates that the optimal number of lags that fit the data is 3.

Table 0.4 Lag selection

lag	DF	p	AIC	SBIC
0			10.3764	10.6485
1	1	0.002	10.1407	10.4582
2	1	0.514	9.9374	10.3455
3	1	0.001	9.8897*	10.2525*

4.4 Results from the Auto Regressive Distributed Lag model

The table 4.5 shows the relationship between the exogenous and endogenous variables. The study found out that in the short run an increase in the rainfall above the normal average by 1 percent will decrease productivity by about 0.55 percent; however the long run relationship is not significant. In the short run a devaluation of Malawi Kwacha against the dollar by 1 percent will not have a significant effect on agricultural productivity, however in the long run a devaluation of Kwacha against the dollar by 1 percent will decrease agricultural productivity by 0.42 percent.This is because in the short run producers cannot adjust fully however in the long run factors of production can be altered.

Another variable that is significant in the long run is expenditure to agricultural research, an increase in agricultural expenditure will increase productivity by 0.55 percent. This conquers with theories of technology absorption. In the short run an increase in inflation will increase agricultural productivity by 0.15 because an increase in the prices will make the producers to produce more percent however there is no significance in the long run because all the cost of production. These findings concur with findings of many researchers such as Brownson et al (2012) and Block (1994)

Table 0.5 Results from Model Estimation

	coefficient	**Standard error**	**Z value**	**P.value**
Value added				
L1.	-0.457	0.2401	-1.91	0.086
L2.	0.222	0.2520	0.09	0.931
L3	-0.467	0.3021	0.5	0.880
Research	0.056	0.111	0.49	0.637
L1	0.174	0.122	1.43	0.185
L2	0.550	0.2023	2.73	0.022
L3	0.522	0.1835	2.85	0.017
Rainfall	-0.5416	0.1829	-2.96	0.014
L1	0.844	0.1366	0.40	0.698
L2	-0.437	0.1845	-0.24	0.817
L3	0.068	0.1431	-0.47	0.649
Exchange	0.3042	0.1862	1.63	0.135
L1	0.244	0.1516	1.61	0.138
L2	-0.428	0.1545	-2.74	0.021
L3	0.2486	0.1387	1.79	0.103
Inflation	0.1545	0.067	2.28	0.044
L1	-0.122	0.1211	-1.01	0.334
L2	0.2130	0.1263	-1.36	0.202
L3	0.1573	0.1158	0.69	0.120
Labour	2.50	1.52	-1.64	0.129
L1	0.9815	1.52	-0.65	0.527
L2	-0.274	1.47	-0.19	0.855
L3	0.5101	1.525	0.33	0.744
subsidy	-0.9064	0.388	-0.23	0.000
L1	0.926	0.2046	0.45	0.157
L2	-0.3424	0.1940	-1.76	0.105
L3	-0.0903	0.1976	-0.46	0.656

CONCLUSIONS AND RECOMMENDATIONS

In this chapter, there is a summary of the results from the study and recommendations to various stakeholders.

5.1 Conclusions

This study was conducted to determine the effect of Labour, inflation, real exchange rate, rainfall, research expenditure and subsidy on agricultural productivity in Malawi. The study used time series data from1980-2015 and Autoregressive Distributed lag Model was applied. The study found out that in the short run an increase in the rainfall above the normal average by 1 percent will decrease productivity by about 0.55 percent; however the long run relationship is not significant. In the short run a devaluation of Malawi Kwacha against the dollar by 1 percent will not have a significant effect on agricultural productivity, however in the long run a devaluation of Kwacha against the dollar by 1 percent will decrease agricultural productivity by 0.42 percent. This is because in the short run producers cannot adjust fully however in the long run factors of production can be altered.

Another variable that is significant in the long run is expenditure to agricultural research, an increase in agricultural expenditure will increase productivity by 0.55 percent. This conquers with theories of technology absorption. In the short run an increase in inflation will increase agricultural productivity by 0.15 percent however there is no significance in the long run.

5.2 Recommendations

Based on the results from this study, several recommendations have been made to various stakeholders in agriculture

Firstly, the government and the NGOs should increase research expenditure either through Department of Agricultural Research Services (DARS) under Ministry of Agriculture, Irrigation and Water Development or direct to researchers in academic institutions such as LUANAR and University of Malawi. Research increases the availability of technologies which farmers can use to improve agricultural productivity.

Secondly the government should implement effective policies to manage inflation and devaluation of Kwacha for example through diversifying export base to increase volume of exports which will in turn strengthen Malawi kwacha against the dollar. This recommendation takes into consideration factors that affect devaluation however the researcher understands that exports diversification can influence devaluation and vice versa. There has been an ongoing debate on whether devaluation is good for countries like Malawi; devaluation of Kwacha affects productivity in two ways as depicted in the findings the increase the output prices in the local currencies hence motivate the producers to increase productivity however for an import dependent country this means an increase in the cost of production and this reduces the agricultural productivity.

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APPENDICES

Appendice A: Summary descriptive

Variable	Obs	Mean	Std. Dev.	Min	Max
labour	36	78.31389	4.486434	69.9	83
inflation	35	20.37797	14.62607	7.411591	83.32578
exchange	36	95.11282	146.4355	.8120957	564.9076
valueadded	36	361.33	73.91916	211.9829	463.456
research	30	1.16	.399655	.6	1.9
subsiddy	36	.5	.5070926	0	1
rainfall	36	857.7427	121.1997	611.192	1138.107

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. list year exchange research inflation in 21/36
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	year	exchange	research	inflat~n
21.	2000	59.5438	.9	29.5815
22.	2001	72.1973	1	22.7
23.	2002	76.6866	.8	14.7446
24.	2003	97.4325	.7	9.5768
25.	2004	108.898	.7	11.4298
26.	2005	118.42	.8	15.4103
27.	2006	136.014	.7	13.9743
28.	2007	139.957	.7	7.95221
29.	2008	140.523	.6	8.7126
30.	2009	165.345	.8	8.42204
31.	2010	167.435	.9	7.41159
32.	2011	163.55	.	7.62282
33.	2012	268.485	.	21.2713
34.	2013	431.268	.	27.2833
35.	2014	552.467	.	23.7921
36.	2015	564.908	.	21.8691

Breusch-Godfrey LM test for autocorrelation

lags(*p*)	chi2	df	Prob > chi2
1	1.239	1	0.2657

H0: no serial correlation

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. estat dwatson

Durbin-Watson d-statistic(  7,    30) =  1.633992
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Labour results

Dickey-Fuller test for unit root   Number of obs = 35

	Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value
		Interpolated Dickey-Fuller		
Z(t)	-0.172	-3.682	-2.972	-2.618

MacKinnon approximate p-value for Z(t) = 0.9418

Dickey-Fuller test for unit root   Number of obs = 34

	Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value
		Interpolated Dickey-Fuller		
Z(t)	-5.481	-3.689	-2.975	-2.619

MacKinnon approximate p-value for Z(t) = 0.0000

Inflation

Dickey-Fuller test for unit root   Number of obs = 34

	Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value
		Interpolated Dickey-Fuller		
Z(t)	-3.023	-3.689	-2.975	-2.619

MacKinnon approximate p-value for Z(t) = 0.0328

Exchange rate

Dickey-Fuller test for unit root — Number of obs = 35

	Test Statistic	Interpolated Dickey-Fuller 1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-0.048	-3.682	-2.972	-2.618

MacKinnon approximate p-value for Z(t) = 0.9544

Dickey-Fuller test for unit root — Number of obs = 34

	Test Statistic	Interpolated Dickey-Fuller 1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-4.064	-3.689	-2.975	-2.619

MacKinnon approximate p-value for Z(t) = 0.0011

Value added

Dickey-Fuller test for unit root — Number of obs = 35

	Test Statistic	Interpolated Dickey-Fuller 1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-2.025	-3.682	-2.972	-2.618

MacKinnon approximate p-value for Z(t) = 0.2757

Dickey-Fuller test for unit root Number of obs = 34

	Test Statistic	Interpolated Dickey-Fuller 1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-10.755	-3.689	-2.975	-2.619

MacKinnon approximate p-value for Z(t) = 0.0000

Research

Dickey-Fuller test for unit root Number of obs = 29

	Test Statistic	Interpolated Dickey-Fuller 1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-2.287	-3.723	-2.989	-2.625

MacKinnon approximate p-value for Z(t) = 0.1762

Dickey-Fuller test for unit root Number of obs = 28

	Test Statistic	Interpolated Dickey-Fuller 1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-8.500	-3.730	-2.992	-2.626

MacKinnon approximate p-value for Z(t) = 0.0000

Subsidy

Dickey-Fuller test for unit root Number of obs = 34

	Test Statistic	Interpolated Dickey-Fuller 1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-5.831	-3.689	-2.975	-2.619

MacKinnon approximate p-value for Z(t) = 0.0000

Rainfall

Dickey-Fuller test for unit root Number of obs = 35

	Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value
		Interpolated Dickey-Fuller		
Z(t)	-6.743	-3.682	-2.972	-2.618

MacKinnon approximate p-value for Z(t) = 0.0000

valuadedlog2	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
valuadedlog2						
L1.	-.4578493	.2401856	-1.91	0.086	-.9930163	.0773177
L2.	.0222594	.2520687	0.09	0.931	-.5393848	.5839035
L3.	-.0467021	.3021418	-0.15	0.880	-.7199159	.6265117
researchlog2						
--.	.0545276	.1119711	0.49	0.637	-.1949596	.3040148
L1.	.1743676	.1223301	1.43	0.185	-.0982009	.4469361
L2.	.5506485	.2023509	2.72	0.022	.0997826	1.001514
L3.	.5228674	.1835431	2.85	0.017	.1139078	.931827
rainfalllog						
--.	-.5416222	.1829194	-2.96	0.014	-.9491921	-.1340523
L1.	.0544797	.136601	0.40	0.698	-.2498863	.3588457
L2.	-.0437933	.1845385	-0.24	0.817	-.4549706	.367384
L3.	-.0680111	.145101	-0.47	0.649	-.3913163	.255294
exchangelog2						
--.	.3042243	.1862248	1.63	0.133	-.1107104	.719159
L1.	.2443716	.1516038	1.61	0.138	-.0934227	.582166
L2.	-.423862	.1545097	-2.74	0.021	-.7681312	-.0795929
L3.	.248673	.1387156	1.79	0.103	-.0604045	.5577506
_cons	4.026772	2.107898	1.91	0.085	-.6699177	8.723462

valuadedlog2	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
valuadedlog2						
L1.	-.6252354	.3330034	-1.88	0.087	-1.358171	.1077002
L2.	-.0912967	.4092113	-0.22	0.828	-.9919648	.8093714
L3.	.1370136	.522055	0.26	0.798	-1.012022	1.286049
L4.	.0529265	.5474725	0.10	0.925	-1.152052	1.257905
inflationlog						
--.	.154554	.0678383	2.28	0.044	.0052429	.3038651
L1.	-.1223687	.1211201	-1.01	0.334	-.3889522	.1442147
L2.	.2130156	.1263072	1.69	0.120	-.0649846	.4910158
L3.	-.1573256	.1158225	-1.36	0.202	-.4122491	.0975979
L4.	.0850607	.0792083	1.07	0.306	-.0892755	.259397
labourlog2						
--.	-2.506849	1.525577	-1.64	0.129	-5.86462	.8509229
L1.	-.9815554	1.50145	-0.65	0.527	-4.286224	2.323113
L2.	-.274925	1.470242	-0.19	0.855	-3.510905	2.961055
L3.	.5101635	1.525653	0.33	0.744	-2.847777	3.868104
L4.	-1.007802	1.493552	-0.67	0.514	-4.295087	2.279483
subsidy						
--.	-.090647	.388231	-0.23	0.820	-.9451376	.7638437
L1.	.0926997	.2046415	0.45	0.659	-.3577133	.5431127
L2.	-.3424961	.1940645	-1.76	0.105	-.7696293	.084637
L3.	-.0903984	.1976578	-0.46	0.656	-.5254403	.3446435
L4.	.0412684	.1826121	0.23	0.825	-.3606583	.443195
_cons	-.4909026	.3075951	-1.60	0.139	-1.167915	.1861096