

**INVESTIGATING THE RELATIONSHIP BETWEEN AGRICULTURAL
PRODUCTIVITY AND ECONOMIC GROWTH IN NAMIBIA**

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ABSTRACT

Over the years, Namibia has made efforts to promote the agriculture sector in its National Development Plans. The current five-year plan still identifies the agriculture sector with the potential to boost economic growth to address challenges of food security, unemployment and poverty reduction. However, despite these efforts, the sector's contribution to GDP remains minimal. Even though, economic theory supports the view that agriculture is a pre-requisite to stimulate growth it might not be the case for all countries. Therefore, this study investigated the relationship between agricultural productivity and economic growth in Namibia. The study specifically aimed to investigate the long run relationship between agricultural productivity and economic growth. Moreover, the study aimed to determine the direction of causality between agricultural productivity and economic growth. The study used time series data for the period 1981 to 2016. The Autoregressive Distributed Lag (ARDL) model was employed to analyze the data. The time series properties of the data were analyzed using Augmented Dickey Fuller and Philip Peron unit root tests. The long run relationship was assessed through the bound test to cointegration. In order to assess the nature of the causal relationship the Toda-Yamamoto Granger causality test was carried out. The unit root test results indicated that three of the four variables employed were non-stationary in levels, hence, they were integrated of order one and only one variable was integrated of order zero. The bound test to cointegration test results indicated a long run relationship among the variables employed. The Toda- Yamamoto Granger causality test results indicated a unidirectional causality from agricultural productivity to economic growth. No reverse causal flow was observed from economic growth to agricultural productivity. The study recommended that sectoral linkages should be strengthened and government should target policies that would improve the performance of the agricultural sector such as investing in the sector thereby increasing productivity as well as addressing other constraints that affect the sector.

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DEDICATION

I dedicate this thesis to my son, Hercules Lubasi Chikusi Munyanya who was born during this challenging time of my study.

DECLARATION

I, Lydia Kahundu Mubita, hereby declare that this study is my own work and is a true reflection of my research, and that this work, or any part thereof has not been submitted for a degree at any institution.

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LIST OF ACRONYMS

ADF	Augmented Dickey Fuller
AGVA	Agricultural Value Added
AMTA	Agro Marketing and Trade Agency
ARDL	Auto Regressive Distributed Lag
BON	Bank of Namibia
INFR	Inflation Rate
NAU	Namibia Agricultural Union
NAP	Namibia agricultural Policy
NDP	National Development Plan
NSA	Namibia Statistics Agency
OLS	Ordinary Least Squares
PP	Phillips- Perron
RGDP	Real Gross Domestic Product
TOP	Trade Openness
VAR	Vector Auto Regression
VECM	Vector Error Correction Model

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CHAPTER ONE: INTRODUCTION

1.1 Background of the study

Namibia is endowed with natural resources such as land and water. Among these, land plays an important role for agricultural purposes by providing agricultural produce that can be used to advance structural economic transformation through value addition. The agricultural sector plays an important role in contributing to socio-economic development in many countries. It is important in terms of job creation, addressing poverty, as well as uplifting people's living standards. In Africa, the majority of people acquire their livelihood directly or indirectly from agriculture (Mushendami, Biwa & Gaomab, 2008).

Namibia's agricultural sector is currently underdeveloped, making it one of the priority sectors with the potential; especially for cereals and horticulture production and be able to expand the economy sustainably, address inequality as well as create the much needed employment. Agricultural productivity growth is the most effective driver of poverty reduction, raising farmer's incomes and reducing food shortage. Agriculture remained the highest employment sector in Namibia as it employs about 31% of the population (Namibia Statistics Agency, 2016). More than 46% of the country's population in Namibia depends on the agricultural sector for their livelihood (Ministry of Agriculture, Water and Forestry, 2017). However, the majority of the population derives their livelihood from small scale farming using traditional methods of cultivation and mostly producing for self-consumption.

A growing agricultural sector contributes to both overall growth and poverty alleviation. As from 2007 to 2016, the agricultural sector's contribution to GDP was 4.2% on average. Despite the minimal contribution of the agricultural sector to GDP, it remained crucial to the lives of the Namibian population, making it one of the principal contributors to GDP (Odero, 2017).

The government's long-term goal of food security and poverty reduction depend among others, on the productivity of the agricultural sector given that the majority of Namibians rely on this sector for survival. The agricultural sector is mostly characterized by the informal economy, which is often the overlooked share of the economy as it account for about 89.6% of informal employment (NSA, 2016). If rural poverty is to be reduced and agriculture is the basis for growth, the contribution of the informal sector to GDP should not be neglected. According to the country's Vision 2030, Namibia should be an industrialized country by the year 2030 through value addition. The realization of this hinges on the importance of agricultural production as a primary source of inputs in terms of raw materials for the manufacturing sector.

Overview of the agriculture sector in Namibia

For many developing countries' economies, agriculture played an important role as a source of livelihood for citizens. Therefore, for most governments and development agencies raising agricultural productivity was an important policy goal. Agriculture in Namibia comprises of crop and livestock production. Numerous studies on economic development have proven that, generally, economies began mainly as agricultural

economies before becoming industrialized through manufacturing industries. Of importance to note was that, very few countries managed to industrialize without a strong agricultural base (Namibia Agricultural Union, 2014).

The Namibian economy has relied heavily on mineral extraction as well as agricultural products, which are exported in raw form (Sheefeni, 2016). The reliance on primary production and exports of raw materials is unsustainable in the long-run as it entails forgone economic gains and income through value addition. The sector continues to receive support from government through programs aimed at increasing productivity. One of the initiatives by government to support the sector is the Growth at Home strategy, which is on value addition aimed to discourage reliance on primary production exports. On the other hand, an increase in productivity might be seen as a trade off as more people would be laid off from their jobs, thus, increasing unemployment. Nonetheless, the idea behind this view is that, as productivity increases, countries produce more food to feed the growing population with less labor inputs. Thereby, releasing labor for the manufacturing sector. With regard to food security, agricultural productivity has the potential to combat hunger by ensuring that more food is produced. A reduction in crop yields has a negative impact on food security at both national and household level.

Namibia being one of the semi –arid countries in Southern Africa, is subjected to persistent droughts. The effect of climate change continues to be a great concern amongst agricultural producers in Namibia. Regions where rain fed agriculture is practiced are the most affected areas. The long absence of rain leads to low production

in both crop farming and livestock farming. Moreover, the dependence on rain fed agriculture poses a threat to rural food security. Thus, leading to high levels of poverty, a challenge that the Namibian government is trying to address.

The performance of the agricultural sector has been sluggish over the years with overall contribution to GDP dropping from 5.3% in 2007 to 3.4% and 4.5% in 2016 and 2017, respectively (NSA, 2017). Moreover, the economy on average grew by 3.7% between 2008 and 2017. On the other hand, growth in the agricultural sector contracted by 0.5 % over the same period. Figure 1 demonstrates the agriculture sector growth rates between 2008 and 2017.

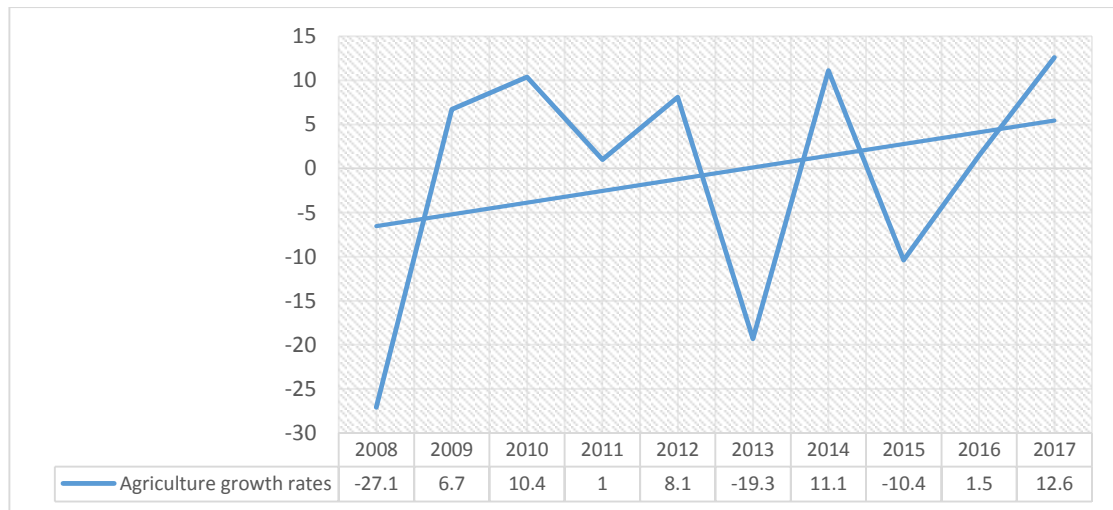


Figure 1.1: Agriculture sector growth rates (2008 to 2017)

Source: Author's computations using NSA 2017 preliminary national accounts

Agricultural output in Namibia is extremely sensitive to climatic conditions. In view of sectoral growth, an examination of Figure 1 shows that during the past years (2008, 2013 & 2015) the agricultural sector experienced contractions due to drought. The drought experienced resulted in stock losses and reduction in crop production. The

sector was also hit by low rainfall, which affected both livestock and rain fed crop production attributable to weaker performance during the period of 2015 and 2016 (Smit, Zaaruka & Tjeriko, 2018). However, in 2017 the agricultural sector performed relatively well. This was attributed to better rainfall received during the year, which resulted in an increase in both livestock farming and crop production (Smit, Zaaruka & Tjeriko, 2018). In as much as the contribution of the agricultural sector to GDP is relatively low, it still remained vital to the livelihoods of most Namibians.

Agricultural Policies in Namibia

Just five years after independence (1995), the Namibian government formulated the National Agriculture Policy (NAP) to guide agricultural development in the agricultural sector. The main aim of the policy is increasing agricultural production, agro-processing and marketing. The objectives of NAP are among others to accelerate the agriculture sector contribution to national growth domestic product, create a conducive environment for increased and sustained agricultural production and productivity as well as promote development of national agriculture sector across the value chain (NAP, 2015).

The Green Scheme policy (2008) was also an initiative by government under the Ministry of Agriculture, Water and Forestry (MAWF) to encourage the development of irrigation based agronomic production in Namibia. The aim of the policy was to increase the contribution of the agricultural sector to the country's gross domestic product and to achieve social development and upliftment of communities located within suitable irrigation areas as well as promote human resources and skills development.

In addition, the Agriculture Marketing and Trade Policy and strategy (2011) was formulated. This policy aims to contribute to the successful performance of the agriculture sector as well as compliment other policies and strategies across the agricultural value chain. The legal framework for the policy and strategy is defined on the basis of the Namibian constitution and major acts in the agriculture sectors. The policy framework outline draws from the MAWF's mandate and strategic plan, Vision 2030, subsidiary policies, schemes and projects.

In line with the National Agricultural Policy, the National Drought Policy and Strategy was formulated to manage drought a challenge facing the agricultural sector. The policy specifically aims to shift responsibilities for managing risk from government to the farmers with financial assistance and food security interventions. The objectives of the policy are among others to ensure that household food security is not threatened by drought, encourage and support famers to adopt self-reliant approaches to drought risk as well as finance drought relief programmes efficiently and effectively by establishing an independent and permanent National Drought Fund.

The National Horticulture Development initiative was implemented through the Namibian Horticulture Market Share Promotion (MSP) scheme by the Namibian Agronomic Board. The initiative was funded the Ministry of Agriculture, Water and Forestry under the Agronomic Industry Act no 20 of 1992 to promote the consumption of local produce, import substitution, agro-processing and export marketing of local fresh produce. Importers are expected to ensure that a minimum percentage of their horticulture produce purchases consists of Namibian products, failure to meet the required percentage they are curtailed in their imports pro rata.

Through the Act no. 5 Agricultural Bank of Namibia of 2003, Agribank was mandated to advance money to persons or financial intermediaries for the promotion of agriculture and related activities. Under this act Agribank introduced the Affirmative Action Loan Scheme (AALS) which enables emerging farmers from previously disadvantaged communities to acquire farms in commercial areas. The Affirmative Action Loan Scheme is complemented by the North South Incentive Scheme which is a vehicle for communal farmers to sell their livestock north of the Veterinary Cordon Fence (VCF) and to purchase disease free livestock south of the VCF on a newly acquired farm.

1.1.3 Challenges hampering the agriculture sector in Namibia

Namibia's agricultural sector is constrained by a number of challenges, among the others are:

Climate changes and water scarcity: Namibia as a semi-arid country is subjected to recurrent droughts. The effect of climate change continues to be of concern for agricultural producers in Namibia given the fact that the country depends more on rain fed agriculture. Farmers in Namibia, especially in the northern part of the country, have to deal with the threat of drought. The challenge of climate change prompted the government to promote green scheme irrigation projects to increase food security in the country. However, scarcity of water is also a major threat to development as the agricultural sector is the major user of water in Namibia. Both the agricultural sector and the water sector are vulnerable to climatic conditions, thus the country is faced with water shortages. The implications of climate change for agriculture are a major concern in Namibia.

Livestock diseases: The agriculture sector is also affected by frequent outbreaks of animal diseases such as foot and mouth. These outbreaks have affected growth in the agricultural sector especially in the northern parts of Namibia (Smit, Zaaruka & Tjeriko, 2018). Animal diseases might lower market value due to changes in livestock appearance, which is less attractive to buyers. The true market value of the final product might be altered. This could result in reduced meat consumption, thereby reducing exports.

High cost of production: According to Shapi (2017), high cost of production inputs such as seeds, fertilizers and lack of funding is the number one challenge followed by water and electricity bill. Farmers in communal areas are unable to afford seeds and a fertilizer due to higher prices thus, a hindrance to agricultural productivity. Another challenge for farmers is high transportation cost for their products to markets. When high transportation costs are involved, farmers find it difficult to get their produce to markets. In the end, profits are affected or losses are incurred.

Lack of quality agricultural data by policy makers: Policy makers are faced with lack of up to date quality data on the structure of agriculture. Therefore, farmers have a problem in accessing information related to production technologies, access to markets, price information and credit business.

Access to credit: Credit involves the risk of the borrower defaulting, thus, lenders pursue measures to reduce default risk to minimize losses that might be incurred. Potential borrowers are screened due to asymmetric information to which moral hazard could rise. A situation of opportunistic behavior in which a borrower takes advantage of

the lack of information by the lender. Moreover, a challenge faced by farmers in accessing credit was lack of collateral, high interest rates, delay in the processing and approval of loans. Collateral is a requirement one needs to have access to financing from any bank for business purposes, however, not everyone wanting to do business has collateral. People might be willing to engage in agricultural related activities but couldnot do so due to lack of collateral. According to Cloete (2013), farming without capital is pointless for any farming operation. Despite the availability of financial institutions such as Development Bank of Namibia, Agricultural bank of Namibia and other commercial banks, access to finance remains a challenge to farmers wanting to engage in agricultural related activities due to high interest rates and provision of collateral.

Weak capacity in processing and marketing of agricultural products: Since 1995, the government of Namibia took an initiative to encourage the diversification of subsistence farming into commercial farming through value addition. Namibia has also adopted the agricultural policy which aims at contributing to increased agricultural production, agro processing and marketing (Namibia Agriculture Policy, 2015). Comparatively, the Agro Marketing and Trade Agency (AMTA) under the Ministry of Agriculture, Water and Forestry was mandated by government to facilitate agricultural marketing for ease access to markets. However, it still remains a challenge as producers still encounter difficulties in marketing their produce. In addition, AMTA is still unable to expand markets for farmers, hence many fresh produce get spoiled at AMTA's hub (Shapi, 2017). Moreover, increased agricultural productivity requires investment in transport, storage and processing facilities.

1.1 STATEMENT OF THE PROBLEM

The performance of the Namibian economy has been mixed. It has been marked by positive but slow growth over the years. Over the years, Namibia has tried to promote agriculture through its development plans, however this has not been fruitful. The current National Development Plan (NDP5) still identifies the agricultural sector with the potential to boost economic growth, thereby, addressing challenges of food security, unemployment and poverty reduction. The desired outcome under NDP5 is to have food production increased to 30% cumulatively during the five-year period. Despite the government's efforts, the sector's contribution to GDP has not been significant enough, it decreased to about 3.4% in 2015 and 2016, respectively (Namibia Statistics Agency, 2016). Even though Oyakhilomen and Zibar (2014) stressed that agriculture is critical in achieving global poverty reduction in terms of its share of GDP, the sector's contribution to GDP is still minimal to stimulate economic growth as the country aspires. It is for this reason that this study sought to investigate the relationship between agricultural productivity and economic growth. Although, some economists support the view that agricultural development is a pre-requisite to stimulate growth, it might not be the case in some countries. Of importance, is to determine the causal relationship between agricultural productivity and economic growth, particularly, in Namibia. Hence, there is a need to investigate this relationship in the Namibian context. Odero (2017) has looked at the relationship between agricultural value addition and economic growth in Namibia. This study considered other variables which were found to be significant in the literature on the same topic with the use of Autoregressive Distributed Lag (ARDL) model.

1.2 OBJECTIVES OF THE STUDY

The main objective of the study is to investigate the relationship between agricultural productivity and economic growth in Namibia.

The specific objectives were:

- To analyze the long run relationship between agricultural productivity and economic growth in Namibia.
- To determine the direction of causality between agricultural productivity and economic growth (if any).

1.3 HYPOTHESES OF THE STUDY

In light of the above objectives, this study tested the following hypotheses:

H_{0a}: There is no long run relationship between agricultural productivity and economic growth in Namibia.

H_{1a}: There is a long run relationship between agricultural productivity and economic growth in Namibia.

H_{0b}: There is no causal relationship between Agricultural productivity and economic growth in Namibia.

H_{1b}: There is causal relationship between Agricultural productivity and economic growth in Namibia.

1.4 SIGNIFICANCE OF THE STUDY

The purpose of this study is to add to existing knowledge and benefit policy decision makers to implement better policies that would enhance agricultural production and promote international trade through value addition and be able to compete globally.

1.5 LIMITATION OF THE STUDY

The study is confined on the number of observations.

1.7 DELIMITATION OF THE STUDY

In analyzing the relationship between agricultural productivity and economic growth, this study is applied to the entire economy using national data. The study focused mainly on the agricultural sector since it is the major sector, which is supporting many Namibians. In other words, it is the source of survival for many Namibians.

1.8 OUTLINE OF THE STUDY

The structure of the study is outlined as follows: Chapter one presents the introduction in which the background of the study, statement of the problem, objectives, limitations, delimitations and significance of the study are discussed. Chapter two reviews both the theoretical and empirical literature on agricultural productivity and economic growth. Chapter three presents the research methods of the stated Autoregressive Distributed Lag (ARDL) model used for the study. It also includes the research design, procedure and data analysis. Presentation of results, research ethics, econometric tests and discussions are analyzed in chapter four. Finally, chapter five gives the conclusions and recommendations.

1.9 CONCLUSION

This introductory chapter defined the problem statement, which focused on the relationship between agricultural productivity and economic growth with emphasis on the Namibian economy. The chapter also outlined the study's background and research

objectives. The next chapter presents literature on agricultural productivity and economic growth.

CHAPTER TWO: LITERATURE REVIEW

2.1 INTRODUCTION

There is extensive literature and theories on agricultural productivity as a contributor to the well-being of an economy as a whole. This chapter outlines the theoretical and empirical literature on the relationship between agricultural productivity and economic growth. Various studies have examined the agricultural productivity and economic growth. A selective list of empirical studies done at a global perspective and Namibia in particular are discussed in this chapter. The chapter is organized as follows: section 2.2 reviews the theoretical literature on agricultural productivity and economic growth. A review of recent empirical literature is presented in section 2.3. Section 2.4 concludes the chapter.

2.2 THEORETICAL LITERATURE REVIEW

There have been different views on the role of agriculture in the process of stimulating economic growth. Earlier work on economic development state that agriculture was often neglected. Whereas, industrial development was considered the main driver of economic growth. Moreover, as early as Adam Smith, economists recognized that economic growth was accompanied by a sectoral transformation that leads to the movement of labor and other resources out of agriculture into other activities. This movement has important implications for income levels and growth rates (Gollin, 2010).

2.2.1 The Agriculture Growth Led theory

Advocates of the Agriculture Led Growth argued that agriculture development was a pre-requisite for industrialization through the increase in rural incomes and provision of

industrial raw materials, and the release of resources to support the industry. Thus, if the agriculture sector was neglected in favor of the industrial sector, it would only lead to slow growth. The notion of an agriculture led growth strategy was influenced by Johnston and Mellor (1961), and Schultz (1961) among others. Emphasis was put on the role of smallholder farming in stimulating economic growth and development. The importance of agricultural growth in raising incomes and foreign exchange earnings through linkages between agriculture and non- agriculture was also stressed (Badiane & Makombe, 2014).

Johnston and Mellor (1961) as cited in Dercon and Gollin (2014), demonstrate that economic policy ought to have favored agriculture as a vehicle for growth in poor economies such as those of Sub-Saharan Africa. Furthermore, Johnston and Mellor (1961) state that agriculture should not only be seen as a source of surplus to support industrialization but as a dynamic source of growth, employment and equal income distribution (Breisinger & Diao, 2008).

Schultz (1964) was among the earlier economists who emphasized that productivity led agricultural transformation could make a much more important contribution to the economy than just providing surplus labour and savings to support industrialization. Furthermore, Schultz alluded that farmers should be entrepreneurs even within traditional agricultural systems. The existence of a micro foundation of farmers to adopt modern technologies could make agriculture an important driver of growth (Breisinger & Diao, 2008). Moreover, it was argued that only after the productivity in the agricultural sector had increased and agricultural output had grown, then economic growth could be experienced (Los & Gardebroek, 2015). Higher agricultural

productivity increases the income of the rural population, raising demand for industrial output.

2.2.2 The Physiocrats

The physiocrats argued that the development of an economy depended on the growth of the agricultural sector. The physiocrats emphasized that agriculture is crucial in the development of an economy. In their views, the development of an economy depended on the growth of the agricultural sector and the economy was regulated by productivity in agriculture. That is, its surplus was diffused through transactions (Matthew & Mordecai, 2016). The idea of the physiocrats was such that, agriculture was the productive sector of an economy; it was divided into landlords, farmers and artisans. The founder of the physiocracy was Francois Quesnay (1694-1774). According to Quesnay wealth originated with production from the land and then flowed hand to hand with trade transactions providing income for the nation. Moreover, agriculture was the first and primary step to survival. Quesnay and other physiocrats believed that the removal of practices such as unfair tax systems that were exploiting agriculture; allowed the flow of capital to agriculture to increase from small scale capital starved subsistence farming to a more prosperous farming system. Furthermore, the physiocrats stated that the economy had a natural beginning with production of a net product from land and the income received from this production flowed through the rest of the economy. The whole system operated naturally without government intervention advocating for a policy of laissez-faire (de Yong, 1994). According to the physiocrats, agriculture was the only genuinely productive sector of the economy and the generator of surplus to which all depends.

Adam Smith criticized the physiocrats' belief that agriculture alone produced true wealth and that manufacturing and trade merely changed production in a way. However, Smith agreed that labor working in agriculture provided new wealth by harvesting production from the earth and that agriculture was a necessary step in the economy (de Yong, 1994).

2.2.3 The Lewis model

Lewis (1955) model's development is a process of transformation of rural agriculture into urban manufacturing sectors. Lewis viewed economic development as a growth process of relocating factors of production such as labor from an agricultural sector with low productivity and the use of traditional technology to a modern industrial sector with higher productivity. Agriculture acted more as a source of food and labor than a source of growth (Byerlee, Diao & Jackson, 2005). The Lewis model rested on the idea of surplus labor in the agricultural sector. It is stated that, lower productivity in the agricultural sector led to higher wages in the modern sector, which in turn generated economic growth. Johnston and Mellor (1961) built on the Lewis model by recognizing the agricultural sector as an active sector in the economy. Furthermore, the agricultural sector played an important role in economic growth through production and consumption linkages, in addition to providing labor and food supply. Johnston and Mellor (1961) further stress that agriculture could provide raw materials to the modern sector for non-agricultural production, therefore, higher productivity in agriculture could increase the income of rural population. The linkages were further emphasized by Singer (1979) who stated that, because of production and consumption linkages, a country's development strategy should not be export driven but rather agriculture driven.

Therefore, increased agricultural productivity would be the initiator of industrialization (Dethier & Effenberger, 2011). Greyling (2012) debates on the Lewis model and states that the problem of a decrease in rural production leads to a decrease in rural income which in turn reduces industrialization due to a decrease in the demand of manufactured goods. Hence, low agricultural productivity would result in an insufficient market for agricultural goods.

2.2.4 Rostow's growth stage theory

According to Rostow's growth stage theory, the agriculture sector had a dynamic role in the transition process of the economy. Therefore, the primary sector industries would act as leading sectors, thereby, carry the burden of accelerating growth. Agriculture would provide: (i) food for the increasing population; (ii) provide a mass market for the products and; (iii) generate capital investment for sectors outside of agriculture (Ruttan, 1968). Rostow listed five growth stages such as the traditional society, the preconditions for take-off, the take-off, the drive maturity and the age of high mass consumption.

2.2.5 The Fisher- Clark Model

The Fisher- Clark theory of structural change by Fisher (1935) and Clark (1940) state that every economy would pass through three stages. The first stage being agriculture, the second stage is industrial and the third stage is services. The theory described structural transformation in the process of economic development as a sequential denomination by the primary sector (agriculture) followed by the secondary sector (manufacturing) and the tertiary sector (trade and service). Fisher and Clark stated that because of low-income elasticity of demand for agricultural products and high-income elasticity of demand for manufactured goods and services shifts from agriculture to

industry occurred. With rising levels of income the demand for agricultural products declined while that of industrial goods increased. However, after reaching a reasonable high level of income demand for services increased. Fisher emphasized the saturation of demand for manufactured goods and high-income elasticity of demand for services (Aggrey, 2009).

2.3 EMPIRICAL LITERATURE REVIEW

Various studies have focused on understanding the association between agriculture and economic growth yet some disagreements still exist. Among the papers that analyzed agricultural productivity are discussed in the next section.

Empirical Literature on agriculture from various countries

A study by Katircioglu (n.d) on North Cyprus investigated the possible cointegration and causality between economic growth including agriculture, industry and services. It used time series data from 1977 to 2002. The study revealed that agriculture was still the backbone of North Cyprus economy and a unidirectional causality running from real GDP to industrial output and services sector was found. The GDP growth gave a unidirectional causation to agricultural expansion while agricultural growth did not.

Diao, Hazell and Thurlow (2010) investigated the role of agriculture in African development. The findings show that while Africa does face many new challenges unlike Asian countries, there was little evidence to suggest that these countries could bypass a broad based agricultural revolution to successfully launch their economic transformations.

A study by Ludena (2010) analyzed agricultural productivity growth, efficiency change and technical progress in Latin America and the Caribbean using data from 1961 to 2007 employing the Malmquist Index a non- parametric methodology that uses data envelopment analysis (DEA). The results showed that Latin America and the Caribbean showed the highest agricultural productivity growth. On a similar note, Awan and Alam (2015) investigated the impact of agriculture productivity on economic growth in Pakistan using time series data from 1972 to 2012 with the use of the Autoregressive Distributed Lag model (ARDL). The study conclude that inflation has a negative effect on economic growth while trade openness, employed labour force and agricultural value added are positively related to economic growth. In addition, the study indicated that the big share of agriculture contribute more in economic growth thus government should increase the higher education in both agriculture and industrial sector to enhance employed labour force.

In Thailand, Jatuporn, Chien, Sukprasert and Thaipakdee (2011) investigated the long run relationship between agriculture and economic growth. A Granger causality approach and the Wald coefficient statistic were utilized to reveal a causal relationship and impact transmission between the variables. The study used time series data for the period 1961 to 2009. The study discovered a long run relationship running from both agriculture and economic growth. Moreover, the study concluded that policy makers should regard agriculture as an important supporter of economic growth in Thailand economy.

In Pakistan, Faridi (2012) examined the contribution of agricultural exports to economic growth. The study employed the Johansen's cointegration technique for the period 1972

to 2008. The findings of the study showed that the agricultural exports had a negative and significant effect on economic growth with elasticity of 0.58. Moreover, a bidirectional causality in agricultural exports and real GDP was observed. Thus, the study suggested the promotion of non-agricultural exports. Similarly, Bulagi, Hlongwane and Belete (2014); Ali Shah, Abrarulhaq and Farooq (2015); Toyin (2016); Venter and Becvarova (2016); Sheefeni and Simasiku (2017); Alam and Myovella (2017) analyzed the impact of agricultural exports and economic growth in various countries. In South Africa, Bulagi, Hlongwane and Belete (2014) also examined the causal relationship between agricultural exports and agriculture's share of gross domestic product. The study made use of time series data for the period 1994 to 2011. The results of the Granger causality test revealed a unidirectional causality running from agricultural exports to GDP.

Ali Shah, Abrarulhaq and Farooq (2015), also analyzed the impact of agricultural exports and economic growth in Pakistan. The study employed Johansen cointegration technique on secondary data for the period 1972 to 2008. The main finding of the study was that agricultural exports had a negative relationship with economic growth while non- agricultural exports had a positive relation with economic growth. The study further suggested that Pakistan had to do structural changes in agricultural exports by converting its agricultural exports into value added products. These results were similar to those of Faridi (2012).

Toyin (2016) investigated the causal relationship between agricultural exports and economic growth in South Africa and used time series data for the period 1975 to 2012. The study concluded that there was no existence of causality between agricultural export

components (processed and unprocessed) and economic growth. The study further revealed that the non-causation between agricultural exports and economic growth indicated that the level of agricultural exports in the past was insufficient to stimulate economic growth and the present economic growth in the country did not exclusively rely on the level of agricultural exports either. These results contradicted those of Bulagi, Hlongwane and Belete (2014). Venter and Becvarova (2016) also analyzed the impact of agricultural exports and economic growth in Nigeria. The study used OLS regression, Granger causality, impulse response function and variance decomposition approaches. The findings showed an inverse relationship between the agricultural degree of openness and economic growth. The impulse response function results revealed upward and downward shocks from agricultural exports and economic growth. Furthermore, variance decomposition results revealed that a shock to agricultural exports contributed to the fluctuation in the variance of economic growth in the long-run. The study concluded that for Nigeria to experience a favorable trade balance in agricultural trade, domestic processing industries should be encouraged.

On the same subject matter, Alam and Myovella (2017) studied the causality between agricultural exports and GDP and its implications for Tanzanian economy. The study employed secondary time series data from 1980 to 2010. The study found evidence that agricultural exports Granger cause GDP growth but not the other way round. Furthermore, the study recommended the promotion of agricultural exports as a tool to promote economic growth in Tanzania. These results were in line with those of Bulagi, Hlongwane and Belete (2014). Furthermore, worth noting was that, the contribution of agricultural growth to economic growth varied from country to country and from one

period to another within the same economy. This explained the difference of results by Bulagi, Hlongwane and Belete (2014) as well as those of Toyin (2016) particularly in South Africa.

In Namibia, Sheefeni and Simasiku (2017) analyzed the relationship between agricultural export and economic growth. The study made use of time series quarterly data covering the period 1990 to 2014. The study employed Augmented Dickey Fuller test, Johansen cointegration test and error correction model respectively. The study revealed that agricultural exports had a positive and insignificant effect on economic growth while non-agricultural exports had a positive and significant effect on economic growth. It further concluded that agricultural exports, non-agricultural exports and consumer price index are long run determinants of economic growth. These results contradicted those in Pakistan by Faridi (2012) and Ali Shah, Abrarulhaq and Farooq (2015), in that, a negative relationship between agricultural exports and economic growth was recorded. This could be attributed to the use of different methodologies in both countries.

In North Carolina, Herath, Bashir and Gebremedhin (2013) examined the potential use of agricultural sector in the economic growth for the period 2000 to 2010. The results revealed that increasing income increased agricultural activities and vice versa. Countries with high income were more capable of improving agriculture as high income would prompt more investment in the agricultural sector, thereby increase production.

In Ghana, Enu (2014) investigated the agricultural sector and its economic impact on economic growth using time series data from 1996 to 2006 and the study employed the

Ordinary Least Squares. The results revealed that agricultural output had a significant positive impact on the growth of Ghana. A 1% increase in agricultural output would cause GDP to increase by 0.354515%. Furthermore, the study revealed that both crops and livestock have positive impacts on GDP growth in Ghana while fisheries and forestry were found to have negative impacts.

In Nigeria, Olajide, Akinlabi and Tijani (2012) analyzed the relationship between agricultural resource and economic growth. Agriculture resource was defined as agricultural output in this study. The study employed Ordinary Least Square regression method using annual time series data for the period 1970 to 2010. The results revealed a positive cause and effect relationship between gross domestic product and agricultural output. In order to improve agriculture the government should see that special incentives are given to farmers, provide adequate funding as well as provide infrastructural facilities like good roads, pipe borne water and electricity.

In their study, Uma, Eboh and Obidike (2013) assessed the influence of agriculture on economic growth in Nigeria, their study employed Augmented Dickey Fuller and Phillips Perron tests, the Johansen co-integration and Error Correction model. In their study, agriculture was defined as crop production, livestock, forestry and fishing. The study found that the contributions of crop production, livestock and fishing on economic growth were insignificant while forestry contributed significantly to growth. Oyakhilomen and Zibah (2014) analysed the relationship between agricultural production and economic growth in Nigeria and used ARDL testing approach. The results indicated that agricultural production was significant in influencing economic growth. The study further recommended that pro poor policies should be designed to

alleviate rural poverty. This could be done through increased investments in agricultural development by both the public and private sector. Private sector engagement was crucial, as the government (public sector) could not operate alone.

In a similar manner, Odetola and Etumnu (2014) examined the contribution of agriculture to economic growth in Nigeria and made use of time series data from 1960 to 2011. The study employed a growth accounting framework. The study found that the agriculture sector contributed positively and consistently to economic growth in Nigeria, reaffirming the sector's importance in the economy. The study also found that crop production subsector contributes the most to agricultural sector growth. The Granger causality test results showed that agricultural growth Granger causes GDP growth, however, no reverse relationship was found. Again, in Nigeria, Sertoglu, Ugural and Bekun (2017) also investigated the contribution of agricultural sector on economic growth using Vector Error Correction Model. The findings revealed that the speed of adjustment of the variables towards their long run equilibrium path was very low, though agricultural output had a positive impact on economic growth. The study recommended that government and policy makers should embark on diversification and enhance more allocation in terms of budgeting to the agricultural sector.

Ismail and Kabuga (2016) also explored the impact of agricultural output and economic growth in Nigeria. The study used ARDL for the period 1986 to 2015. The study concluded that agricultural output was an important determinant of economic growth. Similarly, a study by Obalanji, Adebisi, Ese and Emmanuel (2017) also examined the relationship between agricultural output and economic growth in Nigeria for the period 1981 to 2014 using time series data. The study employed the Vector Error Correction

model and Johansen co-integration approach. The results showed evidence of a long run relationship between agricultural output and economic growth while Granger causality test confirmed the existence of causality between the variables. Despite the use of different methodology in their studies, their results concluded that agricultural output was an important determinant of economic growth.

Awoyemi, Afolabi and Akomolafe (2017) explored agricultural productivity and economic growth in Nigeria employing annual data for the period 1981 to 2015 using Error Correction model and the Johansen co-integration test. The study found that agricultural labor productivity and agricultural value added were positive determinants of economic growth.

Empirical Literature on agriculture from Namibia

For increased productivity and value addition to be realized, the manufacturing sector is of importance in terms of providing machinery equipment as part of production input. Both the agricultural sector and manufacturing sector are crucial players in Namibia's growth path. Therefore, sectoral linkages or interrelationships between the two sectors should be emphasized. However, Siboleka, Nyambe and Osterkamp (2014) analyzed agriculture and manufacturing sector growth in Namibia. The study employed a Granger causality model for the period 1981 to 2012. The study discovered that sectoral linkages between the two sectors were not effective enough to have a strong impact on one another. This simply meant that without effective linkages there was no multiplier effect on economic growth. Moreover, industrialization could take more than anticipated.

Finally, Odero (2017) analyzed the causal relationship between agricultural value addition and economic growth in Namibia employing annual data for the period 1980 to 2015. Using the Vector Autoregressive approach, the results revealed a unidirectional causal relationship running from agricultural value added to economic growth. This present study was similar with that of Odero (2017) however, it employed two control variables namely, trade openness and inflation rate which were not covered by Odero (2017) identified through literature and relevant for the study.

2.4 CONCLUSION

The vast literature covered in this chapter showed that agricultural productivity had a positive impact on economic growth, thereby, supporting economic theory. It was observed that there was no consensus regarding the relationship of agriculture and economic growth. In some cases empirical literature varied from what theory states and some researchers were for or against other researchers.

Oyakhilomen and Zibah (2014) found that agricultural production was significant in influencing economic growth which concurs with economic theory by the physiocrats that development of an economy depended on the growth of the agricultural sector. Therefore, agriculture is crucial in the development of an economy. Herath, Bashir and Gebremadhin (2013) revealed that increasing agricultural activities also increased income which was consistent with economic theory by Schultz (1964) who argued that higher agricultural productivity increases the incomes of the rural population, raising demand for the industrial output (Los & Gardebroek, 2015). Researchers such as Ali Shah, Abrarulhaq and Farooq (2015) and Faridi (2012) observed similar results that

agricultural exports had a negative relationship with economic growth while nonagricultural exports had a positive relation with economic growth. However, Sheefeni and Simasiku could not agree more as they found that agricultural exports had a positive and insignificant effect on economic growth. A study by Bulagi, Hlongwane and Belete (2014) found a unidirectional causality from agricultural exports to GDP whereas Toyin (2016) found no existence of causality between the variables. On the other hand, Alam, and Myovella (2017) found evidence that agricultural exports Granger cause GDP growth and these results were in line with those of Bulagi, Hlongwane & Belete (2014).

Numerous studies found one way causal relationship and some found no causal relationship. With regards to the review of literature particularly on Namibia, the studies were closely related to the present study. This present study was similar with that of Odero (2017) however, it employed a different methodology (ARDL) and considered two control variables namely, trade openness and inflation rate which were found to be significant in the literature on the same topic but not covered by Odero (2017).

For economic growth to be realized, economic transformation of the agricultural sector through value addition (manufacturing) should take place. In theoretical terms, the agricultural sector and the manufacturing sector are crucial players in stimulating economic growth through its backward and forward linkages, however in Namibia; a case study by Siboleka, Nyambe and Osterkamp (2014) proved otherwise.

CHAPTER THREE: RESEARCH METHODS

3.1 INTRODUCTION

This chapter describes the methodology used in this study. It also discusses the data analysis procedure as well as the sources of data used for the study.

3.2 RESEARCH DESIGN

A quantitative research design was used in this study. Economics analytical tool E-Views was used to analyze the data. Autoregressive Distributed Lag (ARDL) model, unit root and Toda-Yamamoto Granger causality were employed in the analysis.

3.3 DESCRIPTION AND MEASUREMENT OF VARIABLES

The variables of interest in this study were real Gross Domestic Product growth as the dependent variable, agricultural value added as the independent variable, with inflation rate and trade openness as control variables. Brief descriptions and measurement of these variables are presented in the next sections.

3.3.1 Agricultural Productivity

Agricultural productivity is defined as the ratio of final output to inputs (Awoyemi, Afolabi & Akomolafe, 2017). Agricultural productivity refers to the output produced by a given level of inputs in the agricultural sector of a given economy. It consists of all factors of production such as labour, capital, farming, availability and management of water. This study used the same definition used by Odero (2017) and Awoyemi, Afolabi and Akomolafe (2017) for measuring productivity. In this study, agricultural productivity is measured by Agricultural value added expressed as a percentage of GDP.

The agricultural sector increases real GDP by generating agricultural surplus by increasing agricultural production and utilizing the surplus labor.

3.3.2 Economic Growth

A country's economic condition and its growth are measured by its Gross Domestic product. Economic growth is defined as the increase in production of goods and services over time. It was measured by the annual percentage change in Real Gross Domestic Product. Economic growth is important for one country to achieve a higher living standard for citizens and it is the leading goal of policy makers worldwide (Hernandez, 2011) as cited in Alam and Myovella (2017). However, in achieving the goal of economic growth, approaches in attaining economic growth do vary across countries. Economic growth earnings were expected to have a trickling down effect of providing monetary resources for embarking on developmental programs in any country (Toyin, 2016). Among the macroeconomic drivers of economic growth was agricultural productivity through the export of agricultural goods and services.

3.3.3 Trade Openness

Osabuohien (2007) defines trade openness as the integration among nations. Openness is likened to a situation where nations work together in order to have free trade and free movement of capital and financial activities. Therefore, trade openness is assumed to stimulate economic growth through the flow of foreign investment from developed countries to their developing counterparts. The indicators of openness include the rapid growth of international trade, foreign direct investment and flows of capital. Trade openness is measured as the ratio of the sum of both imports and exports to the country's

GDP. Increasing foreign trade could have a significant impact on wages, employment and investment thereby resulting in higher aggregate output in the agricultural sector and overall country development (De silva, Malanga & Johnson, 2013).

3.3.4 Inflation Rate

Inflation was defined as the increase in the level of consumer prices or the decline in the purchasing power of money. In real terms, inflation means that your money cannot buy much of what it could have bought the previous day. High inflation indicated that the economy was not controlled properly, which leads to low growth of the economy. Inflation could lead to uncertainty of future profitability of investment projects. It also reduced a country's international competitiveness making its exports more expensive thus, impacting the balance of payments (Gokal & Hanif, 2004). Moreover, inflation rate was measured by the annual percentage change in consumer price index divided by the consumer price index from the base year.

3.4 PROCEDURES

The study used secondary annual time series data for the period 1981 to 2016 and the variables considered were identified from literature. The sources include World Bank's data base and Namibia Statistics Agency's national accounts (2016).

3.5 DATA ANALYSIS

The methodology followed the following procedures; testing for unit root using the Augmented Dickey Fuller test and the Phillip Peron test, followed by ARDL cointegration approach to analyse the long run relationship between the variables. The

Toda-Yamamoto Granger causality approach was also employed to test the causal relationship between the variables.

3.6 MODEL SPECIFICATION

To empirically analyse the long run relationships among the variables, this study adopts the model used by Awan and Alam (2015). This model is estimated using bounds testing ARDL cointegration procedure. The estimated equation to analyse long run relationship between agricultural productivity and economic growth can be specified as:

$$RGDPg_t = \beta_o + \beta_1 AGVA_t + \beta_2 TOP_t + \beta_3 INFR_t + \varepsilon_t \dots \dots \dots (1)$$

Where RGDPg is the real gross domestic product growth rate, AGVA is agricultural value added, TOP is trade openness, INFR is inflation rate, β_o is a constant, $\beta_1, \beta_2, \beta_3$ are coefficients of the independent variables and ε_t is the error term.

3.7 UNIT ROOT TESTING

The initial step was to test for stationarity of variables to determine the order of integration. This was because, regression involving non-stationary variables yields spurious results or gives misleading inference leading to poor understanding and forecasting as the estimated coefficients would be biased and inconsistent. Thus, the variables were subjected to unit root test; to test for stationarity. Time series data has trends over time, hence they might contain unit root. The presence of unit root in the time series indicated that the variables are non-stationary while the absence implied that the variables are stationary, meaning the mean, variance and covariance are constant over time. They do not depend on time, therefore, they are time invariant. In addition, if

time series are stationary they do not move far from each other, whereas, if time series are non-stationary, they tend to wander too far from each other. It is therefore important to ensure that the series are stationary for the model to be feasible. Even though, ARDL does not require pre-testing of variables for unit root, unit root still remains necessary to ensure that none of the variables are integrated of order I (2) or more. The presence of variables integrated of order (2) or more would mean the computed F-statistic was not valid based on the assumption that variables are integrated of order zero and one. It was for this reason that this present study employed the unit root test to check whether the time series were stationary and integrated of what order. Various literature propose the use of these unit root tests such as the Augmented Dickey Fuller test (ADF), the Phillips Perron test (PP) and the KPSS test among others.

3.8 BOUNDS TESTING TO COINTEGRATION TEST

After testing for stationarity, one had to test for cointegration, which implies a long run relationship among variables. If there is cointegration, it means that variables do converge to some kind of equilibrium in the long run. Co-integration can be tested in several ways depending on the model being tested. When testing a single equation, the Engle Granger method is used and when testing a multivariate system, the Johansen approach is used. Furthermore, the unit root test results can dictate which method to be used. If some of the variables are integrated of order zero while others are integrated of order one the use of the Autoregressive Distributed Lag (ARDL) also known as the cointegration bound test approach was appropriate. This present study used the bounds test to cointegration approach proposed by Pesaran, Shin and Smith (2001) to analyse the presence of long run relationships among variables. The bound testing approach to

cointegration is applicable regardless of whether the variables are integrated of order zero I (0) or order one (1) (Mah, 2000). The ARDL method is based on the estimation of an unrestricted error correction model (UECM). Pesaran, Shin and Smith (2001) developed two sets of critical values for the cointegration test, the upper bound and lower bound (Narayan, 2005). The upper bound assumes that all variables are integrated of order one implying the existence of cointegration among the variables. The lower bound test assumes that all variables are integrated of order zero I (0) meaning that there is no cointegration between the variables. If the computed wald or F- statistic falls outside the critical value bounds a conclusive inference can be drawn. However, if the F- statistic falls inside the critical value bound inference would be inconclusive. However, these critical values by Pesaran, Shin and Smith (2001) were only generated for sample sizes of 500 and 1000 observations and 20 000 and 40 000 observations respectively. Narayan (2005) argued that the existing critical values were based on large sample sizes thus could not accommodate small sample sizes. Furthermore, he introduced critical values for 30 to 80 observations. Therefore, given the relatively small sample size in the present study (36 observations) critical values were calculated specific to the sample size.

The advantages of using the ARDL approach is: Firstly, the method is more efficient in small sample size like for this present study while the Johansen cointegration approach require large sample sizes to achieve reliability. Secondly, this method is simple compared to other cointegration techniques such as the Johansen cointegration test. Thirdly, the method does not require pre- testing of the variables to determine whether there is unit root in the variables or order of integration to determine the long run

relationship among the variables. However, it is of importance to note that the bound testing approach does not accommodate variables that are integrated of order I (2) or more (Ziramba & Dembure, 2015). Thus, the variables were subjected to pre- testing to check their individual unit root to ensure that none of the variables were of I (2) or more. Lastly, it accommodates a combination of variables integrated of order zero and one. The bound testing was based on the null hypothesis of no cointegration against the alternative hypothesis of cointegration. To test for the hypotheses requires conducting the F-test. The bounds testing to cointegration involves the comparison of the F- statistic against the critical values generated for specific samples sizes. If the F-statistics is above the figure for the upper critical bound, the null hypothesis of no cointegration is rejected. Similarly, if the F-statistics is below the figure for the lower critical bound the null hypothesis cannot be rejected (Narayan, 2005). The F- test has a non- standard distribution that depends on i) whether variables included in the ARDL model are of order zero or one ii) the number of regressors iii) whether the ARDL contains an intercept or a trend iv) the sample size.

The bounds test approach to cointegration involves estimating the following unrestricted error correction model (UECM):

$$\Delta RGDPg_t = \beta_0 + \sum_{i=1}^n \beta_{1i} \Delta RGDPg_{t-i} + \sum_{i=0}^n \beta_{2i} \Delta AGVA_{t-i} + \sum_{i=0}^n \beta_{3i} \Delta TOP_{t-i} + \sum_{i=0}^n \beta_{4i} \Delta INFR_{t-i} + \gamma_1 RGDP_{t-1} + \gamma_2 AGVA_{t-1} + \gamma_3 TOP_{t-1} + \gamma_4 INFR_{t-1} + \varepsilon_t \dots \dots \dots (2)$$

Where Δ is the denotes the difference operator, ε_t is the error term and t is the time period, where as $\beta_1, \beta_2, \beta_3, \beta_4$ are coefficients of the independent variables. The bounds test analyzes the following hypotheses.

$$H_0: \gamma_1 = \gamma_2 = \gamma_3 = \gamma_4 = 0$$

$$H_1: \gamma_1 \neq 0, \text{ or } \gamma_2 \neq 0, \text{ or } \gamma_3 \neq 0, \text{ or } \gamma_4 \neq 0$$

The null hypothesis states that there is no cointegration while the alternative states that there is cointegration. The null hypothesis is tested by means of the F- statistic which tests the significance of the lagged levels of the variables. The critical values (upper and lower bound) to reject the null hypothesis were developed by Pesaran et al (2001). The lower bound assumes that all variables are integrated of order I (0) meaning that there is no cointegration among the examined variables. The upper bound assumes that all variables are integrated of order I (1) meaning that there is cointegration. These, critical values by Pesaran, Shin and Smith (2001) were only designed for large sample sizes not small sample sizes like in this present study. However, Narayan (2005) introduced critical values for samples from 30 to 80 observations to accommodate small sample sizes of this nature. Thus, the critical values for rejecting the null hypothesis for this study with 36 observations were based from the critical table of Narayan (2005) based on 30 to 80 observations. The decision rule whether to reject the null hypothesis is such that if the F- statistic was lower than the lower critical bound, the null hypothesis is not rejected. On the other hand, if the F-statistic exceeds the upper bound, the null hypothesis is rejected. However, if the F-statistic lies between the lower and upper bounds the test is inconclusive. Studies such as Ziramba and Dembure (2015), Amiri and

Ventelou (2012), have used ARDL approach to cointegration and the Tado- Yamamoto approach to Granger causality.

3.9 THE TODA-YAMAMOTO APPROACH TO GRANGER CAUSALITY

Furthermore, as outlined by the objectives of this study was to analyse the direction of causality among the variables. Granger causality test was developed by Granger (1969) to examine for causality among variables. Granger causality; is used to test if the variables are able to predict one another (Stock & Watson, 2001). It was possible to have causality running from variable X to Y but not from Y to X. If Granger causality holds, it does not guarantee that X causes Y, but it suggests that X might be causing Y. Four patterns of causality could be distinguished. Firstly, a unidirectional causality from X to Y; secondly, a unidirectional causality from Y to X; thirdly, a bidirectional causality and lastly, no causality. Granger (1988) as cited in Chang and Hong Ho (2002) stated that if there exists co-integrating vectors among variables, there must be causality between these two variables in at least one direction. Granger causality test was the most common way to test for causality among variables. However, the test was associated with weaknesses of non-stationarity which lead to spurious results.

To test for the causal relationship between agricultural productivity and economic growth in Namibia, this study used the Toda- Yamamoto approach to granger causality. The Toda- Yamamoto is a modified version of the Ordinary Granger Causality. It uses a modified Wald test (MWALD) for the causality test. The Toda- Yamamoto was employed for the following reasons:

- a) The Toda- Yamamoto (1995) test augments the correct order of the VAR k by the maximum order f of integration, d_{max} and ensures that the usual test statistics for statistic for Granger causality have the standard asymptotic distribution (Amiri & Ventelou, 2012).
- b) It involves estimation of a VAR model in levels which minimizes the risks associated with wrongly identifying the order of integration of variables (Amiri & Ventelou, 2012).
- c) The Toda –Yamamoto approach was found to be superior as opposed to the Ordinary Granger Causality as it does not require pre-testing of variables for cointegration. Thus, it overcomes the problem of asymptotic critical values when the causality test is done on non-stationary or non cointegrated variables (Dembure & Ziramba, 2016).

The following steps are involved under the Toda- Yamamoto approach: Firstly, the determination of the maximum order of integration which involves the testing of variables to determine their order of integration with the use of Augmented Dickey Fuller (ADF) test, Phillips Peron (PP) among others. Secondly, the determination of the optimal lagged length (k) which is unknown and has to be estimated from the VAR estimation of variables in their levels. The lag length criteria can be obtained using the following criteria such as the Akaike Information Criterion (AIC), Schwarz Information Criterion (SIC), Final Prediction Error (FPE) and the Hannan Quinn Information Criterion (HQIC). Lastly, testing for causality which is utilised using the Modified Wald (MWALD) approach. The MWALD test which follows a Chi-square distribution has an asymptotic property when VAR ($k + d_{max}$) is estimated.

To apply the Toda- Yamamoto's version of the Granger non causality test we summarize the model in the following VAR system:

$$\begin{aligned}
 RGDPg_t = & \alpha_0 + \sum_{i=1}^k \alpha_{1i}RGDPg_{t-i} + \sum_{j=k+1}^{d \max} \alpha_{2j}RGDPg_{t-j} + \sum_{i=1}^k \beta_{1i}AGVA_{t-i} + \sum_{j=k+1}^{d \max} \\
 & \beta_{2j}AGVA_{t-j} + \sum_{i=1}^k \phi_{1i}TOP_{t-i} + \sum_{j=k+1}^{d \max} \phi_{2j}TOP_{t-j} + \sum_{i=1}^k \sigma_{1i}INFR_{t-i} + \sum_{j=k+1}^{d \max} \\
 & \sigma_{2j}INFR_{t-j} + \varepsilon_{1t} \dots \dots \dots (3)
 \end{aligned}$$

$$\begin{aligned}
 AGVA_t = & \beta_0 + \sum_{i=1}^k \beta_{1i}AGVA_{t-i} + \sum_{j=k+1}^{d \max} \beta_{2j}AGVA_{t-j} + \sum_{i=1}^k \gamma_{1i}TOP_{t-i} + \sum_{j=k+1}^{d \max} \gamma_{2j}TOP_{t-j} \\
 & + \sum_{i=1}^k \theta_{1i}INFR_{t-i} + \sum_{j=k+1}^{d \max} \theta_{2j}INFR_{t-j} + \sum_{i=1}^k \delta_{1i}RGDPg_{t-i} + \sum_{j=k+1}^{d \max} \delta_{2j}RGDPg_{t-j} + \\
 & \varepsilon_{2t} \dots \dots \dots (4)
 \end{aligned}$$

Where ε_1 and ε_2 are error terms that are assumed to be white noise, k is the optimal number of lags and $dmax$ is the highest order of integration. The maximum lag length will be determined using the Akaike information Criterion (AIC). The model is estimated using Seemingly Unrelated Regression (SUR). The Toda- Yamamoto uses a modified Wald (MWALD) test and it follows a Chi-square distribution.

When testing whether AGVA Granger causes RGDPg from equation (3) above the null (H_0) and alternative (H_1) hypotheses are specified as follows:

$$H_0: \beta_{11} = \beta_{12} = \beta_{13} = \dots = \beta_{1k} = 0$$

$$H_1: \beta_{11} \neq \beta_{12} \neq \beta_{13} \neq \dots \neq \beta_{1k} \neq 0$$

Similarly, when testing whether RGDPg Granger causes AGVA from equation (4) above the null (H_0) and alternative (H_1) hypotheses are specified as follows :

$$H_0: \delta_{11} = \delta_{12} = \delta_{13} = \dots = \delta_{1k} = 0$$

$$H_1: \delta_{11} \neq \delta_{12} \neq \delta_{13} \# \dots \# \delta_{1k} \neq 0$$

In both cases, failing to reject the null hypothesis means there is no causality from either direction. The causality between the variables can be unidirectional, bidirectional or no causality. Unidirectional causality exists when the null hypothesis of equation (3) is rejected and fail to reject the null hypothesis of equation (4) then concluding that changes in RGDPg are caused by changes in AGVA or if the null hypothesis of equation (3) is not rejected and reject the null hypothesis of equation (4) concluding that changes in AGVA are caused by changes in RGDPg. Bidirectional causality occurs when both null hypotheses of equation (3) and (4) are rejected. No causality exists if neither null hypotheses of equation (3) and (4) are rejected.

3.10 LONG RUN MODEL

Based on the evidence of the bounds to cointegration, the long run relationship between agricultural productivity and economic growth is estimated by determining the lag orders of the ARDL model with the use of Akaike Information Criterion (AIC).

The model to be estimated is:

$$RGDPg_t = \beta_0 + \sum_{i=1}^n \gamma_i RGDPg_{t-i} + \sum_{i=0}^n \delta_i AGVA_{t-i} + \sum_{i=0}^n \phi_i TOP_{t-i} + \sum_{i=0}^n \theta_i INFR_{t-i} + \varepsilon_t \dots \dots \dots (5)$$

3.11 DIAGNOSTIC TEST

In order to ascertain the goodness of fit of the ARDL model, diagnostic and stability tests should be conducted. The model is subjected to diagnostics to ascertain the appropriateness of the ARDL model. The test is used to check for normality, serial correlation, autoregressive conditional heteroscedasticity and the functional form of the model for omitted variables (Manyeki & Kotosz, 2017). The stability test is tested using the cumulative sum of recursive residuals (CUSUM) and the CUSUM of square test. Stability test is important as unstable parameters results in the misspecification of the model. The Breusch Pagan Godfrey test was used to test for heteroscedasticity while the Arch test was used to test for conditional heteroscedasticity among the variables. The Breusch- Godfrey was used to test for serial correlation. Finally, the Jacque- Bera test was used to test for normality distribution in the residuals.

3.12 RESEARCH ETHICS

All cited sources of information used in the study were acknowledged using Harvard referencing style. There was no alteration of results. The study reflects the original work of the author in its entirety.

3.13 CONCLUSION

This chapter outlined the research methods adopted in this study as well as the description of variables used. It also laid a foundation on what chapter 4 entails.

CHAPTER FOUR: ANALYSIS AND DISCUSSION OF EMPIRICAL RESULTS

4.1 INTRODUCTION

This chapter outlines the results of tests presented in the previous chapter. It analyzes the data of the macroeconomic variables for Namibia. The chapter starts by giving the stationarity tests (unit root), determination of lags, bound testing to cointegration and the Tado- Yamamoto approach to Granger causality to further understand the interactions of the variables. The results are analyzed using E-Views 7 and presented and interpreted as obtained.

4.2 UNIT ROOT TEST

Before testing for the existence of co-integration between the variables, the study employed the Augmented Dickey Fuller test (ADF) and the Phillips Perron test (PP) to test for stationarity of the variables. The use of the two tests was due to the fact that every test had limitations; therefore this was for confirmatory reasons as they tend to under reject the null hypothesis of unit root. These tests involved testing the null hypothesis of non-stationary of the variables against the alternative hypothesis of stationarity. The null hypothesis being tested states that there is a unit root in the series against the alternative hypothesis that there is no unit root in the series. The decision rule to reject the null hypothesis is such that, the test statistic should be greater than the critical values in absolute terms. Thereby, concluding that the series does not contain unit root; thus is stationary. If the test statistic is smaller than the critical value in absolute terms, the null hypothesis cannot be rejected. Therefore, it would be concluded that the series is non-stationary (i.e. the series contains a unit root). Table 4.1 shows the results of the unit root test.

Variable	Model specification	ADF levels	PP levels	ADF 1 st Difference	PP 1 st Difference	Order of Integration
RGDPg	Intercept	-3.63** (-4.43)	-3.63** (4.39)			I (0)
	Intercept & trend	-4.24** (-5.18)	-4.24** (-5.11)			I (0)
AGVA	Intercept	-3.63 (-2.25)	-3.63 (-2.23)	-3.64** (-6.27)	-3.63** (-7.84)	I (1)
	Intercept & trend	-4.24 (-2.33)	-4.24 (-2.33)	-4.26** (-6.62)	-4.25** (-15.33)	I (1)
TOP	Intercept	-3.63 (-3.40)	-3.63 (3.14)	-3.63** (-4.62)	-3.63** (-5.78)	I (1)
	Intercept & trend	-4.25 (-3.75)	-4.24 (3.36)	-4.25** (-4.62)	-4.25** (-7.57)	I (1)
INFR	Intercept	-3.63 (-2.52)	-3.63 (-2.36)	-3.63** (-7.50)	-3.63** (-10.43)	I (1)
	Intercept & trend	-4.24 (4.16)	-4.24 (4.18)	-4.25** (-7.40)	-4.25** (10.19)	I (1)
	None	-2.63 (-1.43)	-2.63 (-1.34)	-2.63** (-7.52)	-2.63** (-8.92)	I (1)

Table 4.1: Unit root test

Source: Author's compilation and values obtained from E-views

*Note: ** denote stationarity at 5% significance level*

Numbers in parentheses are the test statistics

The bound testing of cointegration requires that none of the variables be integrated of order I (2) or more. Table 1 shows the results of ADF and PP unit root tests of all variables in levels and first difference. The results revealed that in both ADF and PP, the variable AGVA, TOP and INFR were non-stationary in levels. However, when the series were differenced once, AGVA, INFR and TOP were found to be stationary in first difference. Both tests rejected the null hypothesis of unit root in differences. It was therefore concluded that they were integrated of order one. The results further indicated that RGDP growth was the only variable stationary in levels for both ADF and PP, thus integrated of order zero. The results indicated that none of the variables were integrated of order I (2) or more. Thus, making the bound testing of cointegration appropriate for this study.

4.3 BOUNDS TESTING TO COINTEGRATION

To determine whether there is a long run relationship between the variables, the bounds test to cointegration known as ARDL was used as suggested by the results from the unit root test which revealed that the variables were integrated of order zero and one and none of the variables were integrated of order two. From the parsimonious model, the F-statistic was computed using the formula,
$$F = \frac{(R^2ur - R^2r)/m}{(1 - R^2ur)/(n - K)}$$

Where m = the number of restrictions, n = the number of observations and k = the number of parameters in the unrestricted model. The F-statistics value was then compared against the critical values from Narayan (2005) for case III: unrestricted intercept and no trend. The results from the bounds test to cointegration are presented in Table 4.2 below.

	Critical value bounds of the F- Statistics at:					
	10%		5%		1%	
K=3	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
	2.958	4.100	3.615	4.913	5.198	6.845
Calculated F-Statistics: (RGDPg, AGVA, TOP, INFR) 10.47***						

Table 4.2: Bounds test to cointegration results

*Note: ***denotes significance at 1% level. The critical values are taken from Narayan (2005) for 35 observations, Case III: Unrestricted intercept and no trend.*

To get the computed F-statistics value to be compared against the two critical bounds value from Narayan (2005), a parsimonious model was estimated based on equation (2). Based on the parsimonious model, the computed F-statistic value of 10.47 was found to be greater than both the upper critical value of 6.845 and the lower critical bound value of 5.198 at 1% for case III: unrestricted intercept and no trend with three explanatory variables (k=3) taken from Narayan (2005). To this end, the null hypothesis of no cointegration is rejected therefore we conclude that there is a long run relationship between the variables being estimated.

4.4 OPTIMUM LAG SELECTION CRITERIA

The appropriate optimal lag length was determined using various criteria namely, the Akaike information criterion, Log likelihood ration, Final prediction error, Schwartz information criteria and the Hannan Quinn information criteria. The lag selection criteria results are presented in table 4.3 below.

Lag	Log L	LR	FPE	AIC	SC	HQ
0	-341.12	NA	14255.85	20.92	21.10	20.98
1	-304.53	62.08*	4132.67*	19.67*	20.57*	19.97*
2	-288.65	23.10	4363.69	19.67	21.31	20.23
3	-281.72	8.41	8551.37	20.23	22.58	21.02

Table 4.3: Optimum lag selection criteria

*Note: * Indicates the lag order selected by the criterion*

LR: Sequential modified LR test, FPE: Final prediction error, AIC: Akaike information criterion, SC: Schwarz information criterion, HQ: Hannan-Quinn information criterion.

The optimal lag length selected by majority of the criteria was one. It was suggested by the Sequential modified LR test, Final prediction error, Akaike information criterion, Schwarz information criterion and Hannan-Quinn information criterion.

4.5 TODA- YAMAMOTO GRANGER CAUSALITY TEST

This study employed the Granger causality test to examine whether lagged values of one variable Granger cause those of the other variables. Causality could be described as the relationship between cause and effect. The Granger causality test was used to test if variables were able to predict one another after controlling for past observations. The Granger causality test either rejected the null hypothesis of no causality or failed to reject the null hypothesis of no causality. If the probability value was less than 1%, 5 % or 10% level of significance, the null hypothesis of no causality should be rejected. Therefore, concluding that there is causality between the variables. On the other hand, if

it was greater than 1%, 5% or 10% level of significance, the null hypothesis of no causality should not be rejected. The causal relationship between the variables was tested using the Toda-Yamamoto Granger causality test as it was superior compared to the traditional Granger causality test. The Toda- Yamamoto Granger causality test results are shown in Table 4.4 below.

Cause	Effect	Probability value	Inference from→ to
RGDPg	AGVA	0.401	No
AGVA	RGDP	0.061	AGVA→RGDP

Table 4.4: Toda- Yamamoto Granger causality test results

Source: Author’s compilation using e-views

The causal relationships between the variables were established using the Toda-Yamamoto Granger causality test in figure 4.4 above. The results were estimated using the seemingly unrelated regression to which the null hypothesis of no causality was tested for both equations (2) and (3) and the results are presented in table 3. The null hypotheses being tested stated that agricultural value added does not Granger cause Real Gross Domestic Product growth or Real Gross Domestic Product growth does not Granger cause agricultural value added. The results suggested that the probability value for agricultural value added (0.061) was less than 0.10 (10%) level of significance. Therefore, concluding that the null hypothesis of no causality was rejected. However, the same could not be said for real gross domestic product (0.401) and agricultural value

added as the null hypothesis of no causality was not rejected at all level of significance. Thus, there is evidence of unidirectional causality running from agricultural value added to real gross domestic product but not the other way round. Based on this evidence, it was concluded that agricultural productivity does help to predict real gross domestic product. This finding is in line with that of Odero (2017), Awoyemi, Afolabi and Akomolafe (2017) as well as those of Odetola and Etumnu (2014).

4.6 LONG RUN MODEL RESULTS

Variable	Coefficient	T-statistic	Probability
AGVA	-0.588	-1.284	0.209
TOP	-0.046	-0.852	0.401
INFR	-0.100	-0.587	0.562
AGVA (-1)	0.975	2.088	0.046
INFR (-1)	-0.268	-1.608	0.119
R- squared	0.354		

Table 4.5: Estimated long run coefficients, ARDL (1, 0, 1, 0)

Source: Author's compilation using e-views

According to figure 4.5 above, the coefficient of determination (R^2) of 0.354 means that agricultural value added, trade openness and inflation rate explain about 35.4 % of the variations in RGDP growth rate. The remaining 64.4% variations are captured by the error term which caters for other independent variables or factors not included in the model. The results show that the coefficient of agricultural value added is positive and it

is statistically significant at 5% significance at one lag period. This means that, an increase in agricultural value added by 1 percentage point will result in an increase of about 0.975 percentage points in RGDP growth rate in the next period. Trade openness and inflation rate also carry negative coefficients and are statistically insignificant. These findings are contradicting those of Awan and Alam (2015) in Pakistan which indicated that both inflation and trade openness were statistically significant.

4.7 DIAGNOSTIC TESTS

The parsimonious model was subjected to diagnostic tests to test whether the model does not suffer from problems associated with non-normality of errors, heteroscedasticity and serially correlated errors. The Breusch-Godfrey LM test, Breusch-Pagan-Godfrey test were used to test for serial correlation and heteroscedasticity, respectively. Jacque-Bera test was used to test for normality distribution and the CUSUM and CUSUMSQ for stability of the model. The Ramsey reset test was also used to test for the stability of the model as unstable parameters result in misspecification of the model. The results of these diagnostic tests are presented in table 4.6 below.

TEST	TEST STATISTIC	PROBABILITY
Jarque Bera test	0.349	0.840
Breusch-Godfrey LM test	0.330	0.201
Breusch- Pagan-Godfrey test	0.892	0.538
Arch test	0.074	0.788
Ramsey test	1.103	0.350

Table 4.6: Diagnostic tests results

Source: Author's compilation using e-views

Table 4.6 above shows that the Jacque Bera test for normality indicates that the residuals are normally distributed. The Breusch- Godfrey LM test fails to reject the null hypothesis of no serial correlation at 5% level of significance. Both the results of the Breusch-Pagan-Godfrey test and the Arch test indicated that the residuals are homoscedastic meaning that there is no heteroscedasticity. The Ramsey reset test indicated that there is no specification error thus the model is stable.

The stability of the model was tested using the Cumulative Sum (CUSUM) and the CUSUM of squares. The decision rule is such that, if the plot of CUSUM and CUSUM of squares exceed the 5% level of significance there is instability in the model. However, if the plot of both the CUSUM and CUSUM of squares are within the 5% level of significance it shows the stability of the coefficients. The results are presented in figure 2.

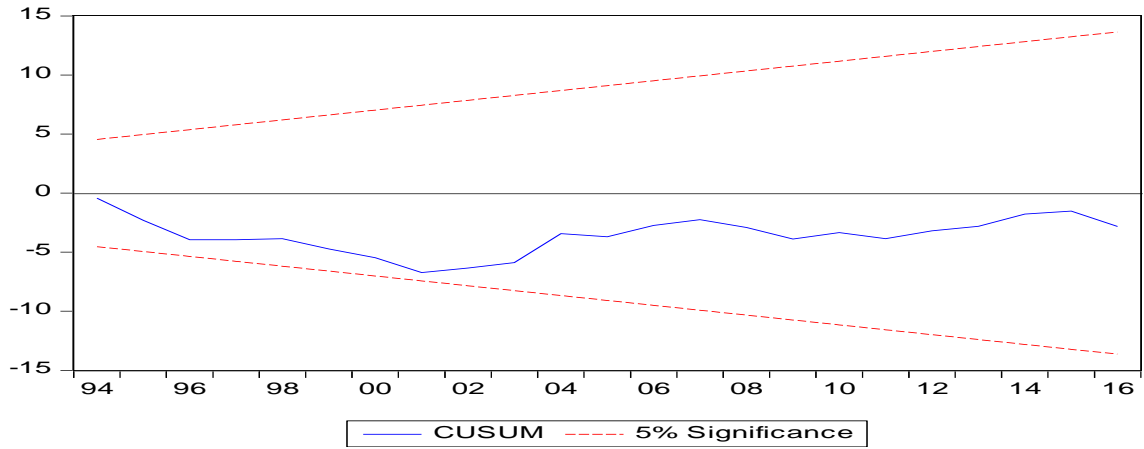


Figure 4.1: Cumulative Sum (CUSUM) of recursive residuals

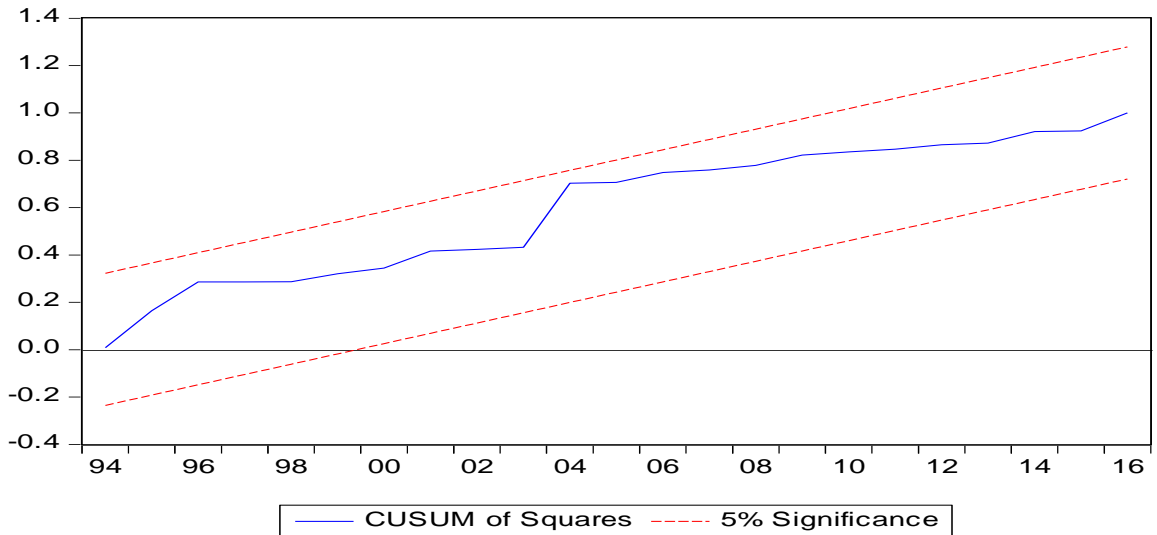


Figure 4.2: Cumulative Sum of Squares (CUSUMSQ) of recursive residuals

Figure 4.1 and figure 4.2 results for both the CUSUM and the CUSUM of squares indicated that there is stability in the model as the plot fall within the critical band of 5% confidence interval.

4.8 SUMMARY

This chapter presented and discussed the empirical findings using tests such as the unit root test, Bounds test to cointegration, Toda- Yamamoto Granger causality and the long run model. Based on the results for this study, three variables were integrated of order one whereas only one variable was integrated of order zero. Thus, making ARDL the appropriate method for this study as none of the variables were integrated of order two or more. To address the objectives of this study, the bounds test to cointegration and Toda-Yamamoto Granger causality were employed and a long run relationship was found among the variables. Moreover, a unidirectional causality running from agricultural productivity to economic growth was observed. However, no reverse causal flow was observed from economic growth to agricultural productivity. The next chapter provides the overall summary of the study and recommendations for policy interventions.

CHAPTER FIVE: CONCLUSIONS AND POLICY RECOMMENDATIONS

5.1 INTRODUCTION

The previous chapter presented the analysis of results. In this concluding chapter, conclusions based on the findings are outlined. Recommendations to policy decision makers and future areas are also outlined.

5.2 CONCLUSIONS

The present study investigated the relationship between agricultural productivity and economic growth in Namibia and made use of annual time series data from 1981 to 2016. In investigating the relationship between agricultural productivity and economic growth, agricultural value added was used to measure agricultural productivity while economic growth was measured as a percentage change in real gross domestic product. Trade openness and inflation were used as control variables. The study started by defining the four variables used in the study and how they were measured. According to literature, agriculture is emphasized as a pre-requisite for industrialization through the increase in rural incomes and provision of industrial raw materials and the release of resources to support the industry. Meaning, if the agriculture sector was neglected in favor of the industrial sector would only lead to slow growth. Thus, it is expected that an increase in agricultural productivity would result in an increase in economic growth. Therefore, agricultural productivity should be a positive determinant of economic growth. Based on stationarity test results with the use of ADF test and PP test, the results showed that three variables were non-stationary in levels and only one variable was stationary in levels. Therefore, many variables were integrated of order one, where as, one of the variables was integrated of order zero. This outcome provided the basis to test

for cointegration using ARDL method known as the bounds test to cointegration and estimated the coefficients of the variables from the unrestricted error correction model. ARDL requires the use of variables not integrated of the same order excluding those integrated of order I (2).

The bounds test to cointegration found cointegrating equations, the computed F-statistic (10.47) of the bounds test exceeded the upper bound (6.85) and lower bound (5.198) at all level of significance, implying that there is a long run relationship among the variables. However, results of the long run model indicated that all the variables had a negative impact on economic growth as their coefficients were in negatives and statistically insignificant. These results pointed to the evidence that a 1% increase in these variables would only result in a decrease of economic growth by certain percentage points.

The Toda-Yamamoto Granger causality test was used to analyse if there is a causal relationship between agricultural productivity and economic growth in Namibia. The results obtained from the estimation of a seemingly unrelated regression indicate that there is evidence of a unidirectional causality running from agricultural productivity to economic growth. However, no causality running from economic growth to agricultural productivity was observed. These findings are in line with those of Odero (2017) particularly, in Namibia. Similarly, results obtained from the study of Awoyemi, Afolabi and Akomolafe (2017) as well as those of Odetola and Etumnu (2014) also concurred with this study. That is, they concluded that there was a relationship between agricultural value added and economic growth in developing countries in the short run. In essence, it was concluded that agricultural productivity does help to predict economic growth in

Namibia but not the other way round. Thus, agricultural productivity is a viable engine for economic growth. This answers the question of whether agricultural productivity could be an engine for economic growth in Namibia. However, on the other hand economic growth has no effect on agricultural productivity. This, addresses the objective of this study on the direction of causality between agricultural productivity and economic growth in Namibia. The lack of reverse causal flow from economic growth to agricultural productivity only suggests that although resources from the agriculture are utilized for economic growth there is still little or no effort for value addition to the sector from the returns of economic growth (Odetola & Etumnu, 2016). This ascertains the claim that the agriculture sector might be neglected or is given less attention in Namibia. This is consistent with the literature indicating the lack of attention in the agriculture sector despite its proven potentials.

On the contrary, in North Cyprus, Katircioglu (n.d) found a unidirectional causation from economic growth to agricultural expansion and none from agriculture expansion to economic growth. These results were seen to be supporting the Lewis model theory, which stated that agriculture acted more as a source of food and labor than a source of growth (Byerlee, Diao & Jackson, 2005).

5.3 POLICY RECOMMENDATIONS

Economic growth of any country is a function of several factors; in this case, it does not only depend on the agriculture sector but also on various macroeconomic indicators that play a role in increasing agricultural productivity. These include availability of natural and physical resources, labour force and the country's capital stock among others. As

such, the recommendations are based on the findings obtained from this study. And the constraints alluded to in this study. The following recommendations are made:

- Having seen that agricultural productivity has a significant impact on economic growth in Namibia although the impact might not be in the long run, the government should continue advocating for increased agricultural productivity by investing in the sector. However, there are other constraints that affect productivity in the sector that needs to be addressed as well. Given that the agriculture sector is sensitive to climate conditions such as drought, which affects the overall agricultural output, in order to safeguard the livelihood and food security in the country as envisaged in NDP5, agricultural communities have to adapt to climate change. Therefore, climate change adaptation researches should be more emphasized to help inform decisions by farmers, agribusiness and policy makers.
- The government's goal to increase agricultural productivity comes with the need to invest in transport, storage and food processing facilities. To this end, the government cannot succeed alone therefore, engagement of private sector is crucial. Major requirements to stimulate agricultural investment and growth, the availability of electricity, water, telecommunication, storage facilities and other infrastructural services which are limited especially in the rural areas where subsistence farming is mostly practiced. The government should continue to encourage the sourcing of local produce, however, the private sector should help in terms of easy access to markets for farmers.

- One of government's long-term goals is structural transformation thereby aspiring to be an industrialized country through value addition of agricultural products. Given the evidence on the lack of reverse causal flow from economic growth and agricultural productivity, sectoral backward and forward linkages should be strengthened to impact growth in the country as the agriculture sector and industrial sector (manufacturing) were found not to have an impact on one another (Siboleka, Nyambe & Osterkamp, 2014). This means that development of the agricultural sector will require more investment and sectoral linkages should serve as basis through which the government can target policies in terms of disbursing investment funds to ensure agriculture development.
- Emphasis should be on developing all subsectors throughout the value chain as this will accelerate the industrialization process.
- The agriculture sector remains the biggest consumer of water in the country; therefore, the government should invest in technology for the purpose of harvesting water to ensure long term sustainability of water supply.

5.4 AREA FOR FURTHER RESEARCH

The researcher employed the Autoregressive Distributed Lag (ARDL) model therefore, the study urges further research to consider the use of other approaches such as Vector Error Correction model (VECM), different sample sizes or qualitative research designs. It further encourages other researchers to also focus on other factors (variables) that have an impact on agricultural productivity but were not included in this study. More focus should be on the interrelationships between agricultural productivity and manufacturing

because researchers in Namibia have paid little attention to the forward and backward linkages between the agriculture sector and manufacturing sector. These linkages between the two sectors are of importance because only then would Namibia's agricultural sector contribution to GDP be more appreciated.

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APPENDICES

Figure 1: Normality test

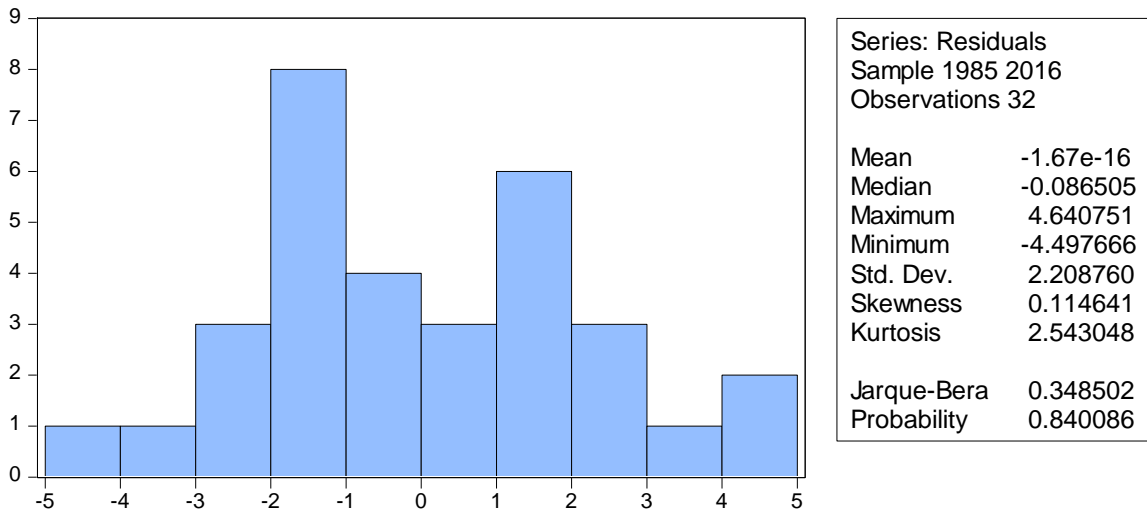


Figure 2: Serial Correlation

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	1.169702	Prob. F(2,21)	0.3299
Obs*R-squared	3.207490	Prob. Chi-Square(2)	0.2011

Figure 3: Heteroskedasticity Test

Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	0.892243	Prob. F(8,23)	0.5384
Obs*R-squared	7.578961	Prob. Chi-Square(8)	0.4756
Scaled explained SS	3.020749	Prob. Chi-Square(8)	0.9330

Heteroskedasticity Test: ARCH

F-statistic	0.073810	Prob. F(1,29)	0.7878
Obs*R-squared	0.078700	Prob. Chi-Square(1)	0.7791

Figure 4: Ramsey Reset Test

Ramsey RESET Test

Equation: PASMONIUS

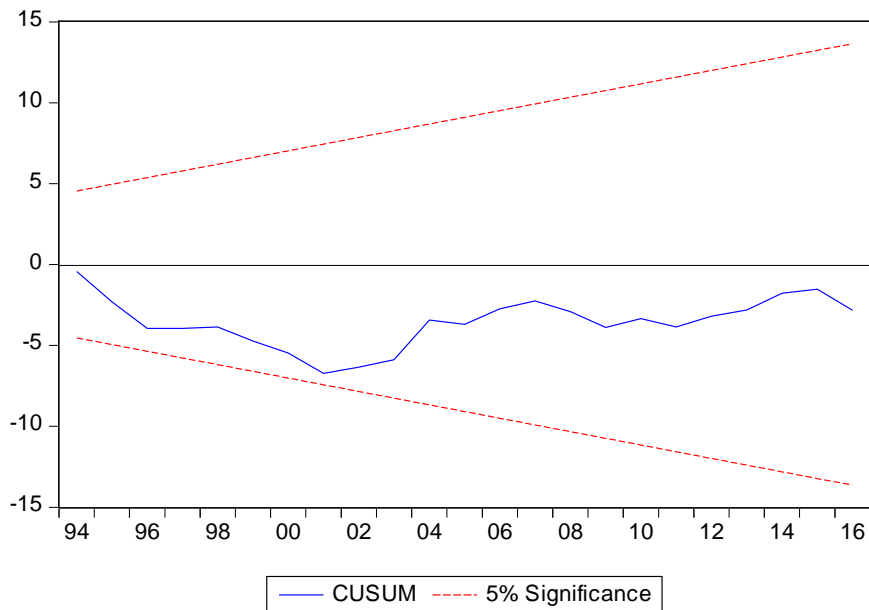
Specification: D(RGDPG) RGDPG(-1) AGVA(-1) TOP(-1) INFR(-1) D(AGVA)

D(INFR) D(INFR(-1)) D(AGVA(-3)) C

Omitted Variables: Powers of fitted values from 2 to 3

	Value	df	Probability
F-statistic	1.103180	(2, 21)	0.3503
Likelihood ratio	3.196926	2	0.2022

Figure 5: Stability Test results



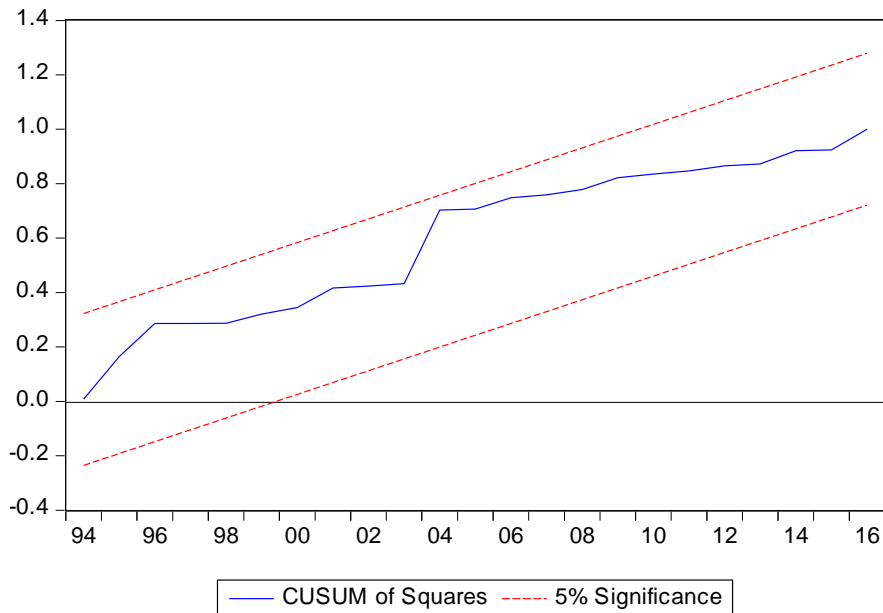


Figure 6: Optimum lag section criteria

VAR Lag Order Selection Criteria
 Endogenous variables: TOP RGDPG INFR AGVA
 Exogenous variables: C
 Date: 02/12/19 Time: 07:58
 Sample: 1981 2016
 Included observations: 33

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-341.1199	NA	14255.85	20.91636	21.09775	20.97739
1	-304.5349	62.08363*	4132.666*	19.66878*	20.57576*	19.97395*
2	-288.6530	23.10099	4363.691	19.67594	21.30849	20.22524
3	-281.7164	8.407995	8551.372	20.22523	22.58337	21.01867

* indicates lag order selected by the criterion
 LR: sequential modified LR test statistic (each test at 5% level)
 FPE: Final prediction error
 AIC: Akaike information criterion
 SC: Schwarz information criterion
 HQ: Hannan-Quinn information criterion

Figure 7: Long run model results

Dependent Variable: RGDPG
 Method: Least Squares
 Date: 02/11/19 Time: 11:38
 Sample (adjusted): 1982 2016
 Included observations: 35 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
AGVA	-0.587996	0.457812	-1.284362	0.2092
TOP	-0.046349	0.054410	-0.851844	0.4013
INFR	-0.100049	0.170507	-0.586774	0.5619
AGVA(-1)	0.974731	0.466744	2.088360	0.0457
INFR(-1)	-0.268214	0.166716	-1.608804	0.1185
C	7.876477	8.371083	0.940915	0.3545
R-squared	0.354232	Mean dependent var		3.568571
Adjusted R-squared	0.242893	S.D. dependent var		2.972533
S.E. of regression	2.586457	Akaike info criterion		4.893260
Sum squared resid	194.0031	Schwarz criterion		5.159891
Log likelihood	-79.63205	Hannan-Quinn criter.		4.985301
F-statistic	3.181560	Durbin-Watson stat		1.825533
Prob(F-statistic)	0.020709			

Figure 8: Toda- Yamamoto Granger causality results

Wald Test:
 System: SYS01

Test Statistic	Value	df	Probability
Chi-square	0.704396	1	0.4013

Null Hypothesis: C(7)=0
 Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(7)	-0.057436	0.068435

Restrictions are linear in coefficients.

Wald Test:
 System: SYS01

Test Statistic	Value	df	Probability
Chi-square	3.508097	1	0.0611

Null Hypothesis: $C(27)=0$
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(27)	0.834270	0.445421

Restrictions are linear in coefficients.