THE IMPACT OF GOVERNMENT SUBSIDIES ON MAIZE OUTPUT IN ZIMBABWE (1985-2017)

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SUBMITTED BY
B1544635

A DISSERTATION SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS OF THE BACHELOR OF SCIENCE (HONOURS) DEGREE IN ECONOMICS OF BINDURA UNIVERSITY OF SCIENCE EDUCATION

APRIL 2019
## RELEASE FORM

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DEDICATION

I dedicate this project to my husband Wilson Mareya who has been a pillar of support in my endeavours, to my father and my brothers. I love you all.
ABSTRACT

This research empirically examined the impact of government subsidies on maize output in Zimbabwe using annual time series data spanning 1985 to 2017. The study uses time series data which was collected from ZIMSTAT and FAO and the researcher used Eviews 7 software for data analysis. The variables considered to affect maize output by the researcher in this research were: Government Subsidies (GS), Average Rainfall (AR), Land Used (LU) and Labour Employed (LE). Ordinary Least Squares method and secondary data were used in this research. Government subsidies and average rainfall variables were not significant in explaining maize output. A negative relationship was established between land used and maize output. Labour employed had a positive relationship with maize output. Both land used and labour were found to be significant in explaining the variations in maize output. The study went on to suggest possible recommendations which the government can adopt to induce an increase in output and these recommendations include investing in research and development, improve on good governance and focus more on accountability and transparency; and the government should eliminate dependency syndrome of communal farmers.
ACKNOWLEDGEMENTS

My profound gratitude goes to my husband and family for their unwavering support in making this study a success. The motivation and love they rendered is what made this dissertation a success. Above all they gave me encouragement to persevere in difficult and challenging times. I feel obliged to my supervisor Mr Chigusiwa who was very supportive and cooperative during the course of the dissertation, his critical comments and insight were profound. May the Almighty bless you abundantly.

Above all I would like to thank God, my Father for crowning my efforts with success, for keeping me on my feet even when it seemed practically impossible. If it wasn’t for you, I would have succumbed to the pressure. You Lord take all the GLORY for the GRACE you have shown me surpasses all understanding.
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<tr>
<td>ADF</td>
<td>Augmented Dickey Fuller</td>
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<td>CSO</td>
<td>Central Statistics Office</td>
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<td>ECM</td>
<td>Error Correction Model</td>
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<td>FAO</td>
<td>Food and Agricultural Organisation</td>
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<td>FIN GAZ</td>
<td>the Financial Gazette</td>
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<td>GS</td>
<td>Government Subsidies</td>
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<td>IMF</td>
<td>International Monetary Fund</td>
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<td>MOA</td>
<td>Ministry of Agriculture</td>
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<td>OLS</td>
<td>Ordinary Least Squares</td>
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<td>SADC</td>
<td>Southern African Development Community</td>
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<td>WB</td>
<td>World Bank</td>
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<td>ZIMACE</td>
<td>Zimbabwe Agriculture Commodity Exchange</td>
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<td>ZIMSTAT</td>
<td>Zimbabwe National Statistics Agent</td>
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CHAPTER 1

INTRODUCTION

1.1 Introduction

In Zimbabwe agriculture is regarded as the backbone of the economy. The sector employs about 70 percent of the national labour force even though its contribution on gross domestic product (GDP) is low (FAO, 2015). The country has vast fertile and arable land, climate and the rainfall patterns are also favourable for crop production (Sithole 2006). Maize production is strategic to food and national security in most African countries and with Zimbabwe once being the largest producer of the grain, other SADAC countries appointed the country as the chief of food security in 1980. There are many reasons behind low productivity of maize such as inadequate institutional support, political instability, diverse agro ecological complexities, low fertilizer use, and the limited availability of suitable high-yielding varieties (Glenn et al 2009). Agricultural subsidies have been promoted as a way to improve productivity and guard against food insecurity (Malhotra 2015). Accordingly, this study wishes to examine the relationship between government agricultural subsidies and maize production.

1.1 Background of the study

Since independence agriculture has been the biggest sector in Zimbabwe with maize being the largely produced crop and the country was referred to as an agriculture-based economy (Patrick, 2006). In the 1980’s maize production was steady as it was actually produced in excess compared to the population in the country since most farmers scrambled for the production of the staple crop and the rains were good. In 1993 maize seed and fertiliser subsidies in form of cheap credit were given to large scale farmers so as boost maize production. This was because the country was in dire need of drought relief measures as the country had suffered crippling drought in the previous year (ZIMSTAT 2011/12). Maize yields of commercial farms were mostly more than double compared to yields from both communal lands and resettlement areas in the 1990’s. Few farmers in rural areas were also given seeds and fertiliser by the government so as to promote food self-sufficiency and sell excess to the Grain Marketing Board (GMB). These subsidies nevertheless resulted in short-lived maize based green revolutions, which is an increase in the maize crop production in developing
countries by the use of artificial fertilisers and pesticides (Glenn et al 2009). Farmers experienced gains in maize productivity but the positive results from the seed and fertilizer subsidies were short-lived, and productivity stagnated.

Furthermore, the Zimbabwean government tried to address the imbalances created by colonisation through land reform programme which was introduced in 2000, maize production drastically declined and food security was threatened in the country. Black native Zimbabweans took over farms and everything owned by white farmers, for example, machinery, agriculture produce and other properties on the farms. They however could not fill the agricultural gap since they took over because of lack of will and technical knowhow in farming. There was no proper planning on part of the government which resulted in chaotic grabbing of land which disrupted farm activities and resulted in decline crop production (Sithole 2006). The outcome was a steady decrease in maize yields as shown by the graph below.

Figure 1: Maize yields in tonnes from 1995 to 2010, Zimbabwe

As illustrated by the graph above, in 1996 maize production was high and there was a sharp decline in production between 1997 and 1998 as many commercial farmers were shifting from maize production. As the diagram indicates, it is from that period that maize production started to fluctuate unpredictably. The linear trend line denotes an overall decrease in maize production. This was because of reasons such as lack of technical knowhow, improper redistribution, and politics (Sachikonye 2004). The then commercial farmers produced less
maize than before and the quantity in the granaries of the country declined. The country was once the breadbasket of the whole of Southern Africa and used to export large quantities of maize to other countries. However, tables turned around as Zimbabwe needs to fill its basket sourcing from outside (Fin Gaz 2013).

The land issue erupted racial tensions in post-2000 and the international community imposed sanctions against Zimbabwe and it worsened the situation as financial aid from the western countries was blocked (Meredith et al 2010). The Zimbabwean government in 2005 to 2006 came up with Operation Taguta/Sisuthi which was an agriculture subsidy aimed at improving maize production (Ministry of agriculture 2010). The army was given the task of tilling large amounts of land and use maize seed and fertiliser provided by the government. The operation was not successful and the government decided to come up with yet another subsidy programme in the following agricultural season called Mechanisation Scheme. Once again, the scheme pathetically failed as a result of alleged corruption as resources were distributed largely on political basis (Sachikonye 2004). The food security crisis further worsened in 2008 due to hyperinflation and liquidity crunches which resulted in commercial, communal and resettlement farmers not being able to afford agriculture inputs like maize seed and fertilisers.

Statistics from ZIMSTAT (2012) show that commercial farmers used to contribute about 49.8 percent to the national maize output between 1993 and 1999. However, the output contributed by commercial farmers in 2011 had fallen to 15.7 percent. Many commercial farmers shifted from maize production to the production of more cash crops such as tobacco. The bulk of Zimbabwe’s maize production was now being produced by communal farmers who contributed 39.6 percent in 2011. This resulted in maize production failing to keep pace with the ever growing population (poverty atlas 2015).

FAO (2017) reported that maize production increased significantly to above average level in Zimbabwe during the agricultural period 2016-2017, hence food security situation also improved. Maize production levels were 2.1 million tonnes, with an increase of 83 percent comparing with the previous year. This was largely due to the support from the government Command Agriculture Scheme to large scale farmers and Presidential Input Support Scheme that targeted small scale farmers. The country’s maize importation was reduced by less than half compared to 2016 when the country imported at least 1 million tonnes of maize so as to cover for the shortfall. However, the increase in maize production does not imply total food security as there are still some households which are food insecure. ZIMACE reported that at
least one percent of rural households were food insecure in 2017. ZIMSTAT (2017) suggested that government should let agricultural aid occupy a permanent position in its planning so as to eliminate food insecurity.

1.2 Statement of the problem

Zimbabwe has been experiencing food shortages for the past few decades due to a decline in maize grain production. Total maize produced does not meet the county’s requirements for consumption. It is not always when the government gives out agricultural subsidy that production levels increase taking for instance the 2006 Operation Taguta. Some institutions in Zimbabwe such as ZIMSTAT are of the view that the government should have provision for agricultural subsidy on its budget. However, the World Trade Organisation (WTO) points out that too much government support will result in inefficiency. Malhotra (2015) is of the notion that agricultural subsidy programs should consistently yield benefits to farmers and improve food security. Agricultural subsidies can be one of the major determinants of an increase in maize production.

1.3 Objectives of the study

The major objective of this research is to determine the impact of government subsidies on maize output from 1985 to 2017. To achieve this general umbrella objective, the following precise objectives guided the study:

- To show the effect of government agricultural subsidies and maize productivity.
- To determine the relationship between labour and maize output.
- To establish whether rainfall affect maize output.
- To identify other factors which affect maize output in Zimbabwe.

1.4 Research questions

- What is the effect of agricultural subsidies and maize productivity?
- What is the relationship between labour and maize production?
- Does rainfall affect maize output?
- What other factors which affect maize output in Zimbabwe?

1.6 Statement of hypothesis

Increase in government agricultural subsidies results in an increase in maize output in Zimbabwe.
1.7 Significance of the study

Zimbabwe continues to suffer from falling maize production output, staple food shortages and acute poverty despite the efforts made by the government to tackle this challenge (FAO 2012). The findings of this research might be helpful to the government on when structuring the yearly budgets especially on apportionment to agriculture (focusing on maize production). Drafting and implementation of effective agricultural policies can be done with knowledge whether subsidies have any influence on increasing production.

The research will add to the existing pool of knowledge on the concept of maize production and document information on effective ways of maximizing productivity which is of paramount importance for the economy. The research will also inform future researches which can be built on the documented knowledge. The research intends to bring ways to increase maize output both for the purpose of consumption and exportation which ultimately will bring an increased favourable balance of payment (BOP) for the nation. Besides that, this research will also be advantageous to schools (staff and students) and will help them understand the importance of farming no matter how small the scale of production may be. More so, the study will add literature to the contemporary debate in regard to whether economies should subsidise other sectors in the economy.

1.8 Assumptions of the study

- Data collected is accurate, complete, reliable and relevant.
- The sample collected is a true representative of the population.
- There is no spurious relationship.

1.9 Scope of the study

This research focuses on the impact of agricultural subsidies on maize production in Zimbabwe. The research covers the period 1985 to 2017 and the values to be used will be on yearly basis.

1.10 Limitations of the study

There are some constraints encountered by the researcher especially during data collection. These constraints include; limited time, lack of research funding, and political constraints such
as denial of access to data (confidentiality) by some government institutions, thus the researcher had to find alternatives i.e. find institutions which could provide the required data.

Zimbabwean data continues to experience incomplete reporting and this may mean a loss of some of the key interpretations. The researcher however, took this into account whilst selecting data sources and chose the most appropriate data source for the different variables.

1.11 Definition of terms

**Agriculture** - Agriculture is the science, art, or practice of cultivating the soil, producing crops, and raising livestock and in varying degrees the preparation and marketing of the resulting products.

**Government Agricultural Subsidies**: refers to the resources a government allocates to farmers to achieve its strategic objectives and satisfy the needs of the members of the nation. They can be in form of monetary value or agricultural inputs.

1.12 Summary

This chapter gave an overview of the whole study and the researcher introduced the research problem, outlining the necessary details required in order to bring the problem into perspective. It highlighted on the background of the study, problem statement and objectives of the research, research questions, hypothesis, assumptions, limitations, significance of the study, and definition of terms. Chapter two presents both theoretical and empirical literature and chapter three outlines the econometric methodology to be used. Chapter four focuses on data presentation and analysis. Finally, chapter five concludes and outlines policy implications and recommendations.
CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

This chapter contains theoretical and empirical literature which outlines the theories associated with the fundamental study and researches that have been carried out by other researchers on the similar field. This study attempts to explore government subsidies and their impact on maize production in Zimbabwe.

2.1 Theoretical Literature Review

This section highlights some basic theories that have been used to support the impact of government subsidies on maize production in Zimbabwe.

2.1.1 The Cobb-Douglas Production Function

Cobb and Douglas put forward a theory in production which is known as the Cobb-Douglas production function. The function relates output to capital and labour. It abnegates the fact that the relationship between output and the different factors is always linear as other economists assume. In other words, it was a development of older theories which related output to factors in a linear relationship. The theory shows that output is not directly related to the factors of production (capital and labour). Although it has proved to be the best one it however ignores other factors, which may affect production such as technology and weather among others. Therefore, it concentrates on these as if they are the only factors which affect production.

The Cobb-Douglas function takes the following form:

\[ Q = AKL \]

Where \( Q \) is the output

- \( A \) is marginal productivity of factors of production
- \( K \) is capital
- \( L \) is labour
2.1.2 Stochastic Production Function

Just and Pope who made use of an input conditioned output distribution introduced the stochastic production function in 1978 (Gardner & Rausser, 2001). This function allows for random elements associated with production uncertainty to enter the functional relationship and it goes beyond the scope of classical inputs. Aigner, Lovell and Schmidt also used the stochastic production function framework as a process that includes a random element corresponding to inefficiencies in a firm’s technical production as well as predicted elements (Battese, 1997). In such an instance, the function is no longer deterministic or explained within the model but also includes a variable to account for production uncertainty.

In production agriculture, a stochastic production function is used to account for random elements of production: such as, weather, price fluctuations and soil quality. The stochastic set-up also allows certain variables to be treated as deterministic, while incorporating random components (Gardner & Rausser, 2001). Random components or stochastic factors which the farmer cannot control have been analyzed for decades and are of great interest for management and policy decisions (Gardner & Rausser, 2001).

2.1.3 Keynesian model

The Keynesian theory discuss the relationship between public expenditures and economic growth. Keynes was among the most noted with his unmistakably viewpoint on this relation. Keynes regards public expenditures as an exogenous factor which can be utilized as a policy instrument to promote economic growth. From the Keynesian thought, public expenditure can contribute positively by boosting growth through injecting purchasing power into the economy. Hence, an increase in the government consumption is likely to lead to an increase in employment, profitability and investment through multiplier effects on aggregate demand. As a result, government expenditure augments the aggregate demand, which provokes an increased output depending on expenditure multipliers. The work of Keynes is somehow related to this thesis in the sense that increased government expenditure (on agriculture) leads to higher economic growth through increase in production of maize. Since expenditure on agriculture is a component of aggregate expenditure and injection into the circular flow of income, optimal economic performance can be achieved as demand for agriculture inputs increase. The total effect of increase in government expenditure will ultimately result in economic growth through the multiplier effect (liu-chih et al, 2008). Nevertheless, Neo-classical model is of the notion that government expenditure does not have any multiplier effect
on economic growth as postulated by Barro (1990). He emphasized the importance of
government policy in economic growth and that there are some kind of expenditures that are
productive and others that are not.

2.1.4 Leontief model

This is a model whose goal is to predict the proper level of production for several types of
goods and services and it was introduced by Wassily Leontief in the 1930s. Travis M (1980)
postulates that the model explains that the proper level of production can be achieved if two
requirements are fulfilled and these are:

   i. There should enough of each good to meet its demand, and
   ii. There should be no leftovers

Therefore, production should be equal to consumption. The input-output matrix is used so as
to come up with the production vector. The Leontief model assumes that an economy can either
be self-reliant and no goods would enter or leave, or the economy will have to satisfy demand
in or out of its boundaries hence the economy can be referred to as closed or open respectively
(Jones, 1984). The model tests two factors of production which are capital and labour and these
can be used to come up with a paradox of whether a country should import labour or capital-
intensive products.

Leontief’s first study was based on computation from input output tables constructed for
various industries in the U.S. Direct and indirect capital and labour were required to produce a
given dollar value of output. He then calculated the effects on capital and labour use of a given
reduction in both U.S. imports and exports so that the relative commodity composition of
exports and imports remained the same.

He came up with the conclusion that the given value of U.S. exports embodied less capital and
more labour than would be required to expand domestic output to provide an equivalent amount
of competitive imports. Expressed inversely, U.S import replacement industries required more
capital relative to labour than did U.S export industries (Jones, 1984). The Leontief conclusion
that in the international division of labour, the U.S specialized in labour intensive rather than
capital intensive goods. This theory applies to the study as maize output can also be largely
determined by labour and capital.
2.1.5 Wagner’s law

Wagner’s law is the model of public expenditure in the area of public finance. The theory was introduced by Adolph Wagner in 1883. It states that during the process of economic development the share of public spending in national income tends to expand (Cosimo et al, 2015). The theory shows that funds for government rides on the public tax so as to generate revenue and sustain the increase in spending. He postulate that the development of modern industrial society would give rise to increasing political pressure for social progress, the rise in public expenditure will be more than proportional increase in the national income and that the expansion of the functions of the state leads to an increase in public expenditure on administration and regulation of the economy.

Wagner pointed out that public spending is an endogenous factor, which is determined by the growth of national income and national income causes public expenditure. Wagner identified three reasons why an increase in public expenditure is needed which are; social activities of the state; administrative and protective actions and welfare functions. This theory can also be used to justify the role of government subsidies and their contribution on maize output as the subsidies are financed by state funds.

2.1.6 Solow’s long-run growth model

The model highlights that investment; savings and population are more important determinants of economic growth. The Solow model of economic growth postulates a continuous production function linking output and inputs of capital and labour which led to the steady equilibrium of the economy. The three major inputs to this model are capital, labour and technology, and the major driving force of economic growth is effectiveness of labour and technological change. The output produced in the economy is determined with these three variables as argued by Solow-Swan (1956). The model is based on the following assumptions; one composite commodity is produced and that output is regarded net output after making allowance for the depreciation of capital. He argued that the exogenous variables determine the steady-state level of income per capita because population growth rate and savings vary across countries. Ever since the appearance of Solow’s long-run growth model, economic growth models have emphasized the importance of human capital in the economic growth of countries (Romer, 1992). A country’s output depends on its human capital, which is determined endogenously, and “knowledge” is a public good which spreads over the economy as an externality (Romer,
1992). This model relates to this paper in the sense that human capital is mainly put to use in the agricultural sector as mechanization is unattainable to most small-scale farmers, especially those in rural areas and they represent a large margin. Land and capital can be viewed as substitutes in the classical sense because sometimes what capital can do labour can attain the same results and an increase in labour may lead to a rise in production.

2.1.7 The Walrasian model

Current status of agricultural production has not met the need of the ever increasing cost of production by inflating prices (Braun, 2008). Food prices have been escalating in Africa generally since food expenditure constitutes a larger share in the basket of consumer prices. As agriculture has a number of interdependent activities which may affect the rest of the economy, it is therefore important to take note of inflation on the agricultural sector. The Walrasian model is based on a simple situation of a closed economy of general equilibrium theorists. Considering for instance a special case where inflation means that all prices (both output and inputs) increase by the same proportion, for example, 5 percent. In this case the Walrasian general equilibrium model would predict no real changes because there have been no real changes in relative prices. The demand function for each product is assumed to be homogeneous of degree zero so that a percentage increase in all commodity prices and income (which is based on factor prices that have also increased by 5 percent) has no effect on the number of units of demand.

Similarly, the supply function is assumed to be homogeneous of degree zero in output and input prices. All prices would therefore increase by 5 per cent and quantity of commodities produced and purchased would remain unchanged. However, inflation itself may have real effects. “Conceptually, the income redistribution, real balance, uncertainty and expectations generating effects of inflation affects both the aggregate level of real expenditure and the composition of that expenditure. This is because of the low-income elasticity of demand for food and the effect of this qualification will be small” Braun (2008). The Walrasian model assumes instantaneous adjustments to all prices. Resulting from leads and lags in the economic system, rarely does inflation mean that all prices would move proportionally during the short period. Extending the Walrasian model to include different lags in price adjustments will mean that inflation will have some short run income distribution effects.
2.1.8 The Agro-ecological model

This can also be referred to as the climatic change model. Agro-climatic conditions mainly imply soil conditions and weather factors including rainfall, temperature and humidity (Heerink and Herman, 2001). In the previous five decades, human activity has altered ecosystems more rapidly and extensively than in any comparable period in the history of mankind, largely to meet the demand for food, fresh water, fuel and other industrial raw materials (FAOSTAT, 2006).

Climate change impacts include the increased atmospheric pollution, increased intensity and frequency of storms, rise in sea level, altered rainfall amounts and distribution, altered hydrological cycles, rising temperatures, desertification, decline of mountain glaciers and snow cover, Arctic warming, persistent droughts and flooding (FAOSTAT 2006). Generally, the impacts of global climatic change on agricultural crop productions include alteration of crop type and variety, reduction of soil moisture, increased evaporation and evapotranspiration, alteration of plant growth stages, reduced periods of grain filling, yield reductions, effects on partitioning and quality of plant biomass, and finally spatial shifts of agricultural potential (Mearns, 1995).

Zimbabwe is already experiencing what scientists explain as the extensive impacts of climate change; persistent food problems as a result of decreased yields, increased water problems, declines in soil fertility, changes in plant diversity which includes indigenous foods and plant-based medicines. The major climatic factors affecting maize production in Zimbabwe include rainfall, temperature, day length, solar radiation, and humidity (Ministry of agriculture 2010).

2.2 Empirical literature review

With the growing populations in most countries and worsening food shortages more researches concerning maize production have been carried out in most countries and they have yielded mixed results. Some authors agree that government subsidies stimulate maize production while others take a different path. This section will provide a review of some of the empirical literature as provided below:

Yasin (1997) studied the relationship between government agricultural expenditure and agricultural output for the period 1987 to 1997 of 26 sub-sub-Saharan African countries using panel data. He used the neo-classical production function and his analysis shows
that government expenditure has a positive and progressive effects on the agricultural output of the nations under study. The same study was also carried by Francis (2013) when he examined the impacts of federal expenditure to agricultural output. The study was carried out using simple regression method and time series data was used. From his study Francis concluded that government should support its fiscal allowances to agricultural sector since there is a positive relationship between government expenditure and agricultural output.

Nyoro (2005) stipulated that high production costs of maize cause a sharp fall in maize produced and this is the case in most developing countries. Production costs can be reduced and maize yield may increase per unit area by increasing technical efficiency. He was of the idea that agricultural subsidies given in form of credit are necessary to encourage technical innovations such as use of yield enhancing input-output relationship. However, small farm producers tend to be unresponsive to economical technical innovations due to reasons such as liquidity constrains and risk attitudes. Risk averse farmers are likely to prefer traditional technologies that may promise a higher yield on average with lower variance to new technologies that may bring about a higher average yield but also present the risk of greater variance (Todaro, 1997). Uncertainty in repayment and high interest rates can cause farmers to be risk averse. He concluded that increased input use (seed and fertiliser) and the farmer’s characteristics impact yield across and within regions.

A study which was done by Oboh (2008) in Benue State using the error correlation model to investigate famers’ allocative behaviour in subsidy utilisation. The study uses time series data and the results reveals that the usefulness of any agricultural subsidy programme does not only depend on its availability, affordability and accessibility. He argues that the usefulness largely depends on its proper and efficient allocation and use for its purposes.

Mir Kalan Shah (2008) studied the impact of government agricultural subsidies on maize productivity and income of farmers in mountainous agriculture in northern Pakistan. He considered rainfall patterns and space used for cultivation as other variables which influence maize production. They used secondary data which was analysed using the OLS method. Simple data analysis techniques like the t-test, frequency distribution and cross-distribution were used and the results shows that there is a significant and positive relationship between subsidies given to famers and agricultural output.
Glenn *et al* (2009) studied how input subsidies improve smallholder maize productivity and they associated it with achieving a green revolution in Africa. They also investigated the relationship between agricultural productivity improvements and economic prosperity together with social development. They argued that sub-Saharan Africa agricultural productivity has not been able to fully provide for its ever growing population. The World Bank had argued for the abolishment of state-led interventions such as subsidies and this caused input prices to rise sharply and small scale farmers were the most affected. Food insecurity increased among many rural households. They realised the importance of state supported subsidies, rural credit and improvement of infrastructure as they greatly contribute to productivity growth of maize.

Chumo (2013) looked at determining factors that affect maize production in Kenya. With the adoption of the Cobb-Douglas production function, his research represented an output-input relationship. Descriptive and inferential method was used to analyse data. He look at the variables agricultural subsidies, rainfall, drought, labour and market price of maize. The final decision on the research was that government should address lack of incentives for farming by improving subsidies available to farmers, create better infrastructures for maize sellers and provide a strategy for combating drought.

Malhotra (2015) conducted a research on food security through agricultural input subsidy focusing on its impact on female headed households in Tanzania. Using pooled data of two years across eight different regions in the country the theory of change was used to illustrate the logic of the research and show parameters which were to be used. Evidence clearly showed that the use of fertilisers in particular was positively correlated to household food security and this proved subsidies to be important in the betterment of production. Since he used two groups which are the beneficiaries and non-beneficiaries, he realised that female heads of households who were part of the beneficiary group preferred to spend more on other aspects such as education, birth control and family planning as they are more food secure and can consume more meals on average. However, the female headed households of non-beneficiaries lack food self-sufficiency therefore preferred to spend more on food.

The impact of government subsidies on agricultural output was also studied by Abbas Ali Chandio (2016) for the economy of Pakistan over the period of 1983 to 2011. He used time series data and applied ADF unit root test, Johansen Co-Ordinary Least Squares technique as analytical tools. From the study, the results of Johansen co-integration showed that there is a long-run relationship between government subsidies and agricultural output. They
recommended that the government of Pakistan should increase its spending on agricultural sector since they found that the sector has some challenges which are limiting the overall output which should be produced in the agricultural sector.

A case study conducted in Uganda by Food and Agriculture Organisation on fertiliser use by crop ascertained that use of improved agricultural technology remains low even when most farmers may be aware of the potential increase in yields due to the inputs used. However, high yield may not guarantee increased adoption, especially for the poor farmers when the cost of these inputs is relatively high compared to the farmers’ basic needs may be relatively high. Thus the economic returns from use of these inputs are more important than yield (FAO, 2006).

Ragasa and Mazunda (2018) carried out a research on the impact of extension services as a complement to input subsidies in boosting production and food security in Malawi. Malawi introduced a program called Food Insecurity Response Program in 2005 and the government spent fifty two percent of its budget on agricultural subsidies that year. The authors noted that despite receiving heavy subsidies in form of fertilizers and maize seed the country still suffers from food shortages. They also looked at how best agricultural services can help farmers to be able to produce what is required by the nation and even produce in excess. The authors noticed that subsidies only induced a rise in production at the beginning. Their research highlighted that without robust complementary services for farmers such as training in effective management practices, climate resilience and markets, subsidized agriculture inputs will not help to improve much productivity. They used a Cobb Douglas growth model which includes subsidies to agriculture, consumer price index, annual average rainfall, population growth rate, and food importation. Their results showed that there is a negative and significant relationship between subsidies to agriculture and agricultural output.

Ntege et al conducted a research entitled: An assessment of factors affecting adoption of maize production technologies in Inga District, Uganda 1997. Data from formal and informal farm surveys as well as secondary data were analysed in the study. Logistic regression model was used to analyse data. Results of the logistic regression model revealed that use of hired labour, membership in farmer group education and land tenure all had statistically significant effects on the adoption of technology. They further provided evidence that strongly suggested that literacy is a strong determinant of farmers’ adoption of improved technologies.
Mashingaidze (2005) carried out a research on maize and development in Zimbabwe. He argued that the key factor of increasing maize yields is engaging in researches which aim at improving maize hybrids which are suitable for both high rainfall and low rainfall regions in Zimbabwe. He was of the opinion that government should rather spend more on research and development as it results in sustainable solutions. His findings were that the adoption of high yielding technology complemented by availability of inputs, support services and credit can do wonders by increasing production of maize. His conclusion was that subsidies and food aid alone cannot solve the problem of food security.

Shiferaw et al (2007) in a study entitled coping better with current climatic variability in the rain-fed farming systems of sub-Saharan Africa alluded that “investment in rain-fed farming systems is essential if chronic food shortages and poverty are to be reduced and progress towards the Millennium Development Goals of any country”. In their study they recommended that in dry seasons farmers must use low plant density per square meter, reduce inputs, increase use of drought tolerant crops such as sorghum and millet, plough and plant early before the start of the rains, adopt water conservation measures and reduce area under cultivation. Similarly, in normal to wet seasons farmers must use higher plant density per square meter, apply fertilizer, plant hybrid maize varieties such as pioneer, adopt intercropping and increase area under cultivation

Eboh, et al (2012) studied factors which drive the Nigerian’s agricultural development. They anticipated an agricultural production function for Nigeria based on the Cobb-Douglas model. They also estimated an econometric model of total factor productivity. The study pointed out that Nigerian agricultural sector is comprised of increasing returns to scale and this implies that farmers work at the low end of the production function. The relatively more significant factors that were useful in manipulating Nigeria’s agricultural value addition include rainfall, technology, fertilizer use and land area. Capital expenditure on agriculture, price of agricultural commodities, per capita income and investment rate in agriculture, human capital and access to credit are activist influences on total factor productivity.

Ibitoye and Shaibu (2014) assessed the effects of rainfall and temperature on maize output in Kogi state using secondary data for a period of 10 years. They used data of monthly rainfall and monthly temperature as their explanatory variables while the dependant variable was output of maize. Multiple regression analysis and descriptive statistics were used to analyse the findings. From their study they concluded that variations in both rainfall and temperature does
not directly affects variations in the output of maize. In Mexico, Meza-Pale and Yunez-Naude Antonio (2015) examined the impacts of rainfall variation on Agricultural output and net income for rural households using panel data. OLS method was used and they concluded that there is a significant relationship between the two variables.

Olwande et al (2004) in a research paper entitled Supply Responsiveness of Maize Supply in Kenya carried out a research on the factors affecting maize supply in Kenya. Their data covered the main cropping season of 2003/4 cropping year for 334 households and thus the data was crosssectional. Multistage and systematic sampling techniques were used in selecting the sample of households. They used OLS to do estimations and the following elasticities with respect to maize supply were obtained: maize price as 0.11, fertilizer price as –0.06, wage rate as -0.08, land area as 0.94, distance to motorable road as 0.05 and education of the household head as 0.17. They concluded that to increase aggregate production of maize in Kenya more focus should be on reducing fertilizer prices through subsidies. Also increasing the land size put under maize was recommended to be a great contributor towards increasing maize production. Also using high yielding maize varieties is also important in boosting maize production.

2.3 Gap analysis

Despite the above studies having been carried out before, the researcher acknowledges that there is very little comprehensive research focusing specifically on the impact of subsidies in Zimbabwe. Thus this study will add to the existing literature and board of knowledge. Most studies that focus on agricultural subsidies and maize production were done outside Zimbabwe hence this research will bridge this gap by focusing on the impact of subsidies in Zimbabwe.

2.4 Summary

The above literature discussed the theoretical arguments and empirical evidence on the impact of agricultural subsidies on maize production. It is clear that researchers did not come up with the same conclusion. The next chapter focuses on research methodology and elaborates the methodological framework of the study.
CHAPTER 3

RESEARCH METHODOLOGY

3.0 Introduction

The rationale of this chapter is to present the description of the research method to be used. It will also show the instruments to be used, the procedures and statistical treatment utilized in assessing the impact of agricultural subsidies on maize output. Quantitative research methods are to be used to make sure all the objectives of the study are met. This chapter also gives an outline of model specification, justification of variables, data sources that are used and a summary.

3.1 Model Specification

3.1.1 Theoretical model

The study will adopt the production theory according to Cobb-Douglas production model. An increase in either A, K and L will lead to an increase in output. While capital and labour input are tangible, total-factor productivity appears to be more intangible as it can range from technology to knowledge of workers (human capital). The reason why Cobb-Douglas equation is used in this function is because it exhibits constant return to scale. The Cobb-Douglas production function in its natural form:

\[ Q = AK^\alpha L^\beta \]  

Where

- \( Q \) = total production (value of all goods produced in a year)
- \( K \) = capital input
- \( L \) = labour input
- \( A \) = total factor productivity, \( \alpha \) and \( \beta \) are the output elasticities of capital and labour, respectively. The elasticities measure the responsiveness of output to a change in the levels of either labour or capital used in production holding other things constant. These values are constants determined by available technology. Returns to scale refers to a technical property of
production that examines changes in output subsequent to a proportional change in all inputs (where all inputs increase by a constant factor). If output increases by that same proportional change then there are constant returns to scale, sometimes referred to simply as returns to scale. If output increases by less than that proportional change, there are decreasing returns to scale. However, if output increases by more than that proportion, there are increasing returns to scale (Cobb, 1970). Since the Cobb-Douglas production is critised for the inclusion of only two variables (capital and labour), (Agarwal, 1998), this study will add some variables into the production function which affects maize production to make it more comprehensive.

3.1.2 Empirical model

In order to achieve the main objective of this study the researcher adopted an empirical model which was used by Chumo (2013) who studied on determining factors that affect maize production in Kenya from the period 1980 to 2012. He used the following model:

\[ MO = \beta_0 + \beta_1 GS + \beta_2 LE + \beta_3 AR + \beta_4 D + \beta_5 MP + \mu \]  \hspace{1cm} (2)

Where:

- \( MO \) = Maize output
- \( GS \) = Government subsidies on maize
- \( LE \) = Labour Employed
- \( AR \) = Average Rainfall
- \( D \) = Drought
- \( MP \) = Market Price of maize
- \( \mu \) = Error term.

The researcher will adopt the variables government subsidies, average rainfall and labour employed only. Area planted will be added in the model.

The model to be used is as follows:

\[ MO = \beta_0 + \beta_1 GS + \beta_2 LE + \beta_3 AR + \beta_4 LU + \mu \]  \hspace{1cm} (3)
To find the relationship between government subsidies and maize output the researcher is going to use the OLS approach and the model is going to be linearized by inclusion of logarithms since the model assumes a linear relationship and it is difficult to regress a Cobb-Douglas function. Equation (3) is linearised as below:

\[ \ln MO = \beta_0 + \beta_1 \ln GS + \beta_2 \ln LE + \beta_3 \ln AR + \beta_4 \ln LU + \mu \] ................................. (4)

Where;

\( \ln MO \) is the natural logarithm of maize output.

\( \ln GS \) is the natural logarithm of government subsidies on maize.

\( \ln LE \) is the natural logarithm of labour employed.

\( \ln AR \) is the natural logarithm of average rainfall

\( \ln LU \) is the natural logarithm of land used for cultivation

\( \beta_0 \) is the intercept

\( \beta_1, \beta_2, \) and \( \beta_3 \) and \( \beta_4 \) are slopes of the regression equation

\( \mu \) is the stochastic disturbance (or error term).

3.2 Justification of variables in the model

The methodology employed for this study involves regression analysis and secondary data is used. Maize output is the dependent variable while government subsidies (credit assistance and inputs to farmers), labour employed in maize production, total annual rainfall received, land used for cultivation and drought are the independent variables. There are many other explanatory variables which can affect maize output but for the purpose of this study only the above stated explanatory variables are included:

3.2.1 Maize output (MO)

The dependent variable is the average output of maize produced in a given year per hectare. It is measured in kilograms per hectare or tonnes. Maize output is related to a number of factors such as capital, labour, average rainfall, knowledge, and so on. An
increase in output is a result of an increase in the efficiency of production and it has a positive effect in solving hunger problems.

3.2.2 Government subsidies on maize (GS)

Government subsidies on maize are payments by the government to farmers of maize for the purpose of stabilizing food prices, ensuring plentiful food production, guaranteeing farmers’ basic incomes, and generally strengthening the agricultural segment of the national economy. These subsidies provide farmers with capital which is a necessity in maize production and is required for planting, spraying and harvesting. The government of has recently engaged in massive subsidy provision in the recent years so as to improve maize production.

3.2.3 Labour Employed (LE)

Labour employed in the agricultural sector refers to the total amount of individuals who will be employed in the agricultural sector (specifically for maize production) for a specific period of time. This study makes use of yearly records of labour employed for maize production purposes. The increase in the labour employed is expected to increase the overall output of maize. Increase in labour can only result in a rise in output if there is an increase in the capital available and other resources, therefore an increase in labour will be expected to increase overall output if there is corresponding increase on capital.

3.2.4 Average Rainfall (AR)

Since the maize plant is severely affected by dry spells, an increase in annual rainfall is likely to increase maize production so there is positive relationship between rainfall and maize output. However, this relationship holds to a certain extent as more and more rainfall can also lead to flooding as well as leaching which can negatively affect maize production. Annual rainfall is the total amount of rainfall received per each year or per each agricultural season and it is mainly affected by both long term and short term climatic changes and it is measured in millimetres.

3.2.5 Land Used (LU)

Area planted will determine the quantity of maize produced so there is need to increase land under cultivation if more output is to be realized. In this case it means that an increase in area planted will result in an increase in maize production therefore a positive sign is expected and vice versa.
3.3 Estimation procedures

The Ordinary Least Squares (OLS) estimator model is used to solve and estimate for unknown parameters which are $\alpha$ and $\beta$. This method gives the most excellent technique for the confirmation and status of parameters. It also provides quantitative estimation of the relationship amongst variables without much prejudiced judgment. According to Gujarati (2003), the simple classical regression model in its general form which is the general set contains simple and multiple regressions as corresponding subsets. This can be represented as:

$$Y = \alpha + \sum \beta_i X_i + \mu$$

Where $Y$ is the dependant variable; $X_1 + X_2 + X_3 \ldots \ldots \ldots X_k$ are $k$ independent variables, $\alpha$ and $\beta$ are the regression coefficients representing the parameters of the model for a specific population and $\mu$ is the stochastic disturbance term which can be interpreted as resulting from the effect of unspecified independent variables.

3.4 Diagnostic Tests

There are several diagnostic tests which the researcher is going to perform before the regression is run. The tests are done to ensure the adequacy of the model to reduce errors in forecasting. The diagnostic tests which will be done are mentioned below.

3.4.1 Unit Root Test

A time series is said to be stationary if its mean, variance and auto-covariance at various lags remain the same no matter at what time we measure them (Gujarati, 1995). The stationarity of a series can powerfully influence its behavior and properties, for instance, perseverance of shocks will be unlimited for non-stationary series. If the variables in the regression model are non-stationary, then it can be proved that the normal assumptions for asymptotic analysis will not be suitable. This is so because the standard t-ratios will not pursue a t-distribution and so the theory tests about the regression parameters cannot be authentically undertaken (Gujarati, 2004). According to Gujarati (2004) the Augmented Dickey Fuller (ADF) is used to test for stationarity. If the ADF is greater than the critical values at 5% level of significance we can conclude that data is stationary, there is no unit root. If ADF is less than critical values then data is non-stationary. The hypothesis that is to be tested is affirmed as:

$H_0$: The series is stationary that is there is no unit root
H1: The series is non stationary that is there is a unit root

3.4.2 Autocorrelation

Autocorrelation arises when the covariance among different error terms are not identical to zero as postulated by Chukwuma and Uju (2013). When two or more successive error terms are linked, we say that the error term is subject to autocorrelation (Kendall and Buckland, 1971). In the regression situation, the classical linear regression model assumes that such autocorrelation does not exist in the disturbances. The classical model assumes that the disturbance term relating to any examination is not inclined by the disturbance term connecting to any observation. Gujarati (2009) postulated that, autocorrelation arises from the violation of the assumption of the independence of consecutive values of the disturbance term. The error term picks up the authority of those variables disturbing the reliant variables that have not been included in the model. Perseverance of the things of excluded variables is therefore a frequent cause of positive autocorrelation. Tests that are typically used to test for the survival of autocorrelation in a model are the graphical method, the Durbin-Watson Test and the Breusch Godfrey test. The researcher is going to use both the Breusch Godfrey test and the Durbin Watson test. The hypothesis used will be as follows:

H0: There is no autocorrelation.
H1: There is autocorrelation.

3.4.3 Multicollinearity

Ragnar Frisch (1934) defined multicollinearity as the survival of a perfect linear connection among some explanatory variables of a regression model. It can also be a situation whereby the explanatory variables are highly intercorrelated. If the explanatory variables are extremely intercorrelated then it becomes tricky to separate the separate effects of each of the explanatory variables on the explained variable as postulated by Maddala (1992) and Kendall and Buckland (1971). This problem can also arise if some or all of the explanatory variables are extremely connected with one another, that is, if the correlation matrix shows the value above 0.8 across two explanatory variables. It reviews itself through low t-ratios and high p values. This study will use the correlation matrix to test for multicollinearity.

The hypothesis will be as follows:

H0: There is no multicollinearity among explanatory variables.
H1: There is multicollinearity among explanatory variables.

3.4.4 Heteroskedasticity

Gujarati (2004) has it that heteroskedasticity arises when the errors do not have a constant variance across observations and it can also arise as a result of the existence of outliers. An outlier is an observation that is much different relative to the remarks in the sample as outlined by Gujarati (2004). The addition or elimination of such an observation, particularly if the sample size is small can significantly change the results of regression analysis. If the regression model is not correctly specified heteroskedasticity also arises. Heteroskedasticity may also be due to the truth that some vital variables are absent from the model. The presence of heteroskedasticity can be detected by using the Spearman Rank Correlation. Other tests are the graphical method and the White’s general H test. This research will employ the White’s test to test for the existence of heteroskedasticity. The hypothesis to be used is as follows:

H0: There is no heteroskedasticity.

H1: There is heteroskedasticity.

3.4.5 Misspecification

A model is said to be misspecified if the important variables are omitted from the model or by choosing the wrong functional form as postulated by Gujarati (2004). The strength of interpreting the predictable regression will be highly dubious. In model misspecification errors we do not know what the true model was to begin with. Knowing the penalty of specification errors is one thing but finding out whether one has devoted such errors is quite another. Specification biases occur involuntarily, perhaps from our inability to formulate the model as exactly as possible because the original theory is weak. This could be because we do not have the correct kind of data to test the model. Davidson (2000) states that any hypothesis in economics always turns out to depend on additional assumptions necessary to specify a reasonably economical model, which may or may not be justified. Gujarati (2004) also states that once it is found that specification errors have been made the remedies often suggests them.

We look at some broad features of the results when determining model adequacy such as the coefficient of determination value, estimated t ratios, signs of the estimated coefficients relative to their prior opportunity and the Durbin–Watson statistic. This research will use the Ramsey
RESET to test for the specification of the whole model specification. The hypothesis will be as follows:

H0: The model is correctly specified.

H1: The model is not correctly specified.

3.5 Data sources and problems

The study uses secondary annual time series data from the period of 1985 to 2017 which was obtained from existing publications. Secondary data is readily available and has already been collected and such data can be obtained more quickly than primary data. Secondary data may be outdated and data pertaining to this research topic is available in inadequate quantities. Problems to be encountered when dealing with secondary data include multicollinearity, heteroskedasticity and autocorrelation.

Data used in this research was obtained from ZIMSTAT, Food and Agriculture Organization (FAO) and World Bank Economic Outlook. However, good quality, reliability, accuracy and consistency are very acute in Zimbabwe which is a major problem of the data which will be used in this research. The data problems arise due to inadequate monitoring of the economy and inaccurate reporting and recoding of data. The other main problem of the data (financial) in Zimbabwe is that in 2009 the data was converted from Zimbabwean dollar to US dollar which brings distortion of data and the data was also affected by hyperinflation of 2008.

3.6 Summary

In this chapter the researcher gives a clear description of research methodology and research design used. The researcher also justified the model and variables which were used in this study. The procedures to be undertaken were also outlined which include model specification and estimation. In addition, the procedures used during data collection were also outlined. Data presentation, analysis and interpretation will be discussed in the next chapter.
CHAPTER 4

DATA ANALYSIS AND RESULTS PRESENTATION

4.0 Introduction

This chapter outlines the findings and results of the study. Eviews was used to estimate the effect of government subsidies on maize output in Zimbabwe between 1985 and 2017. This chapter consists of data description, diagnostic tests, regression results and the significance of the model. Finally, a brief summary of the findings of the study and observed relationships between the explanatory variables and the determinant variable is given.

4.1 Summary Statistics

Table 1: Descriptive Statistics

<table>
<thead>
<tr>
<th></th>
<th>LMO</th>
<th>LAR</th>
<th>LLU</th>
<th>LLE</th>
<th>LGS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>12.17184</td>
<td>6.440660</td>
<td>3.165840</td>
<td>14.88388</td>
<td>22.85145</td>
</tr>
<tr>
<td>Std. Dev.</td>
<td>2.409644</td>
<td>0.196074</td>
<td>0.053142</td>
<td>0.151799</td>
<td>0.182020</td>
</tr>
<tr>
<td>Skewness</td>
<td>-0.346671</td>
<td>-0.392706</td>
<td>-0.380885</td>
<td>-1.211615</td>
<td>0.837160</td>
</tr>
<tr>
<td>Kurtosis</td>
<td>1.208859</td>
<td>2.462691</td>
<td>1.962431</td>
<td>3.154152</td>
<td>3.587380</td>
</tr>
<tr>
<td>Jarque-Bera</td>
<td>5.072248</td>
<td>1.245165</td>
<td>2.278158</td>
<td>8.106728</td>
<td>4.328996</td>
</tr>
<tr>
<td>Probability</td>
<td>0.079173</td>
<td>0.536557</td>
<td>0.320114</td>
<td>0.017364</td>
<td>0.114808</td>
</tr>
<tr>
<td>Sum</td>
<td>401.6708</td>
<td>212.5418</td>
<td>104.4727</td>
<td>491.1680</td>
<td>754.0977</td>
</tr>
<tr>
<td>Sum Sq. Dev.</td>
<td>185.8043</td>
<td>1.230245</td>
<td>0.090369</td>
<td>0.737376</td>
<td>1.060204</td>
</tr>
<tr>
<td>Observations</td>
<td>33</td>
<td>33</td>
<td>33</td>
<td>33</td>
<td>33</td>
</tr>
</tbody>
</table>

Source: Eviews 7

The table above shows descriptive statistics of the variables employed in a model of 33 observations. Mean, median, maximum, minimum and standard deviations of the variables are presented in the table. The table indicates that there is little variability in most of the variables since the standard deviation values are low. However, maize output has a standard deviation of
2.409644 (the largest). Normality test was performed using the Jaque-Bera, whose assumption is that all the variables are normally distributed. From the results we can conclude that annual rainfall, land used and agricultural subsidies are normally distributed as their p-values are greater than 0.1. However, maize output and labour employed variables are not normally distributed since their p-values are less than 0.1. As Green (2002) is of the notion that the assumption can be relaxed and statistically true results are obtained. Except for government subsidies, all other variables are negatively skewed.

4.2 Diagnostic Tests

4.2.1 Unit Root Tests

Table 2: Unit Root Tests in Levels

<table>
<thead>
<tr>
<th>Variables</th>
<th>ADF Test Statistic</th>
<th>1% Critical Value</th>
<th>5% Critical Value</th>
<th>Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>LMO</td>
<td>-0.783168</td>
<td>-3.653730</td>
<td>-2.957110</td>
<td>Non stationary</td>
</tr>
<tr>
<td>LAR</td>
<td>-3.566651</td>
<td>-3.653730</td>
<td>-2.957110</td>
<td>Non stationary</td>
</tr>
<tr>
<td>LLU</td>
<td>-1.778529</td>
<td>-3.653730</td>
<td>-2.957110</td>
<td>Non stationary</td>
</tr>
<tr>
<td>LLE</td>
<td>-2.9558</td>
<td>-3.653730</td>
<td>-2.957110</td>
<td>Non stationary</td>
</tr>
<tr>
<td>LGS</td>
<td>-0.633552</td>
<td>-3.653730</td>
<td>-2.957110</td>
<td>Non stationary</td>
</tr>
</tbody>
</table>

Source: Eviews 7

The ADF Statistic values does not exceed the critical values at both 1% and 5% hence indicating non-stationarity. The Augmented Dickey-Fuller is to be performed at first difference so as to ensure that all variables are stationary.
Table 3: Unity root test at 1st difference

<table>
<thead>
<tr>
<th>Variables</th>
<th>ADF Test Statistic</th>
<th>1% Critical Value</th>
<th>5% Critical Value</th>
<th>Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>LMO</td>
<td>-6.212332</td>
<td>-3.661661</td>
<td>-2.960411</td>
<td>Stationary</td>
</tr>
<tr>
<td>LAR</td>
<td>-4.532869</td>
<td>-3.661661</td>
<td>-2.960411</td>
<td>Stationary</td>
</tr>
<tr>
<td>LLU</td>
<td>-7.441118</td>
<td>-3.661661</td>
<td>-2.960411</td>
<td>Stationary</td>
</tr>
<tr>
<td>LLE</td>
<td>-4.292748</td>
<td>-3.661661</td>
<td>-2.960411</td>
<td>Stationary</td>
</tr>
<tr>
<td>LGS</td>
<td>-4.247532</td>
<td>-3.661661</td>
<td>-2.960411</td>
<td>Stationary</td>
</tr>
</tbody>
</table>

Source: Eviews 7

Table 3 above shows the results of the unit root tests for all the variables in their first differences and indicate that all the variables are stationary. We therefore fail to reject the hypothesis that there is no unit root.

4.2.2 Multicollinearity Test

Multicollinearity is a situation where there is correlation between explanatory variables and it was tested using the correlation matrix which is presented in the table below.

Table 4: Correlation Matrix

<table>
<thead>
<tr>
<th></th>
<th>LGS</th>
<th>LLE</th>
<th>LLU</th>
<th>LAR</th>
</tr>
</thead>
<tbody>
<tr>
<td>LGS</td>
<td>1.000000</td>
<td>0.341711</td>
<td>0.218547</td>
<td>-0.137702</td>
</tr>
<tr>
<td>LLE</td>
<td>0.341711</td>
<td>1.000000</td>
<td>0.881816</td>
<td>-0.045224</td>
</tr>
<tr>
<td>LLU</td>
<td>0.218547</td>
<td>0.881816</td>
<td>1.000000</td>
<td>-0.109892</td>
</tr>
<tr>
<td>LAR</td>
<td>-0.137702</td>
<td>-0.045224</td>
<td>-0.109892</td>
<td>1.000000</td>
</tr>
</tbody>
</table>

Source: Eviews 7

The coefficient of determination between the explanatory variables should be less than 0.80 so as to be able to reject the null hypothesis that the estimated model is suffering from multicollinearity (Gujarati, 2004). Correlation coefficients of some of the variables show that there is no correlation as they are less than 0.8. However, we fail to reject the null hypothesis in the case of labour employed (LLE) and land used (LLU) as there is multicollinearity between the two with a coefficient of 0.881816. This therefore indicates that there is a strong relationship between these two variables so it is not possible to separate the individual effects of the explanatory variables on the dependent variable maize output. Despite the two variables
suffering from multicollinearity, the do nothing approach has been adopted since both variables are important in determining maize output.

4.2.3 Heteroskedasticity Test

Heteroskedasticity was tested using the Heteroskedasticity White Test and its summarized results are presented in table 5.

**Table 5: White Heteroskedasticity Test**

<table>
<thead>
<tr>
<th>Heteroskedasticity Test: White</th>
</tr>
</thead>
<tbody>
<tr>
<td>F-statistic</td>
</tr>
<tr>
<td>Obs*R-squared</td>
</tr>
<tr>
<td>Scaled explained SS</td>
</tr>
</tbody>
</table>

Source: Eviews 7

If the P-value of F-statistic is less than 10%, then the model is suffering from heteroskedasticity. Since the probability of F-Statistic (0.2540) is greater than 0.1 we can conclude that there is no heteroskedasticity. This implies that there is no relationship between the squared residuals and the explanatory variables.

4.2.4 Autocorrelation test

The Durbin Watson statistic is used to test for the presence of autocorrelation. Gujarati (2004) asserts that the Durbin Watson’s critical value of the DW test should be approximately equal to 2 so as to conclude that there is no autocorrelation.

**Table 6: Serial Correlation LM Test**

<table>
<thead>
<tr>
<th>Breusch-Godfrey Serial Correlation LM Test:</th>
</tr>
</thead>
<tbody>
<tr>
<td>F-statistic</td>
</tr>
<tr>
<td>Obs*R-squared</td>
</tr>
</tbody>
</table>

Source: Eviews 7

The null hypothesis which is used when we are testing auto-correlation is that there is no auto-correlation while the alternative hypothesis is that there is auto-correlation. According to the test, the P-value of Fcal is 0.3730, we therefore fail to reject the null
hypothesis and hence conclude that the variables are not correlated. The null hypothesis that there is autocorrelation can only be accepted if the probability value of Fstat < 0.1

4.3 Regression Results

The regression results of the Ordinary Least Squares (OLS) method through the application of E-views 7 are presented in table 7 below.

Table 7 Econometric Results

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>107.5169</td>
<td>35.2744</td>
<td>3.048016</td>
<td>0.0050</td>
</tr>
<tr>
<td>LAR</td>
<td>-1.76576</td>
<td>1.225709</td>
<td>-1.4406</td>
<td>0.1608</td>
</tr>
<tr>
<td>LGS</td>
<td>-1.97258</td>
<td>1.387079</td>
<td>-1.42211</td>
<td>0.1660</td>
</tr>
<tr>
<td>LLE</td>
<td>10.20629</td>
<td>3.384626</td>
<td>3.015487</td>
<td>0.0054</td>
</tr>
<tr>
<td>LLU</td>
<td>-60.2578</td>
<td>9.271311</td>
<td>-6.49939</td>
<td>0.0000</td>
</tr>
</tbody>
</table>

Source: Eviews 7

R-Squared 0.79328  F Statistic 19.85370
Adjusted R-Squared 0.702089 Prob (F Statistic) 0.000000
Durbin Watson 1.660074

The linear regression model

\[
LMO = 107.5169 - 1.76576 \times LAR - 1.97258 \times LGS + 10.20629 \times LLE - 60.2578 \times LLU
\]

\[
\begin{align*}
(3.048016) & \quad (-1.4406) & \quad (-1.42211) & \quad (3.015487) & \quad (-6.49939) \\
(0.0050) & \quad (0.1608) & \quad (0.1660) & \quad (0.0054) & \quad (0.0000)
\end{align*}
\]

4.4 Model significance

The model has a high R-squared of 0.79328 which means that the model is greater than 60% (the benchmark), implying that about 74% of variations in maize output are explained by the explanatory variables and 26% are in the error term. The adjusted R-squared
(0.702089) takes into account the degrees of freedom and also shows that the model is still fit to explain the variations in maize output.

4.5 Results Interpretation and Discussions

4.5.1 Average Rainfall

Average rainfall was found to be insignificant in explaining variations in maize output since it has a p-value of 0.1608 which is greater than 10%. This means that there is no relationship between maize output and average rainfall in Zimbabwe. A research done in Kogi by Ibitoye and Shaibu (2014) is in support of this as they concluded that variations in both rainfall and temperature does not directly affects variations in maize output when they assessed the effects of rainfall and temperature on maize output.

FAO (2015) reported that many farmers have dropped production of maize in preference of cash crops such as tobacco and cotton. Maize producer price is relatively low comparing to the price fetched by tobacco and other cash crops.

The Zimbabwean agriculture mainly depends on traditional approaches to farming which results in less efficiency. Production in agriculture could be accelerated through generation and diffusion of new, improved technologies such as use of fertilisers, improved seeds and irrigation systems (Hayami and Ruttan, 2001). This however is unattainable to most maize producers who are based in the rural areas as they probably cannot afford to purchase inputs like fertilisers and invest in current agricultural knowledge or technologies.

Nevertheless, a study done in Mexico by Meza-Pale and Yunez-Naude (2015) examined the impacts of rainfall variation on agricultural output for rural households and they concluded that there is a significant relationship between the two variables. This could be attributed by the different ecological conditions between the regions.

4.5.2 Government Subsidies

Government subsidies with a p-value of 0.1660 are insignificant in explaining changes in maize output and the two are negatively related. This result is different from studies done by Ragasa and Masunda (2018) in Nigeria. They concluded that subsidies given to farmers have a significant and positive contribution to agricultural output. Their results were also in line with the findings of Nyoro (2005). He supported government subsidies given in
form of credit as they are necessary to encourage technical innovations such as use of yield enhancing input-output relationship hence resulting in an increase in output. A positive relationship between government subsidies and maize output was expected.

In Zimbabwe, government subsidies may be insignificant because some farmers tend to divert the funds and use them for other purposes. As postulated by Sachikonye (2004), agricultural subsidies are largely distributed on political basis and no post management is done by the authorities to make sure funds have been used for the right purposes. Instead of providing the farmer with ability to cater for related expenses, the farmer may use those funds for speculative purposes in case of emergencies such as outbreak of diseases and drought which will then minimise their losses. It is reported that in Zimbabwe, some farmers sell the fuel and maize seed they receive from the government (Machuma, 2017). The World Bank, argues for the abolition of state-led interventions including subsidies and suggests that states use the finance for research and development purposes (Glenn et al, 2009). People in the communal areas may actually prefer food aid instead of agricultural subsidies. This is due to the fact that many young people are now in favour of other ways of making a living instead of farming. The elderly people in the rural areas may not have enough energy to engage in farming activities.

4.5.3 Labour Employed

This variable is significant in explaining variations in maize output at 1%. The results are also showing a positive relationship between labour employed and maize output since a percentage increase in labour employed will cause agricultural output to increase by 10.21%. As expected, there is a positive relationship between these two variables. This goes hand in hand with the findings of Ntege-Nanyeenya, et al (2001) which revealed that use of hired labour had statistically significant effects on the adoption of technology in maize production.

Most commercial farmers adopted use of machinery like tractors and combine harvesters which are not labour intensive. However, these farmers do not focus on maize production but other agricultural produce. Communal farmers have contributed 40.1% of total maize which the country needed for consumption in 2016 (ZIMSTAT). In these areas, agriculture is practised through labour intensive, the effect of labour employed in those areas will be significant since the output which is produced does have significant contribution on overall maize output.
4.5.4 Land Used

A percentage change in land used for cultivation is negatively related to maize production but is significant in explaining the changes in maize production at 1%. A percentage increase in land used will cause output to decrease by 60.26% hence an overall increase in land used will cause a significant decrease in overall maize output. These results are not totally in tally with a research done by Olwande (2004) in Kenya where land used had a coefficient of 0.94 and significant. Increasing the land size put under maize cultivation was recommended to be a great contributor towards increasing maize production.

The relationship between the two is negative because of the law of diminishing returns which states that as more and more of a variable is added to a fixed factor the marginal productivity of the variable will eventually decline. In order to overcome this problem it will be required that the quantity of the fixed factor be increased although this can only be possible in the long-run.

4.6 Summary

The regression results showed that labour employed and land used are significant in explaining the variations in maize output. The variables are also positively and negatively related to the dependent variable respectively. Average rainfall and government subsidies are insignificant in explaining variations in maize output from 1985 to 2017. Based on the findings of this chapter, the next and final chapter will focus on conclusions and policy recommendations and opportunities for further study and research.
CHAPTER 5

RECOMMENDATIONS AND CONCLUSION

5.0 Introduction

In this chapter the researcher outlines a detailed conclusion to the study, stating possible policies which should be implemented to improve the agricultural sector using the results which were obtained from the study. Finally, the chapter will highlight possible areas of future research.

5.1 Summary

In a country like Zimbabwe, there is need to improve maize production output as the population largely depend on maize as a staple food. This means that the improvement and ensuring of food security is very critical to the country, hence this study examined various variables that have a significant influence on maize output. The purpose of the research was to determine the effect or impact of government subsidies on maize output in Zimbabwean. Time series data covering the period 1985 to 2017 was used so as to assess the effect of government subsidies on maize output in Zimbabwe. To achieve the objectives of the study OLS method was used using E-views and many diagnostic tests were done to ensure the accuracy of the results.

Results from the study show that government subsidies are insignificant in explaining variations in maize output in Zimbabwe. The results have also shown that average rainfall received is also not significant in explaining changes in maize output. Land used exhibits a significant and negative effect on maize in Zimbabwe. Labour employed indicates that it is statistically significant and thus to a greater extent it is important in determining maize output in Zimbabwe as the two are positively related.

5.2 Conclusions

This study analysed the effect of government subsidies on maize output in Zimbabwe and found out that government subsidies are not important as they do not lead to increased maize output. Government subsidies were found to be insignificant in explaining the variations in maize output. Even though the government gives out subsidies to farmers so as to reduce their
costs of production, there is no meaningful increase in output. Although the government encourages farmers to produce maize so as to solve the food insecurity in the country, many farmers prefer producing other crops such as tobacco, cotton and soya. This is so because these crops can be exported hence farmers earn more income. Machuma (2017) reported that despite farmers receiving command agriculture inputs from the government in the 2016-2017 agricultural period, the country’s granaries did not improve. In the Zimbabwean economy this could be attributed to corruption. Mismanagement of funds is also another contributor; people tend to divert funds for personal use which was meant for agricultural purposes hence a negative correlation with maize output.

Average rainfall received was also found to be insignificant to maize production. This result was not expected as some studies are of the view that rainfall patterns largely affect maize or crop production in general. For example, Meza-Pale and Yunez-Naude Antonio (2015) found rainfall to be significant in crop production.

Labour employed positively affects maize output in Zimbabwe. This variable was found to be significant at all levels. It was found out from the study that, a percentage increase in labour employed resulted in maize output increasing by 10.21%. This was found to be consistent with a study by Ntege-Nanyeena, et al (2001) who suggested that labour employed has a positive effect on maize production.

Land used has a negative and significant effect on maize output in Zimbabwe. The study reviewed that; 1% increase in land used for cultivation will result in maize output falling by 60.26%. As noted from this research, land used for cultivation has a negative relationship with maize output. This however, contradicts with the empirical research done by Olwande (2004) which found out that land used for cultivation is beneficial and plays a significant role on maize production. From the findings, we can reject the null hypothesis which states that an increase in government subsidies leads to an increase in maize output. The findings from this study contradict with the theories of output growth hence theories like the Neo-classical growth model does not holds in Zimbabwe as they postulate that expenditure by the government contribute positively by boosting growth.

5.3 Recommendations

Basing on the findings of the study there are some possible policies which can be implemented by the government of Zimbabwe in order to improve maize production. Since the results from
the study have shown that government subsidies and rainfall are not significant in improving maize output, the government can adopt other strategies so as to improve maize production. For example, the government can invest in research and development in order to find ways of improving maize output besides provision of subsidies to farmers.

There is need for the government to improve on good governance and focus more on transparency and accountability to improve the effect of government subsidies on maize output. When there is good governance and good institutions, there will be assurance that the government will perform according to its mandate and be able to enforce policies to meet its objectives. It is of paramount importance that the government through relevant ministries and stakeholders, makes follow ups on the subsidies disbursed in order to enforce compliance and accountability on part of the farmers.

The government should also eliminate the dependence syndrome of the communal farmers and encourage them to be self-reliant through usage of own resources in order for them to boost maize output. Farmers could also organize themselves into small groups, societies and / or co-operatives where they will be able to share farming knowledge and assist each other with capital. For instance, co-operatives could invite trainers who can demonstrate or lecture them on ways of increasing productivity at a lower/ minimal cost. They can also pull together their assets and use them as collateral security if they want to borrow from commercial banks to finance their farming activities instead of burdening the government’s budget.

5.3 Further studies

There is room for future research and study as the results obtained in this study should not be viewed as conclusive but as a stimulant for further research on the effect of government subsidies on maize production in Zimbabwe. Further research can also be conducted to determine other factors which affect maize output in Zimbabwe which are not included in this research. Other variables can be used to determine factors that affect maize output besides the variables used in this study. Lastly the research can be extended to other SADC, Sub-Saharan countries and even to all African countries at large and research can also be done in low income countries in other continents at a global level.
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Appendices

Appendix 1: Descriptive Statistics

<table>
<thead>
<tr>
<th></th>
<th>LMO</th>
<th>LAR</th>
<th>LLU</th>
<th>LLE</th>
<th>LGS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>12.17184</td>
<td>6.440660</td>
<td>3.165840</td>
<td>14.88388</td>
<td>22.85145</td>
</tr>
<tr>
<td>Std. Dev.</td>
<td>2.409644</td>
<td>0.196074</td>
<td>0.053142</td>
<td>0.151799</td>
<td>0.182020</td>
</tr>
<tr>
<td>Skewness</td>
<td>-0.346671</td>
<td>-0.392706</td>
<td>-0.380885</td>
<td>-1.211615</td>
<td>0.837160</td>
</tr>
<tr>
<td>Kurtosis</td>
<td>1.208859</td>
<td>2.462691</td>
<td>1.962431</td>
<td>3.154152</td>
<td>3.587380</td>
</tr>
<tr>
<td>Jarque-Bera</td>
<td>5.072248</td>
<td>1.245165</td>
<td>2.278158</td>
<td>8.106728</td>
<td>4.328996</td>
</tr>
<tr>
<td>Probability</td>
<td>0.079173</td>
<td>0.536557</td>
<td>0.320114</td>
<td>0.017364</td>
<td>0.114808</td>
</tr>
<tr>
<td>Sum</td>
<td>401.6708</td>
<td>212.5418</td>
<td>104.4727</td>
<td>491.1680</td>
<td>754.0977</td>
</tr>
<tr>
<td>Sum Sq. Dev.</td>
<td>185.8043</td>
<td>1.230245</td>
<td>0.090369</td>
<td>0.737376</td>
<td>1.060204</td>
</tr>
<tr>
<td>Observations</td>
<td>33</td>
<td>33</td>
<td>33</td>
<td>33</td>
<td>33</td>
</tr>
</tbody>
</table>

Appendix 2: Econometric Results

Dependent Variable: LMO
Method: Least Squares
Date: 04/11/19   Time: 23:38
Sample: 1985 2017
Included observations: 33

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>107.5169</td>
<td>35.27440</td>
<td>3.048016</td>
<td>0.0050</td>
</tr>
<tr>
<td>LAR01</td>
<td>-1.765758</td>
<td>1.225709</td>
<td>-1.440601</td>
<td>0.1608</td>
</tr>
<tr>
<td>LGS</td>
<td>-1.972579</td>
<td>1.387079</td>
<td>-1.422110</td>
<td>0.1660</td>
</tr>
<tr>
<td>LLE</td>
<td>10.20629</td>
<td>3.384626</td>
<td>3.015487</td>
<td>0.0054</td>
</tr>
<tr>
<td>LLU</td>
<td>-60.25783</td>
<td>9.271311</td>
<td>-6.499386</td>
<td>0.0000</td>
</tr>
</tbody>
</table>

R-squared | 0.739328 | Mean dependent var | 12.17184
Adjusted R-squared | 0.702089 | S.D. dependent var | 2.409644
S.E. of regression | 1.315212 | Akaike info criterion | 3.524601
Sum squared resid | 48.43394 | Schwarz criterion | 3.751344
Log likelihood | -53.15591 | Hannan-Quinn criter. | 3.600893
F-statistic | 19.85370 | Durbin-Watson stat | 1.660074
Prob(F-statistic) | 0.000000 |
Appendix 3: Unit root at levels

Null Hypothesis: LGS has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=8)

<table>
<thead>
<tr>
<th></th>
<th>t-Statistic</th>
<th>Prob.*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Augmented Dickey-Fuller test statistic</td>
<td>-0.633552</td>
<td>0.8492</td>
</tr>
<tr>
<td>Test critical values:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1% level</td>
<td>-3.653730</td>
<td></td>
</tr>
<tr>
<td>5% level</td>
<td>-2.957110</td>
<td></td>
</tr>
<tr>
<td>10% level</td>
<td>-2.617434</td>
<td></td>
</tr>
</tbody>
</table>

Null Hypothesis: LLU has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=8)

<table>
<thead>
<tr>
<th></th>
<th>t-Statistic</th>
<th>Prob.*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Augmented Dickey-Fuller test statistic</td>
<td>-1.778529</td>
<td>0.3919</td>
</tr>
<tr>
<td>Test critical values:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1% level</td>
<td>-3.653730</td>
<td></td>
</tr>
<tr>
<td>5% level</td>
<td>-2.957110</td>
<td></td>
</tr>
<tr>
<td>10% level</td>
<td>-2.617434</td>
<td></td>
</tr>
</tbody>
</table>

Null Hypothesis: LLE has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on SIC, maxlag=8)

<table>
<thead>
<tr>
<th></th>
<th>t-Statistic</th>
<th>Prob.*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Augmented Dickey-Fuller test statistic</td>
<td>-2.9558</td>
<td>0.0020</td>
</tr>
<tr>
<td>Test critical values:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1% level</td>
<td>-3.653730</td>
<td></td>
</tr>
<tr>
<td>5% level</td>
<td>-2.957110</td>
<td></td>
</tr>
<tr>
<td>10% level</td>
<td>-2.617434</td>
<td></td>
</tr>
</tbody>
</table>

Null Hypothesis: LMO has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=8)

<table>
<thead>
<tr>
<th></th>
<th>t-Statistic</th>
<th>Prob.*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Augmented Dickey-Fuller test statistic</td>
<td>-0.783168</td>
<td>0.8104</td>
</tr>
<tr>
<td>Test critical values:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1% level</td>
<td>-3.653730</td>
<td></td>
</tr>
<tr>
<td>5% level</td>
<td>-2.957110</td>
<td></td>
</tr>
</tbody>
</table>
Null Hypothesis: LAR has a unit root  
Exogenous: Constant  
Lag Length: 0 (Automatic - based on SIC, maxlag=8)

<table>
<thead>
<tr>
<th>t-Statistic</th>
<th>Prob.*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Augmented Dickey-Fuller test statistic</td>
<td>-3.566651</td>
</tr>
</tbody>
</table>

Test critical values:
- 1% level: -3.653730
- 5% level: -2.957110
- 10% level: -2.617434

Appendix 4: Unit root at 1st difference

Null Hypothesis: LGS has a unit root  
Exogenous: Constant  
Lag Length: 0 (Automatic - based on SIC, maxlag=8)

<table>
<thead>
<tr>
<th>t-Statistic</th>
<th>Prob.*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Augmented Dickey-Fuller test statistic</td>
<td>-4.247532</td>
</tr>
</tbody>
</table>

Test critical values:
- 1% level: -3.661661
- 5% level: -2.960411
- 10% level: -2.619160


Null Hypothesis: LLE has a unit root  
Exogenous: Constant  
Lag Length: 0 (Automatic - based on SIC, maxlag=8)

<table>
<thead>
<tr>
<th>t-Statistic</th>
<th>Prob.*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Augmented Dickey-Fuller test statistic</td>
<td>-4.292748</td>
</tr>
</tbody>
</table>

Test critical values:
- 1% level: -3.661661
- 5% level: -2.960411
- 10% level: -2.619160
Null Hypothesis: LLU has a unit root  
Exogenous: Constant  
Lag Length: 0 (Automatic - based on SIC, maxlag=8)

<table>
<thead>
<tr>
<th>t-Statistic</th>
<th>Prob.*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Augmented Dickey-Fuller test statistic</td>
<td>-7.441118</td>
</tr>
</tbody>
</table>

Test critical values:  
1% level |  -3.661661  
5% level |  -2.960411  
10% level |  -2.619160

Null Hypothesis: LMO has a unit root  
Exogenous: Constant  
Lag Length: 0 (Automatic - based on SIC, maxlag=8)

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Test critical values:  
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5% level |  -2.960411  
10% level |  -2.619160

Null Hypothesis: LAR has a unit root  
Exogenous: Constant  
Lag Length: 1 (Automatic - based on SIC, maxlag=8)

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Test critical values:  
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5% level |  -2.960411  
10% level |  -2.619160


Appendix 5: Heteroscedasticity

Heteroscedasticity Test: White

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Appendix 6: Correlation Matrix

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Appendix 7: Serial Correlation LM Test

Breusch-Godfrey Serial Correlation LM Test:

| F-statistic | 0.820591 | Prob. F(1,27) | 0.3730 |
| Obs*R-squared | 0.973362 | Prob. Chi-Square(1) | 0.3238 |

Appendix 8: Data

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