THE IMPACT OF GOVERNMENT EXPENDITURE AND PRIVATE SECTOR INVESTMENT ON AGRICULTURAL SECTOR: A COMPARATIVE ANALYSIS OF SELECTED SOUTHERN AFRICAN CUSTOMS UNION COUNTRIES

by

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DECLARATION

I declare that the dissertation hereby submitted to the University of Limpopo, for the degree of Master of Commerce (Economics) has not previously been submitted by me for a degree at this or any other university; that it is my work in design and in execution, and that all material contained herein has been duly acknowledged.

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Full names **Date**

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ABSTRACT

Agriculture is a vital economic activity for developing countries, more especially in Africa. The agricultural sector provides employment to the low skilled labour force and plays a pivotal role in the Southern African Customs Union economy as it has the potential of sustaining livelihoods, employment creation, and it is a strong link to the rest of the economy. The study investigated the impact of government expenditure and private investment in agriculture of South Africa, Botswana and Namibia (SACU). To achieve this, an analysis was conducted using the Autoregressive Distribution Lag model (ARDL), Cointegration test and Granger causality test on data spanning the period 1991-2021 to tests for the long run relationship of the variables employed and also to ascertain if Keynesian theory and the Wagner theory hold in the economies of selected SACU countries.

The study attempts to add on literature both the short and long run impact of government expenditure in the agricultural sector of SACU. The study is expected to contribute significantly to macroeconomics. The Cointegration test revealed that there is significant positive long-run influence of government expenditure in agriculture, private investment in agriculture and employment in agriculture at all levels of significance (1%, 5% and 10%). The ARDL test results further revealed that in South Africa government expenditure has a positive influence on agricultural output, while the other two countries (Botswana and Namibia) showing negative results. However, private investment revealed a positive influence on agricultural output in all the selected countries confirming Keynesian and Wagner theory holds. The ARDL test showed that the speed of adjustment for South Africa, Botswana and Namibia was estimated at 69.68%, 99.38% and 61.54% respectively, revealing that the variables will converge back to equilibrium relatively quickly. The study recommends an increase of at least 1% of state revenue to be allocated to the agricultural sector each year, so that at some point it will be in line with the Malabo declaration which recommends that governments spend at least 10% of state revenue in the agricultural sector. Additionally, the study recommends a clear and predictable legal and regulatory framework, effective management, streamlined business registration and permit application processes must be established. This will incentivize companies to operate and develop in the agricultural sector of SACU.

Keywords: Southern Africa Customs Union (SACU), Autoregressive Distributed Lag (ARDL), Cointegration test, Granger causality test, Malabo declaration

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ACRONYMS

ADF	Augmented Dicky Fuller
ARCH	Autoregressive Condition Heteroscedasticity
ARDL	Autoregressive Distribution Lag
AU	African Union
BOT	Botswana
CAADP	Comprehensive African Agriculture Development Program
CASP	Comprehensive Agricultural Support Program
ECM	Error Correction Model
GCF	Gross Capital Formation
GDP	Gross Domestic Product
MDGs	Millennium Development Goals
NAM	Namibia
OECD	Organisation for Economic Cooperation and Development
OLS	Ordinary Least Squares
PP	Phillips-Perron
RSA	Republic of South Africa
SACU	SOUTHERN AFRICAN CUSTOMS UNION
SADC	Southern African Development Community
SARB	South African Reserve Bank
SDGs	Sustainable Development Goals
SONA	State of Nation Address
UN	United Nations
CV	Coefficient of Variation
SSA	Sub-Saharan Africa

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CHAPTER 1

ORIENTATION TO THE STUDY

1.1 INTRODUCTION AND BACKGROUND

Agriculture is of utmost importance to the Southern African Customs Union (SACU) economies since it has the potential to eradicate poverty and extreme hunger (Jambo, 2017). The significant contribution of agriculture has become one of the United Nations Millennium Development Goals (MDG's) which aimed at the eradication of poverty and extreme hunger by at least 2015 but problems persisted (UN, 2015). Increasing agricultural productivity and efficiency is the starting point towards ensuring a growing economy that can be able to support livelihoods. The introduction of the Sustainable Development Plan (SDP) by African Union (AU), saw the need to adopt the initiative by the United Nations (UN) which program of Comprehensive African Agricultural Development Program (CAADP) in 2003 (Jambo, 2017). The 2002 SACU Agreement as mentioned in Article 39 (agricultural policy), outlines that member countries recognise the importance of the agricultural sector to their economies (SACU), and agree to work together to improve agricultural policies to insure corresponding development on the agricultural sector of SACU (SACU, 2022).

The ultimate objective of the CAADP is to end poverty by enhancing food security (NEPAD, 2014). AU and the SACU nations pledged to increase government expenditure to be at least 10% of GDP in order to realise an estimated agricultural growth of 6% which is aligned to the Maputo Declaration of 2003 (NEPAD, 2014). According to the Maputo Declaration of 2003, policymakers have realised that agricultural spending has the potential to enable sustainable economic growth. Agriculture is a vital economic activity for developing countries, more especially in SACU (FAO, 2021). It is worth noting that agriculture is one of the sectors that in most of the times produce a surplus on trade. For instance, in the year 2017, the consolidated surplus on agricultural products for SACU against the USA was calculated at $340 million (SACU, 2022). The agricultural sector also, provides employment to the low-skilled labour force and poses the potential to sustain livelihoods, as well as providing strong links to the rest of the economies (Mkhabela, Ntobela, & Mazibuko, 2022). Additionally, the sector boosts the country’s foreign exchange reserves, through its surplus, provides raw materials for production, and acts as a market for goods and services to other sectors (Jambo, 2017).

Subsequently, Statistics South Africa (2020) published that the agricultural sector was the only sector that had a positive growth rate in the last quarter of 2020. The data makes economic sense considering that agriculture was one of the sectors that remained fully operational during level four and five of lockdown in South Africa as the result of the global pandemic, Covid-19 pandemic. Meanwhile, the economy of Botswana contracted in 2020 due to weaker global demand for diamonds, one of the country's main exports, and the consequence of lockdowns on the industries. The economy largely depends on mining, particularly diamonds, and its service and retail sectors are among the ones that have been hardest hit as well. A smaller part of the economy, agriculture, was affected by the drought conditions in 2020.

Eswatini also experienced economic contraction in 2020. Many sectors were affected, including agriculture, manufacturing, and tourism. The economy of Eswatini was undiversified and highly dependent on exports to South Africa even before the pandemic struck. The relatively more important agricultural sector in the economy, compared with that of other SACU economies, faced logistical challenges, reduced labour, and other COVID-19-related disruptions. Lesotho, equally dependent on the apparel industry and South Africa-based remittances, contracted also in 2020. The pandemic caused global supply chains to break down, while Lesotho's agricultural production was also constrained by labour shortages, logistics problems, and weather conditions. Furthermore, at a Namibian level, the pandemic depressed the economy, especially in the mining, tourism, and retail sectors. Agriculture, being one of the large contributors to Namibia's GDP, didn't spare any woes, especially at export market and logistical levels, since it faced disruption caused by the pandemic. However, Namibia did record positive performance in the agriculture sector, mainly in subsectors like livestock.

But, the contribution of the agricultural sector to SACU economies is often taken lightly because of its small contribution to gross domestic product (GDP) (Kamati & Robinson, 2023). However, agriculture is the backbone of SACU economy, and its contribution goes way beyond its contribution to GDP. Agriculture acts as a market for other sectors, and this is known as the backward linkage. It also provides unprocessed material to other sectors and this action is known as the forward linkage (Mkhabela, Ntobela, & Mazibuko, 2022).

The Agricultural sector is also known for its employment creation opportunities in Africa. The actual number of job opportunities created by the agricultural sector is higher than what the sector is credited based on its contribution to GDP (Ledwaba, 2023). This builds up to the need to support agricultural activities and ensure that the sector continues to thrive. Ensuring the success of agriculture is to have a sensible and vital macroeconomic policy intervention that should be consciously pursued in SACU and Africa at large. Moreover, the agricultural sector has proven beyond measure that it is a money-spinning sector for investment, and that it can be used to support economic growth (Tomsik, Smutka, & Lubanda, 2015). Additionally, the sector can assist to achieve other macroeconomic objectives such as the creation of jobs, alleviating poverty and decline the high rate of inequality in the SACU area (Salisu & Halada, 2021). For the same reasons the success of land reforms and changing section 25 of the Constitution of South Africa is vital to achieving a more democratic society in the Republic of South Africa (RSA). Given the conduciveness of the environment of which the agriculture sector operates, it is assured that the sector can continue to thrive and contribute implicitly to economic growth and ensuring food security (Kamati & Robinson, 2023).

1.2 STATEMENT OF THE PROBLEM

The agricultural sector plays a critical role in the economies of the Southern African Customs Union (SACU) member states, which include South Africa, Botswana, Namibia, Eswatini, and Lesotho. Agriculture not only provides employment for a significant portion of the population but also contributes to national income and food security. However, in recent years, SACU countries have faced several challenges that undermine the sector’s potential to drive inclusive economic growth. One of the key issues is the decline in agricultural employment, which poses a significant threat to both the economies and livelihoods of these nations. The COVID-19 pandemic further exacerbated this issue, with many countries experiencing disruptions in agricultural production and the loss of jobs, particularly in labour-intensive subsectors like horticulture.

Agricultural employment is crucial for poverty alleviation, particularly in rural areas where the sector often serves as the primary source of livelihood. Declining agricultural employment reduces the number of people actively engaged in farming, negatively impacting both rural incomes and overall agricultural productivity. The Lewis dual-sector model of development (1954) suggests that the movement of labour from agriculture to industry and services is essential for economic development. However, for such a transition to be successful, agriculture must first experience improvements in productivity. Without these improvements, the decline in agricultural employment can lead to food insecurity, rural poverty, and slower economic growth in SACU countries, which heavily rely on agriculture.

Despite horticulture being a major employer during the pandemic, the long-term solution lies in transforming the sector through investment in research, technology, and innovation. These investments are necessary for linking the primary (farming), secondary (processing), and tertiary (distribution and retail) sectors of agriculture. Technological innovation, especially in areas like crop science, irrigation techniques, mechanization, and market access, can increase agricultural productivity and, consequently, create new jobs and income generating opportunities. This is where the role of government expenditure and private investment becomes critical.

The Comprehensive Africa Agriculture Development Programme (CAADP), adopted in 2003 by the African Union (AU), aims to address food insecurity and poverty on the continent by fostering sustainable agricultural growth. One of its central targets is that African nations should allocate at least 10% of their national budgets to the agricultural sector and achieve 6% annual growth in agricultural productivity. These targets were reaffirmed in the Malabo Declaration (2014), which urges African countries to prioritize agriculture in their development agendas. The economic theory behind these targets aligns with the notion that increased government investment in agriculture can lead to higher agricultural growth rates and, consequently, greater economic development. According to the Solow growth model (1956), economic growth is driven by factors such as capital accumulation (investment), technological progress, and labour productivity. When governments invest in agriculture, this often includes building infrastructure, improving rural education, and promoting agricultural research, which can lead to higher productivity, and eventually, higher output growth.

However, trends analysed the actual government expenditure in SACU countries, it becomes apparent that most countries fall short of meeting the targets set by the Malabo Declaration. In 2020, the government expenditure on agriculture as a percentage of GDP was recorded as 1,4% for South Africa, 3,7% for Botswana, 2,2% for 1.9% Namibia, 8.39% for Eswatini (Swaziland) and 3% for the Kingdom of Lesotho. None of the SACU countries met the 10% target for agricultural spending, with South Africa and Namibia being the lowest, while Eswatini (formerly Swaziland) managed to achieve a higher percentage of government expenditure on agriculture. These figures reveal a significant underinvestment in agriculture, which could have far reached consequences for food security, rural development, and economic stability. In terms of agricultural growth, SACU countries also struggled to meet the 6% growth rate target set by the Malabo Declaration. SACU countries had only managed to see two of its member countries (namely, Lesotho and Eswatini) achieving the 6% growth rate at 6,3% and 8,4% respectively (SACU, 2022). The remaining countries recorded the following: 2, 4% for South Africa, 4,0% for Namibia and 2,1% for Botswana.

This divergence between government expenditure and agricultural growth rates suggests a negative relationship between the two variables. The countries with lower government expenditure on agriculture also recorded lower growth rates in agricultural output. This points to a possible causal link between insufficient public investment and suboptimal agricultural performance. The decline in agricultural employment and the gap between government expenditure and agricultural growth in SACU countries illustrate a significant challenge for these economies. Despite the strategic importance of agriculture, the sector has not been allocated sufficient public resources, and private investment remains insufficient to meet growth targets. A stronger focus on both government investment and private sector engagement, alongside policies that foster technological innovation and human capital development, will be key to addressing these challenges. By realigning agricultural policy with the goals of the Malabo Declaration, SACU countries can work towards achieving sustainable agricultural growth, improving food security, and creating economic opportunities for their populations.

1.3 RESEARCH AIM AND OBJECTIVES

1.3.1 Aim

The aim of the study is to examine the impact of government expenditure and private investment on agricultural sector for the selected SACU member states.

1.3.2 Objectives

The objective of this study is to:

- Determine the relationship between government expenditure in agriculture and agricultural output.
- Examine the effect of private sector investment on agricultural output.
- Determine the relationship between agricultural employment and agricultural output.
- Establish the causal relationship between the model variables.

1.4 RESEARCH QUESTIONS

The study thrives to answer the following questions in connection to agricultural output:

- Is there a relationship between government expenditure in agriculture and agricultural output?
- Does private investment on agriculture influence agricultural output?
- Can government expenditure in agriculture stimulate agricultural employment?
- Is there any causal relationship between the selected variables?

1.5 DEFINITION OF CONCEPTS

- **Agricultural output**

Agricultural output is the value of production yield of farming enterprises sold or used on the agricultural sector/ farm; this may include sundry income for the agricultural sector (Magazines, 2017). The primary product group of agricultural production comprises of livestock and crops, but not limited to. The component of agricultural output includes, output sold (including trade between agricultural holdings), stock movements, output produced for final consumption, output for further processing (OECD, 2021).

- **Government expenditure in agriculture**

It defines the payments made by government so that farmers and other members of the agricultural sector to harness the agricultural sectors full potential for the good of society. A significant portion of the gross domestic product is thought to be made up of government spending, amongst others this include agricultural expenditure and health (Valoyi, 2019). This represents the portion of overall government spending devoted to agriculture. It covers costs such as those associated with purchasing contemporary agricultural equipment, agricultural inputs including enhanced seeds, training and employing numerous agricultural development agents, and so on.

- **Private Investment**

From a macroeconomic perspective, private investment refers to the acquisition of a capital asset that is anticipated to create income, appreciate in value, or do both. Post (2021) suggest that to satisfy present and future food and water needs, private sector investments might be crucial, the findings of the study further suggest that if food is distributed fairly, increased food production can reduce food insecurity (Post, 2021).

- **Employment in the agricultural sector**

Number of people in the agriculture sector who were working full-time, doing any work-related activity for pay or profit (agriculture, hunting, forestry and fishing) (Mkhabela, 2020).

1.6 ETHICAL CONSIDERATIONS

The study was conducted free of misquotations, unintentional and deliberate plagiarism. The study used secondary data that was obtained from credible sources. All sources used or quoted were identified and acknowledged by means of complete referencing. Therefore, the list of references is equally matched by the in-text sources. In compliance with plagiarism policy from the institution, the University of Limpopo manual for postgraduate research was followed.

1.7 SIGNIFICANCE OF THE STUDY

The effect of government expenditure and private investment in the agricultural sector of SACU countries have been studied by many scholars including that of Thabane and Lebina, (2016); Diyoke, Abubakar and Erkan (2018) and most recently Ngobeni and Muchopa, 2022). However, employment in the agricultural sector has been rarely explored by many of these studies. Thus, the study also aims to fill the gap in the literature by incorporating employment in model to assess the Keynes theory holds in the agricultural sector of the selected SACU countries. This also mean that the study will shed some light on the dynamics of employment in the agricultural sector on how it impacts the agricultural sector productivity (output). The incorporation of employment in the agricultural sector production model will in turn enable policy makes in the SACU countries to draft policies and allocate funds in a manner that will benefit and improve the standard of living and the economies.

The study further used aggregate government spending in the agricultural sector to reflect the exact percentage share of government expenditure in the agricultural sector. Which deviates from the rest of the studies that uses subsidies, or research funds allocated to the agricultural sector by government. The Malabo declaration is one of the important documents in Africa that aims to address the UN SDG’s. However, little research has been done to monitor if these targets are to be attained by 2030. Thus, the study is centred around the Malabo declaration targets as a benchmark of government expenditure in agriculture and agricultural sector contribution to gross domestic product (GDP). The study further will add to the body of knowledge a comparative analysis of SACU countries.

The goal of this research is to add to the body of knowledge on government spending and private investment in the agriculture sector, by establishing literature on the impacts of public spending and private investment in the agriculture sector, particularly in the SACU region. Studies on the SACU region with respect to the study topic are scanty and therefore this study aims to fill that gap. Similarly, the study is expected to contribute significantly to macroeconomists, policymakers, and academics seeking to understand the impact and sensitivity of government expenditure in the agriculture sector. This study offers an alternative perspective on the issue at hand by focusing more on the ways in which government spending and investment in agriculture are influencing the agricultural output.

1.8 STRUCTURE OF THE STUDY

This dissertation is divided into various chapters, namely:

Chapter 2 includes a summary of the numerous trends and descriptive information on the variables used in the research to look at the effects of government spending and investment in SACU's agriculture industry. Chapter 3 comprises the empirical literature and the theoretical foundation. Chapter 4 explains the research methodology, including data collection and analysis techniques. Chapter 5 consists of data analysis, hypothesis testing, and a discussion of the conclusions drawn as suggested by tests in Chapter 4. Chapter 6 is the last chapter, which offers a summary, suggestions for more research, and a conclusion. The study's limitations are also covered in this chapter.

CHAPTER 2

AN OVERVIEW AND HISTORIC TRENDS OF SELECTED VARIABLES IN SOUTHERN AFRICA CUSTOMS UNION (SACU)

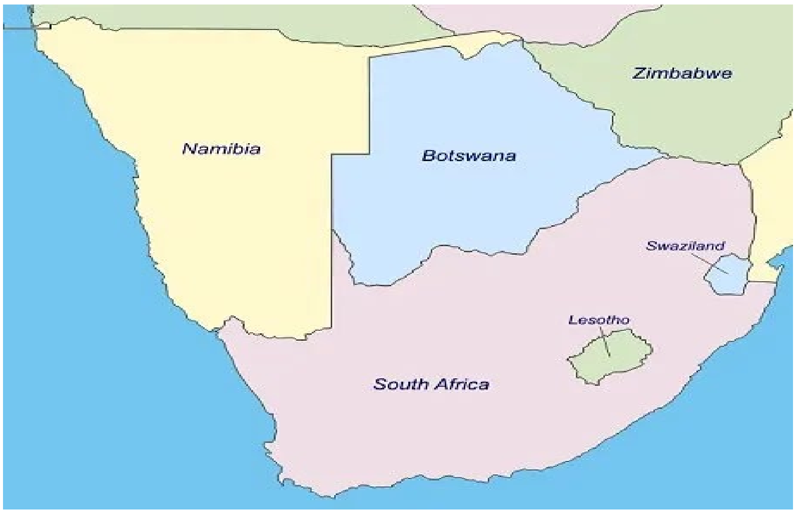
2.1 INTRODUCTION

Chapter 1 discussed the Introduction and background of the study, Aim and objectives of the study and Chapter 2 trends and the descriptive statistics of the variables that affect the agricultural output in the selected SACU countries is analysed in comparison to other regions. This chapter presents graphical and diagrammatic representations of historical trends in the SACU, focusing on model variables that influence the value of agricultural production.

2.2 OVERVIEW OF THE SOUTH AFRICAN CUSTOMES UNION COUNTRIES

From a geographical standpoint, the SACU countries represent the nations that are located on the African continent south of the Sahara Desert as shown in Figure 2.1.

Figure 2.1 SACU GEOGRAPHICAL MAP



Source: SACU, 2012

SACU comprises of five nations namely: Swaziland (Eswatini), Namibia, Botswana, Lesotho, and South Africa. These nations are spread across continent rich in raw materials, precious metals, rich soil, and natural resources. SACU has been around since 1910, making it the oldest Customs Union in the world. On December 11, 1969, South Africa, Botswana, Lesotho, and Swaziland signed the Customs Union Agreement, establishing SACU in its current form and came into effect from the 1st of March 1970, superseding the 1910 Customs Union Agreement. The Customs Union was renegotiated in 2002 preceding the 1994 agreement. Namibia joined the agreement as a full member after gaining independence from South Africa in 1990, where it had been a colony at the time (SACU, 2022). The customs union had a population of over 68.9 million people as of 2021 with a Gini coefficient of over 59% and over 20% of the economic active population working in the agricultural sector (SACU, 2022). South Africa has the highest population in the custom union with a population of over 57.7 million by 2021 and a Gini coefficient of 63% number one in the world (SACU, 2022). SACU has a land area of 2,674,424 km^2 with South Africa occupying almost majority of the land totalling 1 219 090 km^2 (SACU, 2022). Thus, the agricultural sector plays a pivotal role in the economies as well as preserving livelihoods of the neighbouring countries.

2.3 AN OVERVIEW OF SACU ECONOMIC PERFORMANCE

In the SACU region, the GDP increased from R6.0 trillion in 2020 to a projected R6.8 trillion in 2021(World Bank, 2022). Following a 6.4 percent contraction in 2020 (SACU, 2022), the economy expanded by 5.1 percent (SACU, 2022). According to economic activity, manufacturing was one of the major contributors to the economies of Eswatini and Lesotho, while mining and quarrying was one of Botswana's major contributors (15.8%) (World Bank, 2022). Financial and business services were identified as important contributing industries in Namibia and South Africa (SACU, 2022). In 2021, Botswana and South Africa's contributions from the hunting, forestry, and fishing sectors at current prices were notably low at 1.8% and 2.5%, respectively, compared to Lesotho's 4.2% growth rate (SACU, 2022). However, growth rates in Namibia and Eswatini exceeded the 6% projected in the Malabo declaration, coming in at 9.5% and 8.1%, respectively (SACU, 2022).

In 2021, SACU's trade deficit with the global economy was registered at R323.9 billion. compared to the 203.3 billion deficits reported in 2020, which was higher (SACU, 2022). Despite the decrease shown in 2020, SACU's merchandise trade rebounded in 2021 from R191.1 billion in 2020 to R207.4 billion in 2021, intra-SACU imports were recorded (SACU, 2022).

2.4 GOVERNMENT EXPENDITURE IN AGRICULTURE GLOBALLY

Among the sub regions, Central Asia, Eastern Asia, and South-Eastern Asia saw an increase in the percentage of government spending in agriculture between 2001 and 2020 according to FAO (2021) data reported in Table 2.1. In absolute terms, the majority of Asian sub regions also increased their government expenditures on agriculture. The growth in Asia was led by Eastern Asia and Central Asia in particular, mainly by rising agricultural spending in China and Kazakhstan, respectively (FAO, 2021).

Table 2.1 Government expenditure in agriculture by region from 2001 until 2020

Region	**2001**	**2005**	**2010**	**2015**	**2020**
World	1.65	1.53	1.73	2.09	2.18
Africa	3.06	3.08	2.57	2.46	2.55
Eastern Africa	4.56	6.33	6.98	4.25	3.47
Northern Africa	3.52	3.48	2.39	2.69	2.94
Middle Africa	1.79	1.97	1.27	0.96	0.82
Southern Africa	1.93	1.91	1.86	1.58	1.46
Western Africa	3.65	4.20	3.02	2.52	3.06
Americas	1.14	0.99	0.81	0.66	0.81
Caribbean	4.01	3.07	2.05	3.60	3.83
Central America	3.36	3.32	3.42	2.40	1.05
Northern America	1.04	0.87	0.56	0.44	0.77
South America	1.45	1.54	1.64	1.33	1.11
Asia	3.24	3.88	4.57	5.74	5.93
Central Asia	2.85	3.63	3.78	4.31	3.94
Eastern Asia	3.07	3.84	4.77	6.73	5.92
Southern Asia	6.42	5.92	7.15	5.92	5.99
South-eastern Asia	3.11	3.20	2.82	3.95	3.57
Western Asia	1.78	2.02	1.68	1.38	1.24
Europe	1.05	0.92	0.85	0.66	0.62
Eastern Europe	2.12	2.20	1.85	1.46	1.25
Northern Europe	1.04	0.79	0.62	0.50	0.51
Southern Europe	1.32	1.05	0.87	0.64	0.60
Western Europe	0.80	0.70	0.66	0.53	0.49
Oceania	1.50	1.19	1.18	0.62	0.62
Australia and New Zealand	1.49	1.18	1.16	0.63	0.61
Oceania excluding Australia and New Zealand	2.56	1.67	2.63	1.97	2.01

Source: FAO (2021)

The portion of the budget devoted to agriculture increased in many subregions (such as Northern Africa, the Caribbean, and Western Europe), but its share decreased as more government investment went to other areas. The COVID-19 pandemic demonstrated this, as the majority of the increase in government expenditure went to sectors like industry and healthcare (FAO, 2021). It is important to remember that while most subregions saw a decline in their percentage of spending on agriculture, this does not always imply that total support for agriculture decreased (OECD, 2021). The downward trend is caused by the fact that the percentage rise in spending on agriculture is smaller than the percentage increase in spending overall as indicated in Table 2.1.

2.5 DISCRIPTIVE ANALYSIS OF VARIABLES

Based on government expenditure in agriculture descriptive statistics provided in Table 2.2 to Table 2.4 for the three Countries South Africa, Botswana, and Namibia the study observes some similarities and differences. The data indicate All three countries have the same sample size of 32 data points, which allows for direct comparisons between them. Each country has a measure of central tendency, including the mean, median, and mode. The mean and median are relatively close in all three cases, indicating that the data may be approximately normally distributed. The variable in the three countries has measures of spread, including the standard deviation and range. These measures provide insights into how spread out the data is. South Africa has the smallest range at 3.2, while Botswana has the largest range at 3.56. The coefficient of variation is a measure of relative variability. All three variables have CV values greater than 1, indicating moderate to high relative variability in their data.

Table 2.2 Government expenditure in agriculture in SACU

	South Africa	*Botswana*	*Namibia*
Mean	1,77	4,22	3,67
Standard Error	0,10	0,16	0,17
Median	1,60	4,23	3,70
Mode	1,60	4,49	3,98
Coefficient of Variation	1,71	1,07	1,02
Standard Deviation	0,58	0,93	0,98
Sample Variance	0,34	0,87	0,97
Kurtosis	13,16	-0,77	-1,06
Skewness	3,17	-0,08	-0,09
Range	3,2	3,56	3,22
Minimum	1,2	2,22	2,04
Maximum	4,4	5,78	5,26
Sum	56,7	135,16	117,38
Count	32	32	32

Source: Author's calculation using Excel

The skewness and kurtosis values provide information about the shape of the distribution. South Africa has a positively skewed distribution with a very high positive kurtosis, suggesting it could be having a long tail on the right side. In contrast, Botswana and Namibia have nearly symmetrical distributions with kurtosis values close to 0. While the means are similar for all three countries, the modes are different. The mode represents the most frequent value in the dataset. Botswana and Namibia have modes that are different from their means, indicating some level of asymmetry in their data.

The standard error is an indication of the precision of the sample mean estimate and South Africa has the smallest at 0.58 while Namibia has the largest at 0.98, which means that the mean of South Africa is estimated with the highest precision among the three countries. The high skewness and kurtosis in South Africa indicate that it may have an asymmetric distribution with outliers. Understanding the nature of this variable is crucial for drawing meaningful conclusions. The study conducted hypothesis testing and regression analysis to further test government expenditure in agriculture.

Table 2.3 Agricultural output in SACU compared to Sub-Saharan Africa (SSA)

	South Africa	Botswana	Namibia	SSA
Mean	8526,97	4658,39	2434,40	235079,34
Standard Error	901,70	474,53	38,04	2962,60
Median	7837,50	3774	2474,097	235557,50
Coefficient of Variation	0,0001	0,0003	0,0046	5,9670
Standard Deviation	5100,80	2684,32	215,21	16758,98
Sample Variance	26018140,77	7205598,76	46316,57	280863428,90
Kurtosis	-1,36	10,44	-0,19	-0,71
Skewness	0,21	2,96	-0,39	-0,54
Range	15671,30	13430,80	835,01	57644
Minimum	1352,50	2688	1966,45	197335
Maximum	17023,80	16118,80	2801,46	254979
Sum	272863,11	149068,40	77900,94	7522539
Count	32	32	32	32

Source: Author's calculation using Excel

The data in Table 2.3 indicate that means (average) of the variables vary significantly. South Africa and Sub-Saharan Africa have the highest means, while Namibia has the lowest mean. Sub-Saharan Africa has the highest median, indicating the middle value of the data. This information suggests the SACU countries on average receive private investment in agriculture less than that of Sub-Sahara Africa. The coefficient of variation (CV) for South Africa and Botswana is extremely low, indicating very low relative variability. In contrast, Namibia has a higher CV, suggesting higher relative variability. SSA has the highest CV, indicating the most significant variability relative to the mean. The standard deviations, which measure the spread of the data, vary considerably. Sub-Saharan Africa has the largest standard deviation, suggesting the widest spread, while Botswana has the smallest standard deviation, indicating the least spread.

The Kurtosis and skewness values indicate the shape of the distribution. Botswana has a high positive skewness, suggesting a right-skewed distribution, and a high positive kurtosis, indicating heavy tails. Namibia and Sub-Saharan Africa has a negative skewness, indicating a slight left skew, and a negative kurtosis, suggesting a flatter distribution. The range of values for each country varies, with SSA having the widest range, suggesting the most extensive spread of values. It is essential to consider the magnitude of the data. Sub-Saharan Africa has significantly larger values compared to the SACU countries, which could impact analyses that are sensitive to scale. In summary, Sub-Saharan Africa stands out with its much larger values and higher variability compared to the SACU countries.

The other three variables SACU countries have relatively low variability and exhibit different distribution shapes. These similarities highlight that the variables have similar sample sizes, central tendencies within the same magnitude, low relative variability, and precise estimates of the sample means. However, it is important to note that despite these similarities, the actual values and distribution characteristics of the variable in the different countries differ significantly.

Table 2.4 represents the percentage of the active labour force that is employed in the agricultural sector. These statistics provide information about the central tendency, variability, distribution shape, and range of each variable in the data set. These statistics descriptions are used to analyses and compare the characteristics of the three countries and the Sub-Saharan Africa with regards to the levels of employment to analyse the data and compare it to Sub Saharan Africa.

The study focuses on the key statistical measures and characteristics of employment in the agricultural sector of the three countries South Africa, Botswana, and Namibia in contrast to Sub Saharan Africa.Sub-Saharan Africa has the uppermost mean (60.2008), indicating that, on average, it has the highest value among the four countries. South Africa and Namibia have a means of 7.79 and 20.51, respectively. Botswana has a mean of 20.51, similar to Namibia. Sub-Saharan Africa has the highest standard deviation (3.6546), suggesting greater variability in its data. Botswana and Namibia have similar standard deviations (3.0995). South Africa has the lowest standard deviation (2.8204).

Table 2.4 Employment in the agricultural sector in SACU compared to Sub-Saharan Africa

	South Africa	*BOT*	*NAM*	*SSA*
Mean	7,78	20,51	20,51	60,20
Standard Error	0,50	0,55	0,55	0,65
Median	6,76	20,85	20,85	61,78
Coefficient of Variation	0,36	0,15	0,15	0,06
Standard Deviation	2,82	3,10	3,10	3,65
Sample Variance	7,95	9,61	9,61	13,36
Kurtosis	-1,53	-0,86	-0,86	-0,87
Skewness	0,40	-0,55	-0,55	-0,72
Range	7,85	10,02	10,02	11,73
Minimum	4,60	15,07	15,07	52,93
Maximum	12,45	25,09	25,09	64,66
Sum	249,12	656,37	656,37	1926,42
Count	32	32	32	32

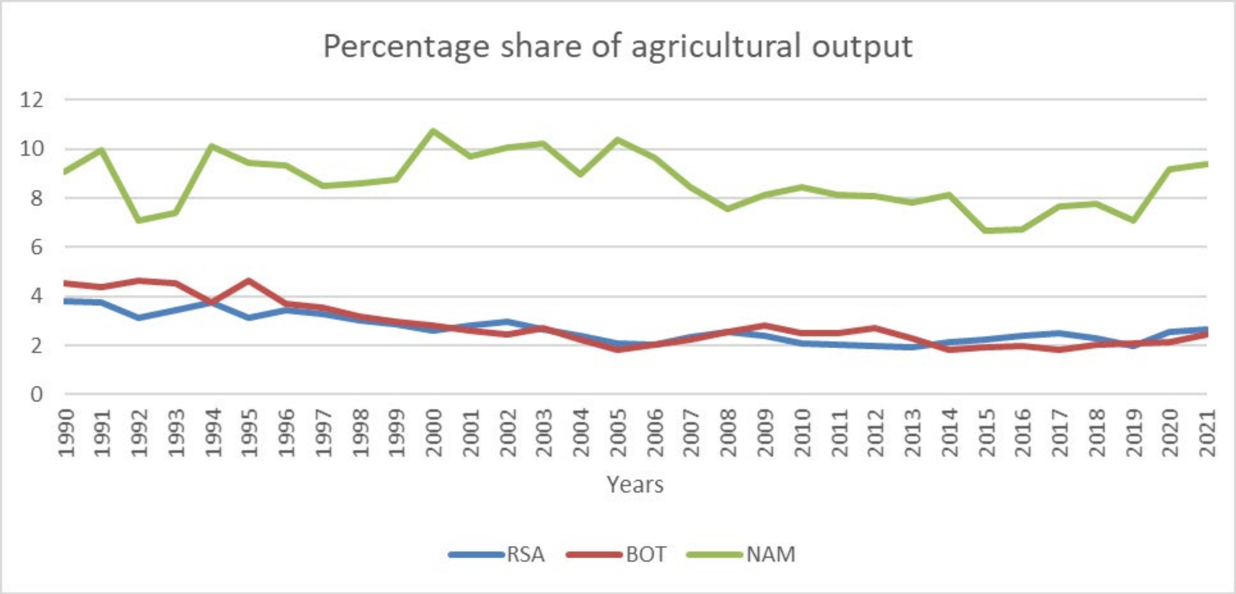
Source: Author's calculation using Excel

Botswana and Namibia have similar medians (20.85). South Africa has a lower median (6.76). Sub-Saharan Africa has the lowest coefficient of variation (0.0607), indicating relative stability in its data. South Africa has a moderately low coefficient of variation of 0.3623. Botswana and Namibia have higher coefficients of variation (0.1511), suggesting more variability relative to their means. Sub-Saharan Africa has the widest range (11.7253), indicating the largest spread between its minimum and maximum values. Botswana and Namibia have similar ranges (10.02). South Africa has the narrowest range of 7.85. All variables have negative kurtosis, suggesting that their distributions are flatter (less peaked) than a normal distribution. Sub-Saharan Africa, Botswana, and Namibia have negative skewness, indicating a left-skewed distribution (tail to the left). South Africa has positive skewness, indicating a right-skewed distribution (tail to the right).

2.6 TRENDS AND ANALYSIS OF VARIABLES COMPARED TO SUB-SAHARAN AFRICA

Figure 2.1 represents the percentage share of Gross domestic product from the agricultural sector in the three (3) SACU countries for the years 1990 to 2021. In the year 1990 which is the base year for the study, South Africa (South Africa) and Botswana (BOT) had their share of agricultural production towards GDP both realizing 3.78% and 4.53% respectively. However, in Namibia (NAM) the value of agricultural production was 9.06%. This is no surprise as Namibia is strongly supporting agriculture as it is one of its major employers. Surprisingly in South Africa and Botswana the value of agricultural production has never passed the 6% mark nor come close. However, the value of agriculture has been declining over the years. Noting that from the year 2003 to 2021 is after the CAADP by the AU with the sole aim of accelerating the MDG's and later the SDGs established by the United Nations aim to enhance food security and alleviate poverty through a development strategy led by agriculture. In order to realize this overarching objective, governments have set a target of achieving a 6% yearly growth rate in agriculture by 2025.

Figure 2.1 Agricultural output in South Africa, Botswana, Namibia, and Sub-Saharan Africa

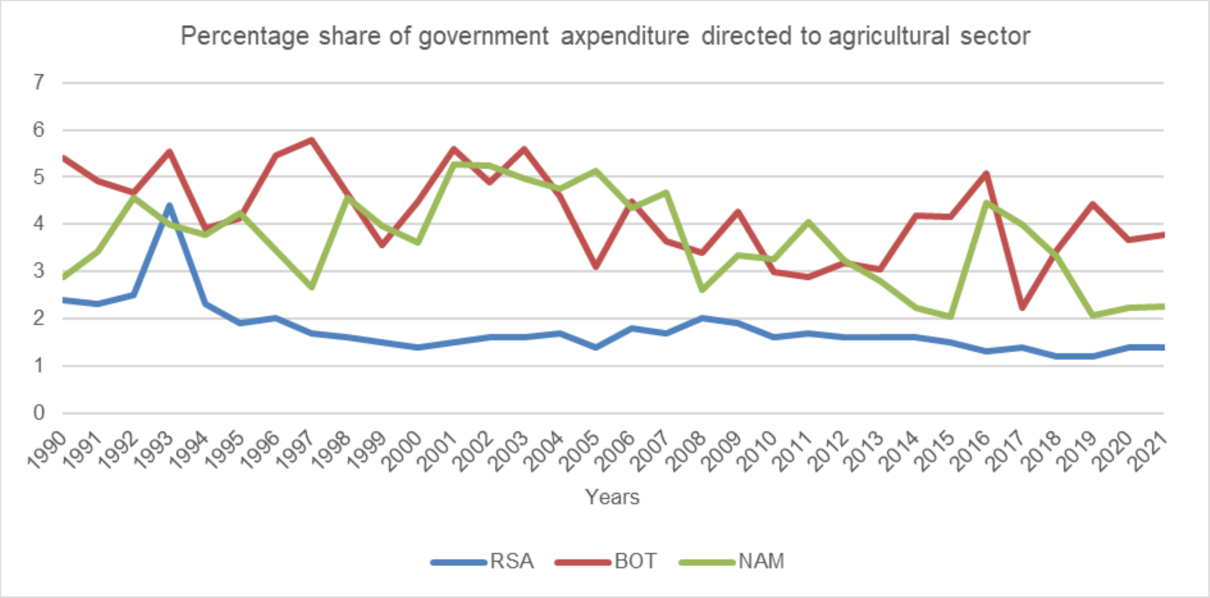


Source: Author's construction using Excel

Insight of the Malabo declaration that kicked in 2015, South Africa and Botswana still failed to achieve the growth rate of 6%. However, it is not the same case in Namibia as it had managed to achieve a growth rate of over 6% throughout the study period. The trends of South Africa and Botswana questions the value of government expenditure in agriculture for these two countries. The study conducts hypothesis testing and regression analysis to further understand the nature of this variable and its relationship with agricultural productivity/output.

Figure 2.2 represents government expenditure in agriculture as a percentage of total government expenditure in the individual countries employed by the study from the period 1990 to 2021. The trend indicate that government expenditure has been fluctuating. The data indicate that the highest government expenditure in agriculture in terms of percentage share was in 1997 at 5.78% in Botswana. Since the year 1997 none of the SACU member state governments has spent over the 5.78% record set by Botswana. The worse performing country throughout the study in terms of government expenditure in agriculture is South Africa spending less than 3% since 1993. The South African government spent 1.4% of its budget in the year 2019.

Figure 2.2 Government expenditure in agriculture in South Africa, Botswana, Namibia, and Sub-Saharan Africa

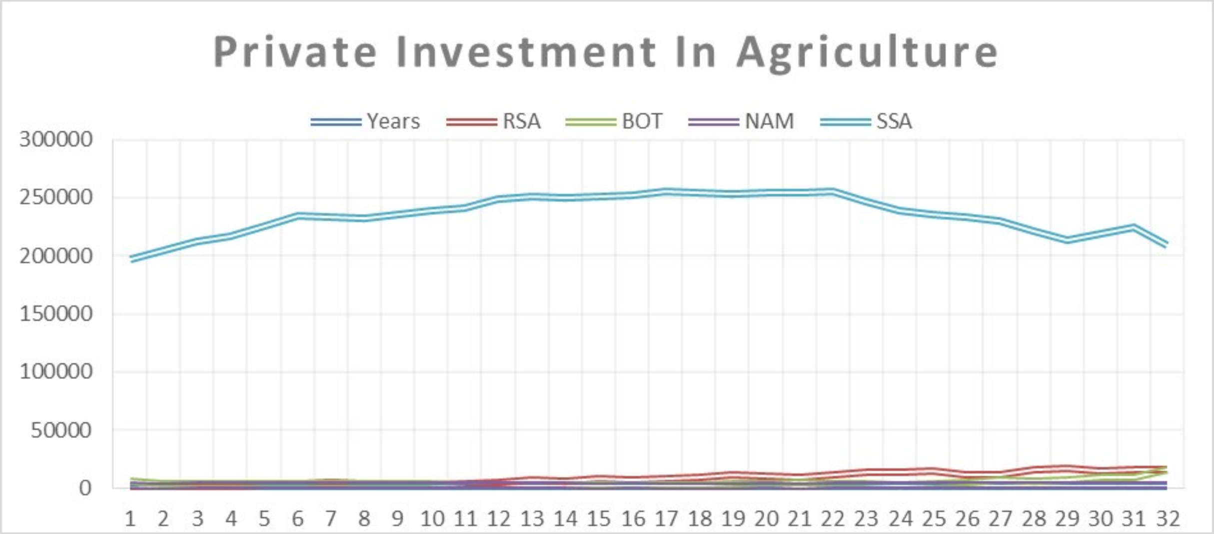


Source: Author’s construction using Excel

According to the Malabo declaration of 2015 suggested that member states of AU should spend at least 10% of its total budget to the agricultural sector and it was estimated that at least a 6% growth rate in agriculture would be attainable ceteris paribus. As seen in Figure 2.1 only Namibia managed to achieve this growth rate despite its spending's being lower than the pledged 10%. Through these two variables as analysed the study speculates that it could be difficult for the SACU countries to attain the goals as set out by the UN in 2015. Jambo (2017) states that nations which embraced the CAADP since it was launched in 2003 and allocated 10% of their national budgets to agriculture saw an annual rise in their agricultural productivity of approximately 5.9% to 6.7%. However, countries that did not pursue the CAADP objectives experienced a growth in farm productivity of less than 3%, as demonstrated by the trends in Figures 2.1 and 2.2. However, it is worth noting that in absolute terms South Africa spends more in the agricultural sector but due to its size it is small.

Figure 2.3 represents the value of private investment in agriculture in millions of US dollars within the period of the study (1990-2021). In the year 1990 Botswana had the largest private investment in agriculture averaging over $5 million and South Africa had the lowest at less than $2,5 million. This date makes economic sense, since by these year South Africa was still under the apartheid regime, Namibia gained its independence in the same year with the Kingdom of Botswana gaining its independence in 1966. This also means that it was difficult for other countries to invest in these countries.

Figure 2.3 Private Investment in agriculture in South Africa, Botswana, Namibia, and Sub-Saharan Africa

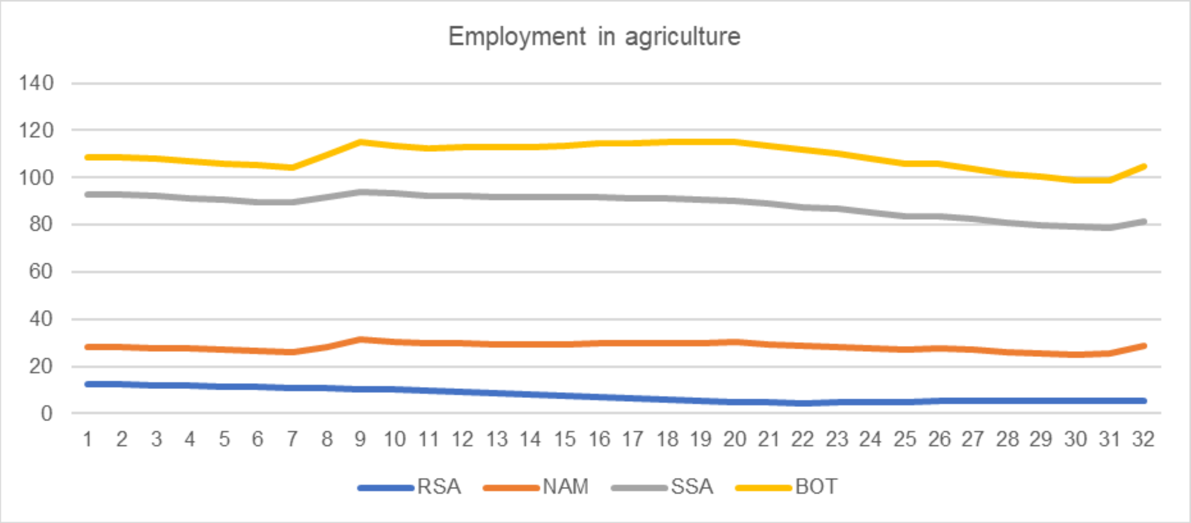


Source: Author's construction using Excel

In the year 1994 Figure 2.3 shows a rise in the value of private investment in agriculture for South Africa and slightly in Namibia and a drop in Botswana. These could be due to the fact that South Africa was always seen as the gate way to Africa, many investors we are choosing South Africa as its destination for investment. The two countries Namibia and Botswana as seen in the previous Figure 2.2 rely heavily on government expenditure in the sector. This could be due to its geographical area with Namibia highly associated dessert and Botswana being mountainous and experiencing snows at times. The study speculate that these could be the major factors for the low levels of investment in agriculture for Botswana and Namibia. However, in South Africa the value of private investment in the agricultural sector has gradually increasing and a bit fluctuating over the years. Additionally, because of technological interventions in the agricultural sector, Botswana as shown in Figure 2.3 Botswana finally caught up with South Africa in terms of private investment in agriculture.

Figure 2.4 represent the employment rate in SACU countries compared to the Sub-Saharan African countries.

Figure 2.4 Employment in the agricultural sector



Source: Author’s construction using Excel

Employment in agriculture for South Africa from 1995 represented about 22% of total employment in the country. This was by far the largest single employment category for rural dwellers in South Africa. However agricultural employment continues to decline at an alarming rate in SACU posing a great threat to rural dwellers of SACU nations. The fall in agricultural employment has different implications as in is the main employment sector for unskilled workers. Employers’ reluctance to pay workers meaningful salaries is one of the many reasons for the decline in the levels of employment in South Africa.

2.7 SUMMARY

This chapter provided a summary, statistical description, and historical patterns of agricultural production, government spending on agriculture, private investment in agriculture, and agricultural employment in the SACU member countries. It also utilized graphical representations for each chosen variable and elaborated on the details of each graph in text, based on historical data from previous years starting from 1990 to 2021. As this chapter reviewed the selected variables, the subsequent chapter will present an in-depth literature review of the study.

With trends, the study learned that Namibia amongst the SACU member states under the study was the only member state of SACU that has seen a growth rate of over 6% as predicted by the Malabo declaration. However, it is not a surprise as the study has already found that these member states that perform below the 6% growth rate in agricultural output are spending less than the recommended 10% spending from the state to fund agricultural activities, resulting to the conflicting results from those of the Malabo declaration. Chapter 3 will be discussing the empirical literature and the theoretical foundation.

CHAPTER 3

LITERATURE REVIEW

3.1 INTRODUCTION

Chapter 2 discussed the summary of the numerous trends and descriptive information on the variables used in the research to look at the effects of government spending and investment in SACU's agriculture industry. This chapter discusses the theoretical literature and empirical literature reviews. The study is primarily interested in how the SACU region, which is defined by high rates of unemployment and poverty, is developing. The first flag that signals ideas that support the connection between government expenditures and private investment in the agricultural sector, the creation of jobs and productivity in the sector, and the potential for economic expansion is the theoretical literature.

3.2 THEORETICAL LITERATURE

The effects of government expenditures and private investment in agriculture from various nations, including SACU countries, have been the subject of numerous studies. The study seeks to investigate those results in this section in order to develop the prior assumptions. The following economic growth theories were used to justify the bearing effect of government expenditure and private investment in agriculture. The theories included the classical growth theory, Keynes growth theory and the Wagner growth theory.

3.2.1 Classical Growth Theory

When Adam Smith wrote "An Inquiry into the Nature and Causes of the Wealth of Nations (1789)," he first proposed a supply-side model of growth and a production function that suggested that labour, capital, technology, and nature were the primary factors affecting output. Adam Smith postulated that investment, population growth, and overall productivity growth all influence the growth of output (Mokgola, 2015). Growth is self-reinforcing since it increases the scale-related returns (Mokoena, Rachidi, & Ngwakwe, 2020).

Adam Smith, David Ricardo, and John Stuart Mill are just a few of the economists who are credited with developing many aspects of classical economics. Similarly, it is argued that fiscal policy is overburdening private investment expenditure (Mkhabela, Ntobela, & Mazibuko, 2022). Private spending on services will decline as a result of public goods replacing private goods as a result of increased government investment (Jambo, 2017). Classical economics contends that interference by the government in the economy or markets should be maintained to a minimum when examining state intervention through its various programmes. Consequently, the government has two options for influencing input prices: it either lead the market or adopt subsidy programmes (Kumar & Dkhar, 2018). The classical viewpoint also suggests that government intervention in the market processes of the economy through inputs and subsidy programmes is associated to long-term price increases and inefficiencies (Tomsik, Smutka, & Lubanda, 2015). Barro (1995) contends that advantageous state policies result in higher per capita GDP levels, which increase the urge for private sector saving. According to the traditional growth idea, savings serve as a starting point for investments. Furthermore, the invisible hand limits the effectiveness of government intervention to the short term.

The growth and production function by Adam Smith (1789) is stated as:

$$Y = f(L, K, N, T) \quad \text{.........} 3.1$$

where: Y stands for output, L represents labour, K is the capital, N stands for Nature while T represents technology.

3.2.2 The Keynesian Theory

The notion of raising government spending with the intention of boosting agricultural productivity is consistent with Keynesian theory, which holds that the state can raise spending in order to have an impact on economic activity (Keynes, 1936). The Keynesian hypothesis was used as the foundation for this investigation. According to Keynes (1936), government spending is an exogenous component that can be employed as a tool in policy to improve performance. According to the Keynesian school of thought, the multiplier effect applies to an economy's productivity and the expenditure function is therefore specified as:

$$Y = C + I + G\ (X-M) \quad \text{.........} (3.2)$$

where: Y = Output, C = Consumption, I =Investment, G = Government Expenditure, and X-M = Net Export (Export minus Import).

It can be noted that the multiplier multiplied by the change in government expenditure will be equal to the change in output (total production) (Keynes, 1936). Therefore, it is conceivable to impact macroeconomic performance and subsequently boost output growth by implementing an expansionary fiscal policy. According to this argument, government spending can help a sector of the economy (like the agriculture sector) thrive. Therefore, this theory asserts that agricultural output depends on government spending on agriculture, private investment, employment in the agricultural sector (a control variable that also takes into account the Smith theory of growth), and output net export, which is left out due to a lack of data in other SACU nations. The SACU economy can benefit from this theory since it explains how the countries' governments can stimulate the agriculture sector's growth by investing in it.

3.2.3 The Cobb-Douglas Production Function

The Cobb-Douglas production function is one of the most widely used functional forms in economics to model the relationship between inputs (such as labour and capital) and output in a production process. It has been central to the study of production theory, growth theory, and empirical analysis of productivity and economic output. The theoretical literature surrounding the Cobb-Douglas production function is extensive and spans several key areas, including its derivation, assumptions, properties, and empirical applications.

The Cobb-Douglas production function was first introduced by economists Charles Cobb and Paul Douglas in the early 20th century. The general form of the Cobb-Douglas production function is expressed as:

$Y= A. L^{\beta} . K^{\alpha}$ ……………………………………………………………………………(3.3)

where:

Y is the output of goods or services produced by the economy. L is the amount of labour input (usually measured in terms of hours worked or number of workers). K is the amount of capital input (which could include machinery, buildings, or financial capital). A is a constant representing total factor productivity (TFP), which captures the efficiency with which labour and capital are used in the production process. α and β are the output elasticities of labour and capital, respectively, and they represent the percentage change in output resulting from a 1% change in labour or capital, holding the other input constant.

The parameters α and β are typically constrained to be between 0 and 1, reflecting diminishing returns to scale, i.e., as more of a single input is added, holding the other inputs constant, the incremental contribution to output diminishes.

The Cobb-Douglas production function exhibits constant returns to scale if $\alpha+\beta=1$. This means that doubling both labour and capital will result in exactly double the output. If $\alpha+\beta<1$, the function exhibits decreasing returns to scale (output increases less than proportionally as inputs are increased). If $\alpha+\beta>1$, it exhibits increasing returns to scale. For each individual input, the Cobb-Douglas function assumes diminishing marginal returns. That is, as more of either labour or capital is added, the marginal increase in output will become smaller, assuming the other input is held constant. The Cobb-Douglas function implies a particular type of substitutability between labour and capital. The elasticity of substitution between labour and capital is constant and equal to 1. This means that a given percentage increase in capital can be exactly replaced by a percentage increase in labour, and vice versa, to maintain the same level of output. The parameter A represents the level of total factor productivity (TFP), which reflects the efficiency with which labour and capital are used in the production process. Technological improvements are often modelled by an increase in A, which leads to higher output for the same quantities of labour and capital.

The coefficients β represent the output elasticities of labour and capital. These values tell us how sensitive the output is to changes in each input. For example, if $\alpha=0.6$ and $\beta=0.4$, a 1% increase in labour would lead to a 0.6% increase in output, while a 1% increase in capital would lead to a 0.4% increase in output. The Cobb-Douglas production function also has important implications for the distribution of income between labour and capital. Under the assumption of competitive markets, the shares of income going to labour and capital are proportional to their respective output elasticities. This implies that:

- The share of income going to labour is α.
- The share of income going to capital is β

Thus, the Cobb-Douglas function provides a simple framework for understanding how economic output is divided between labour and capital in the production process. The Cobb-Douglas production function has been widely used in empirical economic studies to model the production process in various industries and economies. It has been particularly useful in understanding the role of labour and capital in driving economic growth.

The Cobb-Douglas production function provides a fundamental and flexible model for analysing the relationship between output and inputs in production. Its simplicity, coupled with key properties like constant returns to scale, diminishing marginal returns, and factor income distribution, has made it a powerful tool in both theoretical and empirical economic analysis. However, while it offers valuable insights, especially in economic growth and productivity studies, its assumptions and simplifications require careful consideration, particularly when applied to real-world data or in cases where alternative forms of production functions may be more appropriate.

3.2.4 Wagner's Theory

Wagner's Law of Public Expenditure, established by German economist Adolph Wagner (1835–1917), asserts that as an economy grows, so does the relative size of the public sector, particularly government spending. According to this theory, as per capita income rises, there is a corresponding increase in government expenditure, which subsequently influences the overall structure of the economy. Specifically, Wagner hypothesized that increased national wealth and economic growth lead to higher demand for public goods and services, which can drive an expansion in the size of the public sector. This theory is often described as an "organic" theory of the state, suggesting that the state's role in the economy naturally grows as society's needs evolve. In the context of agricultural economics and SACU countries, Wagner's Theory provides a relevant lens through which to analyse the relationship between government expenditure, private sector investment, and agricultural output.

The theory posits that, as economies grow and per capita income rises, the demand for public sector services such as those in agriculture expands. This has important implications for how government expenditure might influence agricultural output.

Wagner’s Law asserts that the expansion of the public sector in the face of economic growth leads to increased demand for public goods and services, including those related to agriculture. The role of government spending in supporting agriculture may grow as the economy of a country expands. Government expenditure on infrastructure, research, education, and subsidies can improve agricultural productivity, making agriculture more efficient and productive. Wagner's theory also implies that as per capita income rises and government expenditure increases, there is greater potential for private investment to flow into the agricultural sector, supported by public infrastructure, technology, and policies. When government expenditure on agriculture increases, it can create an enabling environment for private investment, particularly by improving infrastructure, reducing transaction costs, and fostering a stable economic environment.

Employment in agriculture is another critical variable that can be influenced by government expenditure. Wagner's Law suggests that as the economy grows and per capita income rises, government spending will increase, and the state's role in employment generation may expand. In the agricultural sector, this could manifest as increased employment opportunities through government-funded projects, such as rural infrastructure development, agricultural research, and training programs, as well as subsidies to encourage employment in farming and related sectors.

While Wagner’s theory provides a useful framework for understanding the relationship between government expenditure and economic growth, it has its limitations. Critics argue that Wagner's Law does not sufficiently explain the variability in government expenditure patterns across different countries. For instance, some studies in SACU countries, such as Abdulmalik (2020) in Nigeria, suggest that despite increased government spending, agricultural output may not always respond positively, due to issues such as misallocation of resources, inefficiency in public spending, and poor governance.

Furthermore, Wagner’s theory primarily addresses the demand side of public expenditure, ignoring the supply-side dynamics, such as the efficiency of government spending or the economic conditions that shape the public sector's response. As Ngobeni and Muchopa (2022) point out, government spending may increase in line with economic growth, nonetheless, its effectiveness in stimulating agricultural productivity depends on how well these funds are managed and allocated to productive sectors like agriculture. While Wagner's theory offers valuable insights into the role of public expenditure in fostering agricultural growth, its applicability may be constrained by local economic contexts and governance challenges in the SACU region. Further research is needed to understand the specific factors that mediate these relationships and how they can be enhanced to drive sustainable agricultural growth.

3.2.5 The Solow-Swan Growth Theory

The Solow Growth Model is one of the foundational theories of economic growth and focuses on the long-term changes in an economy's output, driven by factors like capital accumulation, population growth, technological progress, and savings rate. Robert Solow, in his 1956 model, emphasizes how economies evolve over time based on these key factors. The model's central insight is that, in the long run, growth is primarily driven by technological progress, while capital accumulation alone cannot sustain growth indefinitely.

In the context of the agricultural sector, especially in the SACU countries, integrating the Solow Growth Model with the variables of interest such as government expenditure on agriculture, private sector investment in agriculture, agricultural output, and employment provides a clear framework for understanding the dynamics of economic growth in these economies. These variables fit neatly into the Solow model's formulation and help explain the evolution of agricultural productivity in the long run. One of the key elements in the Solow model is capital accumulation, which contributes to economic growth by increasing the amount of capital available per worker. In the context of SACU countries and the agricultural sector, government expenditure on agriculture can be viewed as a form of public investment in capital such as infrastructure (e.g., irrigation, roads, rural electrification), research and development (e.g., agricultural technology), and education (e.g., extension services for farmers).

$Y_t = A_t f(K_t, L_t)$……………………………………………………………………..(3.4)

where:

Y_t is output per worker at time t,

A_t is the level of technology at time t,

K_t is capital per worker,

L_t is labour (in the agricultural sector, specifically).

The growth of capital per worker in the agricultural sector in SACU countries, driven by government expenditure, directly influences output per worker. If government spending increases (such as investments in agricultural capital or technology), the capital to labour ratio (K/L) improves, leading to higher productivity per worker. This aligns with the Solow model’s premise that capital accumulation increases output, but it also suggests that government expenditure, when efficiently allocated, has the potential to boost agricultural growth in the long run.

The Solow model assumes that technological progress is exogenous and contributes to long-term growth. In agricultural economies, private investments can include improvements in farming equipment, irrigation systems, better seeds, and other forms of capital that enhance productivity. As private sector investment in the agricultural sector increases, there is an increase in the amount of capital per worker (K_t), which enhances output per worker (Y_t). In this way, private investment serves as a mechanism to raise the capital to labour ratio and technological adoption in the agricultural sector, similar to the technological progress described in the Solow model. In SACU countries, private sector investment in agriculture could be crucial in pushing the agricultural sector towards a higher steady-state output, particularly through the adoption of modern farming techniques and technologies. This investment, in combination with government policies (such as subsidies or incentives for private investors), helps drive growth in agricultural productivity, which is a core element of the Solow model’s explanation of economic development.

The Solow model assumes that population growth affects the supply of labour, which in turn impacts output. In the context of agriculture, employment in the sector is critical for determining the total labour force available to work with the available capital. As population growth leads to an increase in the labour force, the agricultural sector must adapt by increasing productivity (either through capital deepening or technological progress) to maintain or enhance output per worker. In SACU countries, as employment in agriculture increases, especially through government policies aimed at creating jobs in rural areas, the agricultural sector can see an increase in total agricultural output. However, for this to translate into higher productivity, there must be sufficient investments in capital and technology to ensure that the labour force is productive.

The model's focus on capital accumulation, technological progress, and population growth provides a useful framework for analysing how government expenditure, private investment, employment, and savings interact to drive growth in the agricultural sector. By focusing on these key drivers of economic growth, policymakers in SACU countries can develop strategies to improve agricultural productivity and ensure sustained growth in the sector.

3.3 EMPIRICAL LITERATURE

The relationship between government expenditure, private sector investment, and agricultural output has been studied extensively in various economies, including those in the Southern African Customs Union (SACU). This empirical literature review aims to highlight key findings from studies focusing on SACU countries, with a specific emphasis on the variables of interest, such as government expenditure in agriculture, private investment in agriculture, and agricultural output.

3.3.1 Government Expenditure in Agriculture and Agricultural Output

Manyisa, Chauke, and Anim (2015) conducted a study analysing the impact of government expenditure on agricultural growth in South Africa and Zimbabwe. Using time series data from 1981 to 2006 for Zimbabwe and 1983 to 2011 for South Africa, the study applied stationarity, co-integration, and error correction methods. The findings indicated that capital investment in the agricultural sector was positively correlated with agricultural growth in both countries. The study also noted that while capital expenditure contributed to agricultural development, Zimbabwe's agriculture and South Africa's non-agricultural spending had competed interests, limiting the potential impact of government expenditure on agriculture.

Odhiambo (2015) investigated the relationship between economic growth and government expenditure in South Africa using the Granger causality test. The study found a unidirectional causality from economic growth to government spending, indicating that economic growth in South Africa led to increased government expenditure. However, in the short term, there was also a bidirectional causality between government spending and economic growth, suggesting that government expenditure could have a significant impact on the short-term performance of the economy. Greyling, Vink, and Mabaya (2015) conducted a study on the relationship between agricultural production and economic growth in South Africa, using data from 1970 to 2010. Their findings, based on the Engle-Granger two-step test, demonstrated that gross capital formation, GDP, the labour force, and agricultural exports had a positive long-term effect on agricultural productivity, while inflation (measured by the consumer price index) had a negative effect. The study provided evidence of the importance of investment in physical capital and labour force participation in driving agricultural output, while inflation could undermine agricultural productivity.

Uremadu, Ariwa, and Uremadu (2018) analysed the effects of government agricultural expenditure on agricultural output in Nigeria (a country within the SACU region). Using data from 1981 to 2014 and the Vector Error Correction Model (VECM), the study found a significant positive impact of government agricultural spending on agricultural output, suggesting that increased public expenditure in agriculture could stimulate productivity. Kumar and Dkhar (2018) explored the relationship between government investment in agriculture and agricultural output in Meghalaya, India using the ARDL approach over the period from 1984 to 2013. Although the study was based in India, it offers insights into SACU countries as well. The findings indicated that public expenditure on agriculture had a detrimental effect on agricultural output in the long run, highlighting that in some contexts, government spending might not always be efficient in boosting agricultural growth.

Abdulmalik (2020) examined the effects of state government investment on agricultural growth in Kogi State, Nigeria using the Vector Autoregressive (VAR) model. The study found no significant relationship between government investment and agricultural output, suggesting that public capital expenditure did not have the expected positive impact on the agricultural sector.

3.3.2 Private Sector Investment and Agricultural Output.

Private investment is a critical determinant of agricultural growth, and several studies have explored its impact on agricultural output in the SACU region.

Ngobeni and Muchopa (2022) analyzed the relationship between government spending, private investment in agriculture, and the value of agricultural production in South Africa. Using data from 1983 to 2019 and the Vector Autoregressive (VAR) model, the study found that private investment positively influenced agricultural output, particularly through increased access to technology, capital, and modern farming practices. However, the study also found that government spending on agriculture had a mixed effect, depending on various factors such as population growth, rainfall, and cost of food imports.

Baba, Saini, Sharma, and Thukur (2010) investigated the relationship between government and private investment on agricultural growth in Himachal Pradesh, India, using agricultural GDP as a measure of agricultural productivity. The study revealed a significant positive correlation between both private and government investment in agriculture and agricultural productivity, indicating that private sector investment can complement public sector expenditure in enhancing agricultural output. Jambo (2017) conducted a study on the effect of government expenditure on agricultural growth in South Africa, Zambia, and Tanzania from 2000 to 2014, using the Vector Error Correction Model (VECM). The study found that private investment had a positive effect on agricultural output in Malawi, but in South Africa, private investment in agriculture had a negative impact on agricultural growth, which was in contrast to findings from other studies that found a positive relationship between private investment and agricultural output.

3.3.3 Employment and Agricultural Output.

The role of employment in the agricultural sector is another key determinant of agricultural output, especially in developing countries where agriculture plays a central role in employment.

Ayodotum et al. (2019) explored the importance of employment in agriculture for enhancing agricultural productivity in Sub-Saharan Africa (SSA), including SACU countries. They emphasized that policies aimed at coordinating employment throughout the agricultural value chain, including rural and urban areas, are crucial for boosting agricultural productivity. The study suggested that effective labor utilization can drive productivity, especially in countries where agriculture is a major source of employment. Maga et al. (2021) studied the impact of government spending on agricultural growth in Mali using the ARDL model. The results showed that spending on education and health positively influenced agricultural output. However, they found that employment in the agricultural sector, along with fertilizer usage, had a negative impact on agricultural output. These findings suggest that while employment in agriculture is important, the quality and type of employment (such as mechanized or labor-intensive jobs) also play a crucial role in driving agricultural productivity.

Dao (2012) conducted a study on the impact of population growth on economic development across 43 emerging countries, including SACU members, from 1990 to 2008. The study found that while population growth could provide a larger labor force, it could also impede economic growth if the population growth rate exceeds the capacity to provide sufficient employment opportunities and infrastructure. This underscores the importance of policies that support job creation in agriculture as a means of stimulating agricultural output.

3.4 SUMMARY

The implications of government expenditure and private investment in the agriculture sector for SACU member states are covered by the theoretical and empirical framework described in this chapter. It is evident that the majority of countries' empirical research employed a variety of estimating techniques and generated a range of outcomes. The bulk of research studies revealed that fiscal issues influenced the agriculture sector favorably in both the long run and the short term. Chapter 4 will cover research methodology along with data collection and analysis techniques.

CHAPTER 4

RESEARCH METHODOLOGY

4.1 INTRODUCTION

Chapter 3 discussed the study’s empirical literature and the theoretical foundation. Chapter 4 discusses the methodology used to carrying out the study. The discussion starts with data description, followed by model specification and estimation techniques. The estimation techniques discussed in this chapter include ADF Unit root test, the ARDL modelling approach of cointegration, the error correction model, granger causality analysis and concludes with stability test.

4.2 DATA

To investigate the impact of government expenditure and private investment on the agricultural sector output within the SACU area, the approach of the study is quantitative in nature and is based on secondary annual time series data from 1991 to 2021. The South African Reserve Bank (SARB), Quantec, the World Bank, and the Food and Agriculture Organisation (FAO) all have archives of data from which the information was retrieved. Table 4.1 further indicates the variable description and source.

Table 4.1 Variables description and source

Variables	**Indicator**	**Measurement**	**Source**
output	Agricultural output	Percentage growth	World bank\ Quantec
Gov	Government expenditure in agriculture	Percentage of GDP	SARB/ World Bank/ MADFS
Gcf	Private expenditure in agriculture	Percentage growth	World Bank
Emp	Employment in agriculture	Percentage growth	World Bank

Source: Author compilation

4.3 MODEL SPECIFICATION

The Cobb-Douglas production function is a functional form used to model the relationship between inputs (such as capital and labour) and output in the production process. Originally developed by Charles Cobb and Paul Douglas in the 1920s, the

Cobb-Douglas function is characterised by constant returns to scale and diminishing marginal returns to individual inputs. The general form of the Cobb-Douglas function is:

$Y= A. L^{\beta} . K^{\alpha}$ ……………………………………………………………………(4.1)

where:
Y = Output (agricultural output in this case)
A = Total factor productivity (TFP), capturing technological progress or efficiency improvements.
L = Labour input (agricultural employment)
K = Capital input (which, in this study, is represented by private agricultural investment (LGCF) and government expenditure on agriculture (GOV)).
α and β = Output elasticities, representing the percentage change in output resulting from a 1% change in capital or labour.

The Cobb-Douglas production function provides a solid theoretical foundation for understanding how agricultural output is determined by labour, capital (private and public investment), and total factor productivity. This theoretical framework allows for the empirical investigation of the relationships between agricultural output and key production inputs, offering important insights into the effectiveness of policies that aim to boost agricultural productivity. By estimating the elasticity coefficients, policymakers can tailor their interventions to areas that will yield the greatest impact on agricultural output, such as increasing investment, enhancing employment, or boosting government expenditure in key areas.

The study, adapt the Cobb-Douglas production function to specifically capture the determinants of agricultural output. The three main factors influencing agricultural output are: Agricultural Employment (EMP): Representing the labour force engaged in agriculture. Private Agricultural Investment (LGCF): Representing the private capital allocated to agricultural activities. Government Expenditure on Agriculture (GOV): Representing public investment in the agricultural sector through government spending on infrastructure, subsidies, and other policy initiatives.

Thus, the functional form adapted for this study becomes:

$$output_t = f(gov_t, emp_t, gfc_{t,}) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4.1)$$

where:

OUTPUT = Agricultural output (dependent variable).

GOV = Government expenditure on agriculture (capital input).

EMP = Agricultural employment (labour input).

GCF = Private agricultural investment (capital input).

Equation (4.1) can be formally expressed as follows for the different three (3) countries:

South Africa

$$\mathrm{logOutput_t} = \alpha + \beta_1 \mathrm{loggov_t} + \beta_2 \mathrm{loggcf_t} + \beta_3 \mathrm{emp_t} + \mu_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4.2)$$

NAMIBIA

$$\mathrm{logOutput_t} = \Omega + \theta_1 \mathrm{loggov_t} + \theta_2 \mathrm{loggcf_t} + \theta_3 \mathrm{emp_t} + \mu_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4.3)$$

BOTSWANA

$$\mathrm{logOutput_t} = \sigma + \text{Ϫ}_1 \mathrm{loggov_t} + \text{Ϫ}_2 \mathrm{loggcf_t} + \text{Ϫ}_3 \mathrm{emp_t} + \mu_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4.4)$$

where:

log stands for logarithm, α, Ω, and σ, are the constants, β, θ, and Ϫ are coefficients of the explanatory variables with μ_t being the residual term. Logs are useful in obtaining a constant elasticity model.

4.4 ESTIMATION TECHNIQUES

Different econometric estimation techniques applied in this study are discussed, and that is the unit root tests, cointegration analysis, diagnostic and stability tests. The Autoregressive Distributed Lag (ARDL) methodology is employed in the study to determine the short and long-run relationship of the SACU agricultural models.

4.4.1 Visual Inspection (Informal Test)

Stationarity tests help detect if results are spurious or not. Informal unit root test is used initially, which is the visual data plotting and is performed on the variables under study. The study uses EViews 12 statistical packaged to perform the informal unit root test. In the visual data plotting, if a line graph is upward trending/ downward trending, it shows that there is unit root in the time series, but if it oscillates around the mean, where there is a possibility to draw a straight line across, the time series data assumed to be stationary (Dickey & Fuller, 1979). For the formal tests, stationarity is tested using the standard form of the Augmented Dickey fuller (ADF) unit root test.

4.4.2 ADF Unit Root Test

The null hypothesis, that a series is not stationary (that is, it has a unit root), is the foundation of the ADF unit root test and is tested against the alternative, that the series is stationary, using the Augmented Dickey Fuller (ADF) test. If the null hypothesis is rejected, the conclusion is that the time series is stationary and if the mean and autocovariances do not change over time, a time series is said to be stationary (Dickey & Fuller, 1981). After first differencing, a series that succeeds in stationarity is referred to as having a unit root and require order one integration (Dickey & Fuller, 1979). ADF helps in making sure that there is no second difference I (2) variables as this might crash the ARDL estimator (Kumar & Dkhar, 2018). The study looked into the behaviour of the p-values to make a conclusion on the stationarity of the unit root test.

The Augmented Dickey-Fuller test can be directed using the following regression (Dickey & Fuller, 1979):

$$\Delta Yt = \alpha + \beta t + \vartheta Yt\text{-}1 + \sum \lambda \Delta \times Yt-1 + \mu t\ k\ i-1 \ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \ (4.5)$$

where ΔYt is the first difference of the series Y I(I), μi is a stochastic error term, in which ΔYt-1 = (Yt-1 – Yt-2), ΔYt-2 = (Yt-2 – Yt-3). B1 is a constant, t is the time, β and ϑ are parameters.

Therefore, model specification for unit root testing is expressed as:

$\Delta\text{OUTPUT} = z\text{OUTPUT}t-1 + \mu i$… … … … … ……… … … … … … … … … (4.6)

$\Delta\text{GOV} = z\text{GOV}t-1 + \mu i$ … … … … … … ... ... (4.7)

$\Delta\text{GCF} = z\text{GCF}-1 + \mu i$… … … … … … … … ... ... (4.8)

$\Delta\text{EMP} = z\text{EMP}t-1 + \mu i$ … … … … … … … ... ... (4.9)

4.4.3 ARDL Model

The autoregressive distribution lag technique refers to a combination of the standard autoregressive methodology and regression with distribution lags Pesaren, Shin and Smith (1997). To regress a variable over its previous values using past and current values of the independent variables, the ARDL method incorporates autoregressive approaches with distribution lags (Pesaren at.al 1997). As a result, the ARDL model may be expressed as follows:

$Yt = \sigma + \chi Yt-1 + \beta 0\chi\ t + \beta 1\chi\ t-1 + \varepsilon t$ ……………………..………..……………….(4.10)

Where Yt represents the dependent variables lagged by one year, Xt denotes independent variables lagged by one year, εt indicates the error term. The autoregressive distributed lag is defined by choosing lags for each variable in the regressed model (Pesaren at.al 1997).

The equation is rewritten in autoregressive form as follows:

$Yt = \sigma + (1 + X + X2 + \ldots) + (1 + XL + X2L2 + e)(\beta 0\chi\ t + \beta 1\chi\ t-1 + \varepsilon t)$ ..……………..…..(4.11)

This equation is the autoregressive approach that estimates the effects of changes in Xt on upcoming values of Yt.

4.4.4 ARDL Modelling Approach of Cointegration.

Cointegration is significant for this study as it gives a clear indication about the long and relationship of the model variables. Cointegration is said to exist when the F-statistic is greater than the lower and upper bound (Johansen & Juselius, 1990). In the case where the F-statistic is lower than the upper and lower bounds, then there is no cointegration in the data and if F-statistic is between the upper and lower bounds it is said that there is uncertain cointegration (Johansen & Juselius, 1990). The Autoregressive distribution lag model (ARDL) is employed for the purpose of this study.

4.4.5 Error Correction Model (ECM)

The speed of adjustments from short to long-run equilibrium is reflected using the Error Correction Model (ECM) (Li & Lin, 2016). The ARDL ECM is not an unconstrained vector autoregressive model designed to be used to cointegrated non-stationary series. The occurrence of ARDL cointegration between the series suggests that the variables under examination have an equilibrium association over the long run (Engle & Granger, 1987). In order to confirm the short-run features of the cointegrated series, the usage of ARDL ECM is essential. The ARDL ECM, also known as the speed of adjustment, describes how quickly the model returns to equilibrium.

4.4.6 Granger Causality Analysis

Testing for causality between subsets of variables is done using the Granger causality test. The significance of cointegration testing before granger causality analysis must be emphasised. This is due to the fact that proving causality in a test does not always imply that changes in one variable will result in changes in other variables (Granger, 1969). The Granger causality test determines the direction of causation among the system's variables and determines the value of one variable in forecasting the course of other variables' future trends (Granger, 1969). The number of lag terms that are utilised in a model might cause sensitivity to the test, which makes Granger causality tests vulnerable to abuse in applied research (Brooks, 2014). The general econometrics formula by Granger, (1969) is given as:

$$X_i = \sum_{j=1}^{m} a_j X_t - j + \sum_{j=1}^{m} b_j Y_{t-j} + e_i \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \tag{4.12}$$

$$Y_i = \sum_{j=1}^{m} c_j X_t - j + \sum_{j=1}^{m} b_j Y_{t-j} + n_i \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \tag{4.13}$$

where Xi and Yi are formula-included variables. Equations 4.12 and 4.13 suggest that when aj is not zero, Xi is granger causing Yt. Additionally, when cj is not zero, Yt Granger results in Xi.

The test is based on the null hypothesis that, if a signal on one variable may lead to a signal on another, then the past values of that variable should provide information that, in addition to the information present in the past values of the other variables, helps predict the other variable. Therefore, the null hypothesis will be rejected if the associated probability value (p-value) is less than 5% and will not be rejected if the p-value is more than 5%.

4.4.7 Diagnostic Testing

The section will focus on testing if any of the Ordinary Least Square's assumptions has been violated and examining if the model is relatively stable. Tests including Jarque-Bera for normality testing, Breusch-Pagan Godfrey LM test, and ARCH LM for heteroscedasticity were employed for diagnostic testing.

4.4.8 Normality Test

The normality tests are often employed to determine how much an empirical distribution departs from the normal distribution. For this investigation, the ARDL Residual Normality Tests were applied. The assumption that the empirical and normal distributions are asymptotic leads to the frequent use of natural population studies in statistical analysis (Jargue & Bera, 1987; Milanzi, 2021). The Jargue-Bera test is one of the most used tests for normalcy and is based on the statistical coefficients for skewness and kurtosis.

The hypothesis of the Jargua-Bera is given as:

H0: Residuals are normally distributed.

H1: Residuals are not normally distributed.

As per the standard guideline, if all the P-values from the test are below the significance level of 0.05 (5%), we should reject the null hypothesis that suggests the residuals follow a normal distribution. Instead, we should accept the alternative hypothesis that proposes the residuals do not adhere to a normal distribution. The Classical Linear Regression Model (CLRM) (Jargue & Bera, 1987) implies that the model's errors are normally distributed, hence it is crucial to take into account this test. This model's mathematical formulation is provided as follows:

$U_t \sim N(0, \sigma^2)$……………………………………………..…………………….……(4.16)

4.4.9 Serial Correlation

According to Gujarati (2009), autocorrelation is the correlation between a set of ordered series of observations in cross-sectional data or time series data. The Classical Linear Regression Model makes the assumption that no observation's disturbance term will have an impact on any other observation's disturbance term (Gujarati, 2009).

Autocorrelation or serial correlation happenswhen the disturbance term is discovered to be connected with one another (Brooks, 2014). OLS regressions with correlation produce estimators with inconsistent, inadequate, biased, and weak standard errors (Gujarati, 2009; Valoyi, 2019). This means that estimators may not be Best Linear Unbiased Estimators (BLUE) and may provide inaccurate estimates of standard error when autocorrelation is neglected (Brooks, 2014).

To test for autocorrelation the Durbin-Watson test (DW) and Breusch-Godfrey test are employed for the purpose of the study. The test can only be made as far as the first order autocorrelation, that is, it tests only for a relationship between a disturbance term and its previous value (Ledwaba, 2023; Gujarati, 2009).

4.4.10 Heteroskedasticity

To check for heteroskedasticity in the model, the ARCH must be run. A set of random variables is said to be heteroskedastic, in accordance with Asteriou and Hall (2011), if their variances are random. Any econometric analysis must include hypothesis testing because heteroscedasticity usually renders the typical OLS inference invalid. The hypothesis that must be considered when testing heteroskedasticity is given as:

H0: There is no heteroskedasticity in the model.
H1: There is heteroskedasticity in the model.

When testing for heteroscedasticity, if the p-value is sufficiently small, then we reject the null hypothesis, which is the null hypothesis of homoscedasticity. The existence of an ARCH effect could be interpreted as proof of misspecification due to missing variables or structural changes. This test permits the error terms' variance to exhibit autocorrelation rather than the error terms themselves. There is no ARCH effect, which is the null hypothesis (Letsaolo & Ncanywa, 2019).

4.5 Stability Testing

The section of stability testing will focus on testing if any of the Ordinary Least Square's assumption has been violated and examining if the model is relatively stable. If the mean and autocovariances do not change over time, a time series is said to be stationary. After first differencing, a series that succeeds in stationarity is referred to as possessing a unit root and require order one integration (Matlasedi, 2017; Gujarati, 2009). This suggests that the parameters associated with the model has been inconsistently valued during the whole time (Gujarati, 2009). Because of the inconsistency the model might become unstable, thus testing stability of the model to eliminate such structural breaks. The CUSUM and CUSUM of squares are vital in testing stability and they will be employed in the study.

4.5.1 Cusum Test and CUSUM Of Squares

These tests, which are based on the analysis of scaled recursive residuals, significantly outperform the Chow test since they do not necessitate prior knowledge of the location of the postulated structural break (Ntuli, 2022; Gujarati, 2009). Instead of formal testing procedures, the initial goal of these tests was to offer a diagnostic tool for the discovery of unidentified structural breakdowns. These tests were employed formally in the study to check the consistency of the parameter values. When utilizing the EViews statistics software the cumulative sum of recursive residuals (Cusum) test suggests that the cumulative total must move inside the critical lines at a 5% level of significance to draw the conclusion that the data is stable (Gujarati, 2009).

Cumulative sum of squares of recursive residuals CUSUM Squares is employed in the study to check for stability of the model. The model is deemed to be stable if the line or graph is between the two lines of 5% level of significant and is unstable if it passes or cross the line of 5% level of significant (Mutambirwa, 2016; Gujarati, 2009).

The CUSUM test statistic is given as:

$W = \sum \hat{ej}\ \hat{\sigma\epsilon}\ t\ j=k+1$…………………………………………………………… (4.17)

where $\hat{ej}$ is the recursive residual and $\hat{\sigma\epsilon\epsilon}$ is the standard deviation of the recursive residual, defined as:

$\hat{\sigma\epsilon} = \sqrt{}(1\ T-K \sum (\epsilon t - \hat{\epsilon})\ T\ 2\ t=1\ )$……………………..………………..………..… (4.18)

for robustness, the cumulative sum of squares test is also appliedas:

$\boldsymbol{St} = (\sum wr\ t\ 2\ r=k+1)\ (\sum wr\ t\ 2\ r=k+1)$ ………………………………………….. (4.19)

where wt is the recursive residuals computed for t=k+1,…,T.
Therefore, expected value of under the hypothesis of parameter constancy is:

$(St) = (t - k)(T - k)$…………………………….…………………………..(4.20)

4.6 SUMMARY

Significant study-related information has been presented in this chapter. Chapter 4 begins with a brief description of the type and location of the data (time series) collection. The data's variables have been selected because they are crucial to determining the final value of agricultural output in SACU. Chapter 4 also provides an outline of the methodologies that will be used to conduct the study's analysis. Because of the many benefits that the ARDL provides in comparison to other alternative approaches, the ARDL method is chosen as the primary estimation method. The diagnostic tests utilized in the study were also covered in this chapter. Chapter 5 is discussed next.

CHAPTER 5

DISCUSSION / PRESENTATION / INTERPRETATION OF FINDINGS

5.1 INTRODUCTION

The methodology covered in Chapter 4 is applied in this chapter. The time-series features of the data are first described, and then the augmented Dickey-Fuller test (ADF) is used to determine whether the series is stationary. The Bounds testing strategy are then used to determine whether the variables in the output model have a long-term relationship. The estimation of the ARDL model's long and short run parameters, as well as a description of the model diagnostics and stability tests, complete the Chapter. The econometrics statistical programme Eviews 12 is used to conduct each test.

5.2 EMPIRICAL TEST RESULTS

5.2.1 Informal Unit Root Test Results

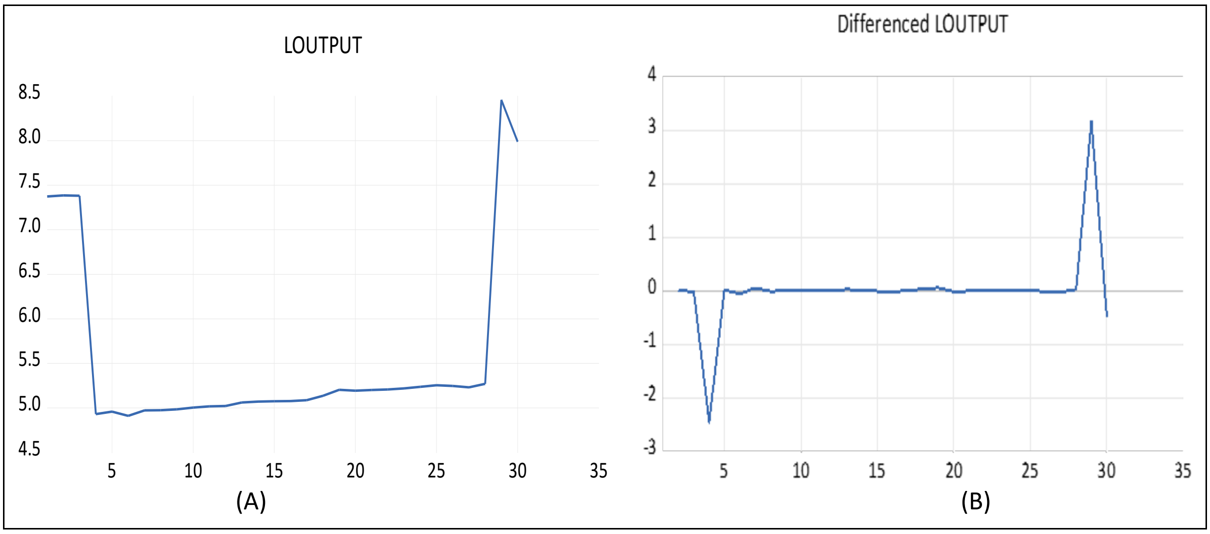
All variables under the study were tested through visual inspection in the SACU countries and the results are presented below:

5.2.1.1 ADF unit root test results

The data under investigation must be stationary to allow for proper analysis of econometric models. Before moving on to the unit root testing, Figures 5.1 to 5.12 provide a subjective visual review of the variables in their level and differenced forms.

Figure 5.1, the log of the agricultural output in level form and the log of agricultural output at the first difference are shown in (A) and (B), respectively. The majority of the sample LOUTPUT is not increasing around the same mean, according to Figure 5.1(A). The variable (LOUTPUT) must be differentiated once to become stationary. The log of the agricultural output oscillates around zero after the first difference, as shown in Figure 5.1 (B). This indicates that the variable (LOUTPUT) has a first-order integration. That is, it stops moving after the first difference.

Figure 5.1 Agricultural output in South Africa

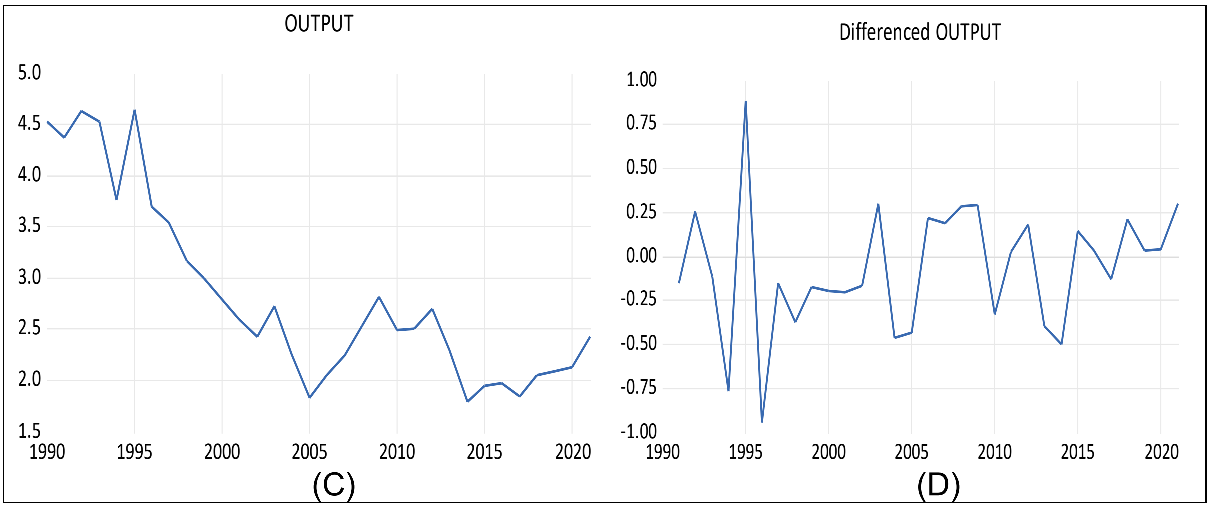


(A) (B)

Source: Author's construction using EViews 12

Figure 5.2 represent the agricultural output in South Africa at I(0) and I(1). Figure 5.2 C is sloping downwards over the estimated period of time, indicating nonstationary at level. However, the differenced agricultural output seems to be trending around the mean of zero, indicating that the value of agricultural output should be stationary at first level.

Figure 5.2 Agricultural output in Botswana

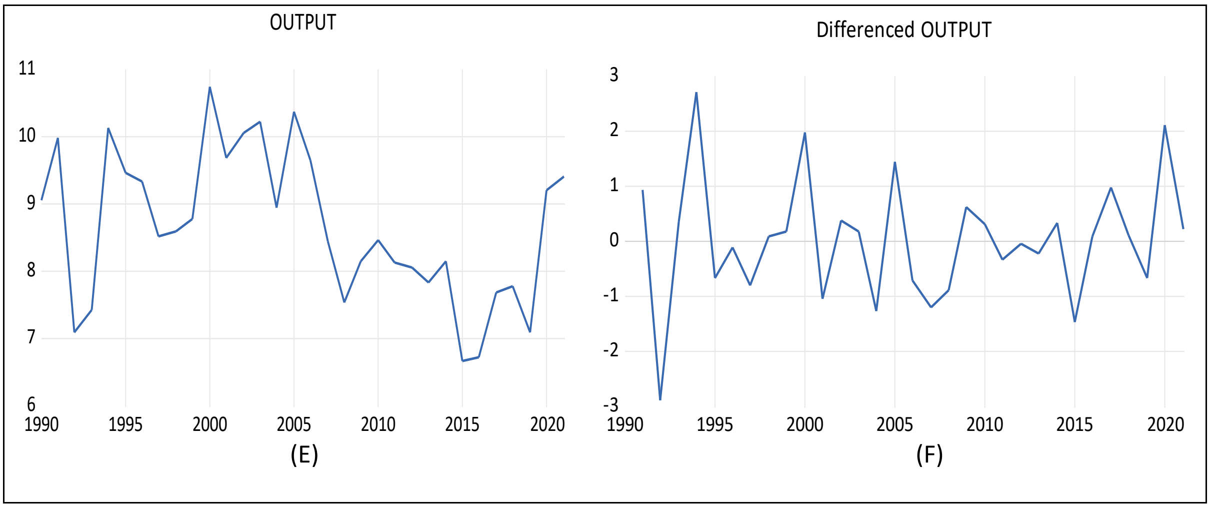


(C) (D)

Source: Author's construction using EViews 12

Figure 5.3 represent the agricultural output in Botswana at I(0) and I(1). Agricultural output seems to be nonstationary at I(0) as it is trending away from the mean of zero. However, at I(1) the data of the value of agricultural output at I(1) appears to be stationary as it trending around the mean of zero.

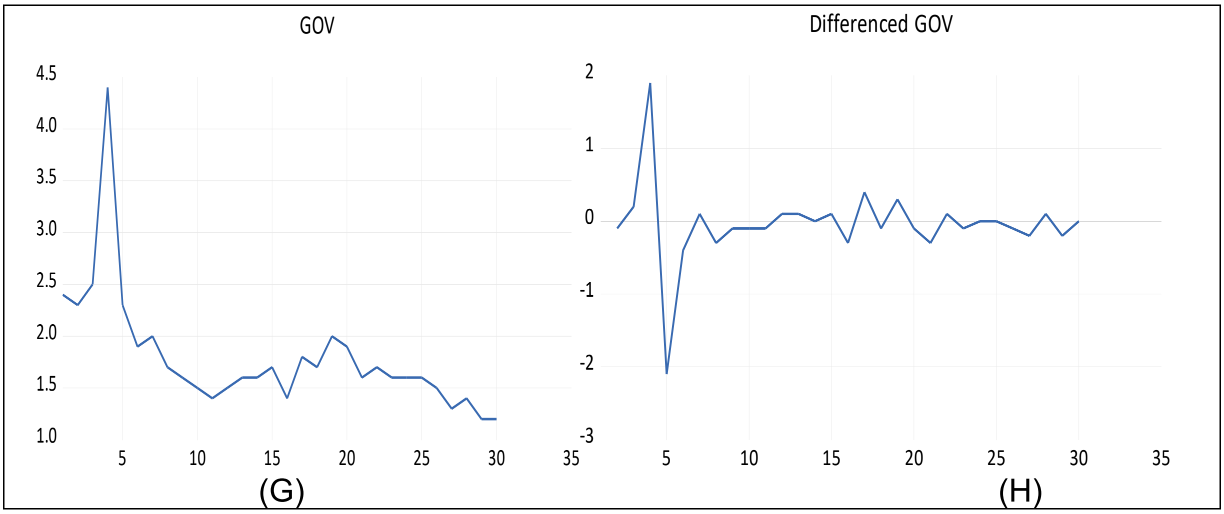
Figure 5.3 Agricultural output in Namibia



Source: Author's construction using EViews 12

Government expenditure on agriculture in Namibia is shown in Figure 5.4 (G) and (H) in both total and first difference amounts. Figure 5.4 (G)'s data pattern shows that the data are volatile and do not move in a circle around the same mean. As seen in Figure 5.4 (H), where it oscillates around the same mean, it was therefore only differed once. This implies that first-order integration of government expenditures on agriculture. i.e. I(1). This was done in order to satisfy the ARDL bounds test assumption.

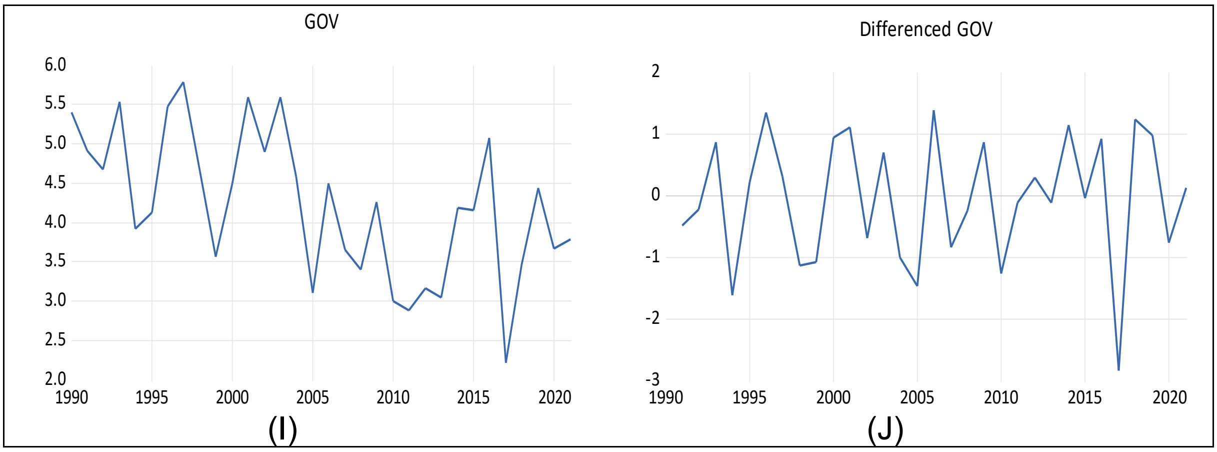
Figure 5.4 Government expenditure in agriculture in South Africa



Source: Author's construction using EViews 12

The graphs in Figure 5.5 indicate the graphical illustration of government expenditure in agriculture of Botswana at level (I(0)) and the differenced at first level (I(0)). At level, government expenditure seems not to be stationary as it is trending away from the mean of zero. Additionally, the differenced government expenditure in agriculture at first level seems to be stationary as it is trending around the mean of zero.

Figure 5.5 Government expenditure in agriculture in Botswana

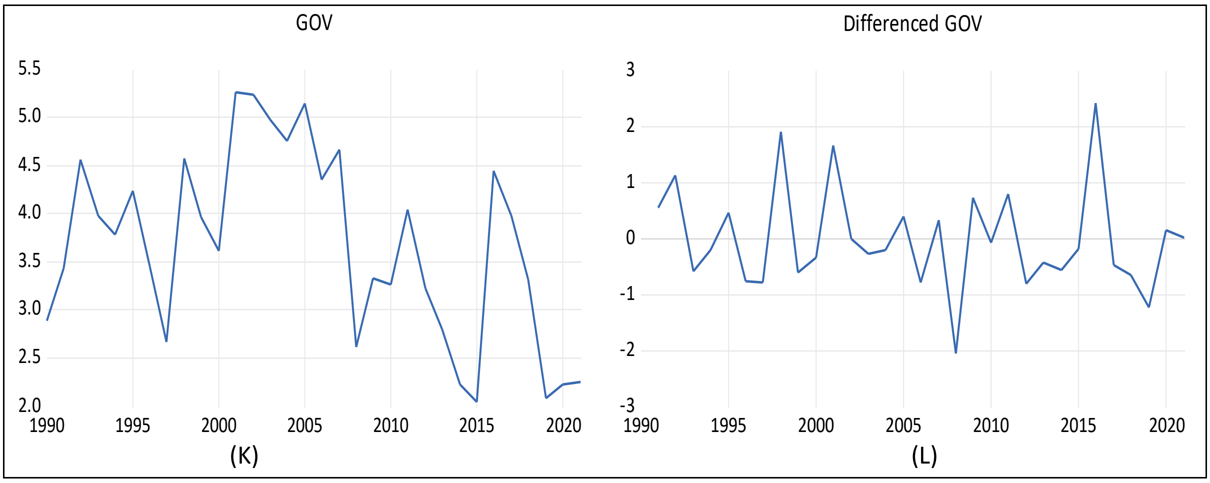


(I) (J)

Source: Authors computation EViews 12

Figure 5.6 represent the government expenditure in agriculture in Namibia at I(0) and I(1) for the estimated period of the study. The data reveal that government expenditure in agriculture of Namibia is trending away from the mean of zero at I(0) but when differenced once (I(1)) is trending around the mean of zero. The differenced government expenditure I(1) is stationary.

Figure 5.6 Government expenditure in agriculture in Namibia

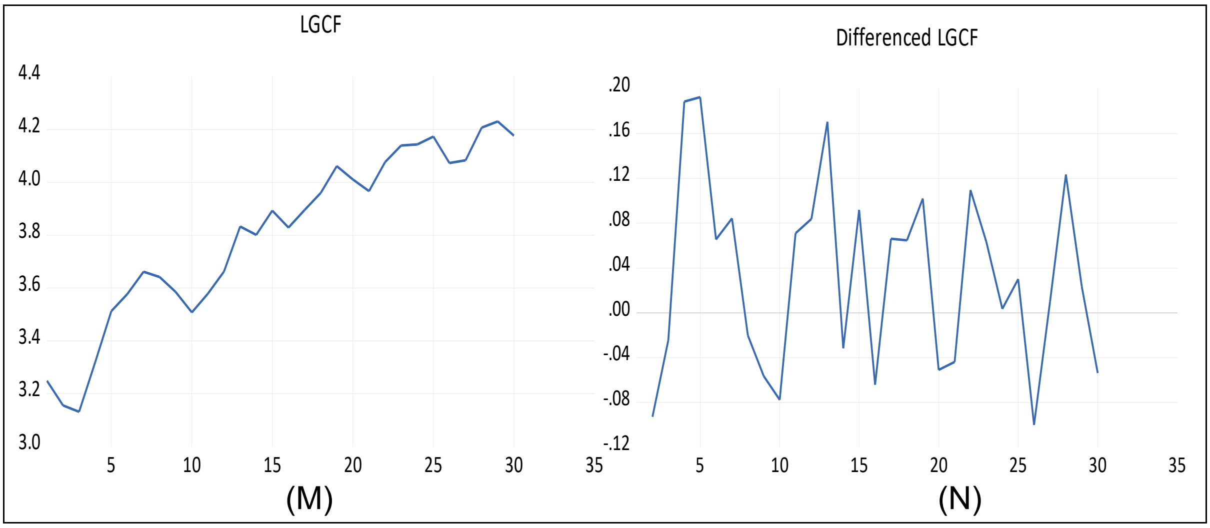


(K) (L)

Source: Authors computation EViews 12

As the variable is moving away from the zero-mean over time, Figure 5.7 (M) demonstrates that the log of private investment in agriculture (LGCF) is nonstationary at certain levels. LGCF was once differenced to create stationarity. The LGCF looks to be trending following the mean over time as stationarity is induced in graph (N).

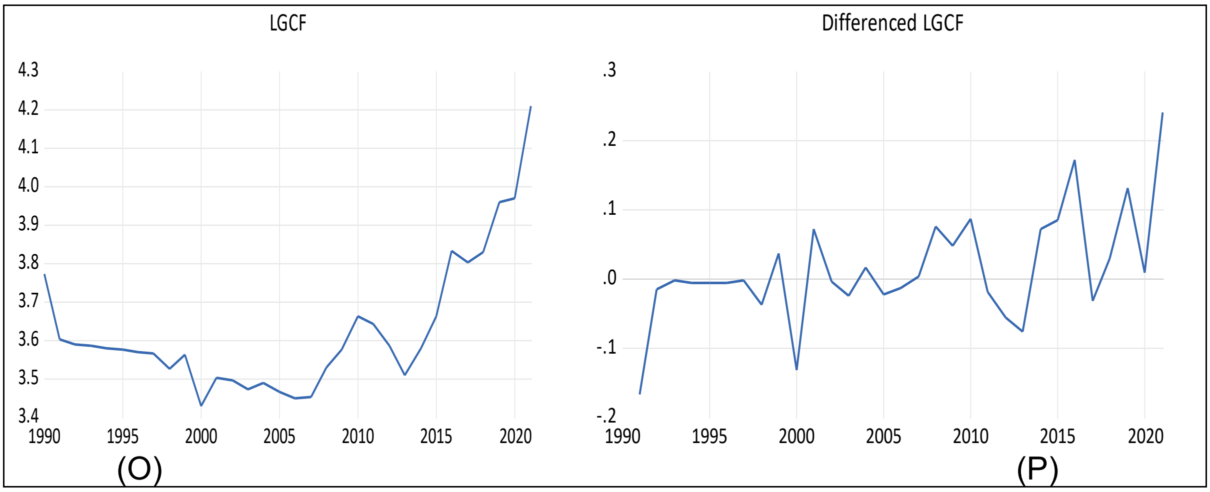
Figure 5.7 Private investment in agriculture in South Africa



Source: Author's construction using EViews 12

Private investment in agriculture of Botswana is graphically illustrated by Figure 5.8 at I(0) and I(1). the logarised private investment in agriculture of Botswana is not stationary at I(0) but becomes stationary at I(1) as it seems to be trending around the mean of zero

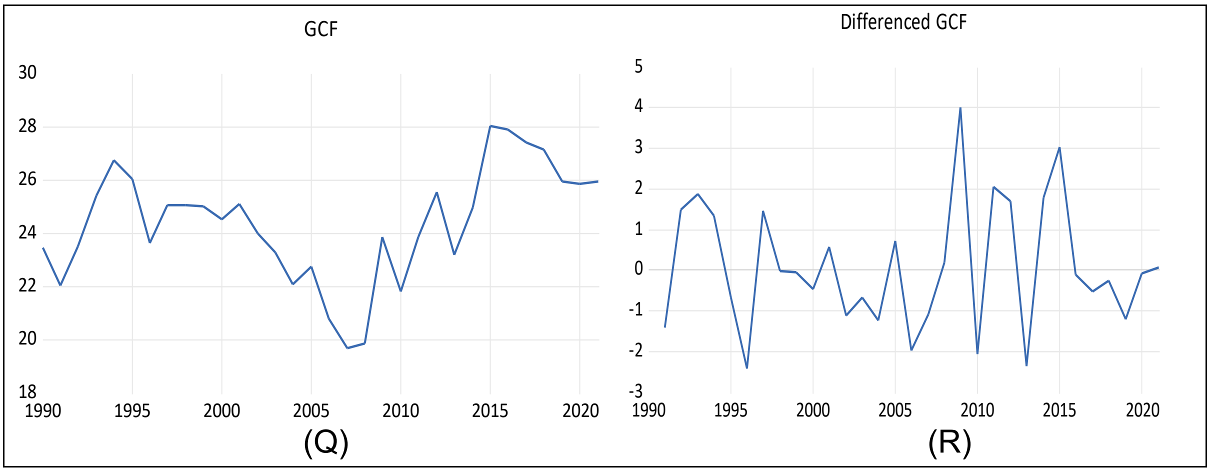
Figure 5.8 Private investment in agriculture in Botswana



Source: Author's construction using EViews 12

Figure 5.9 represent the private investment in agricultural at I(0) and I(1) for the estimated period of the study. The results indicate that private investment in agriculture for investment is not stationary at I(0). However, when the differenced once I(1) private investment in agriculture becomes stationary as the data now trends around the mean of zero.

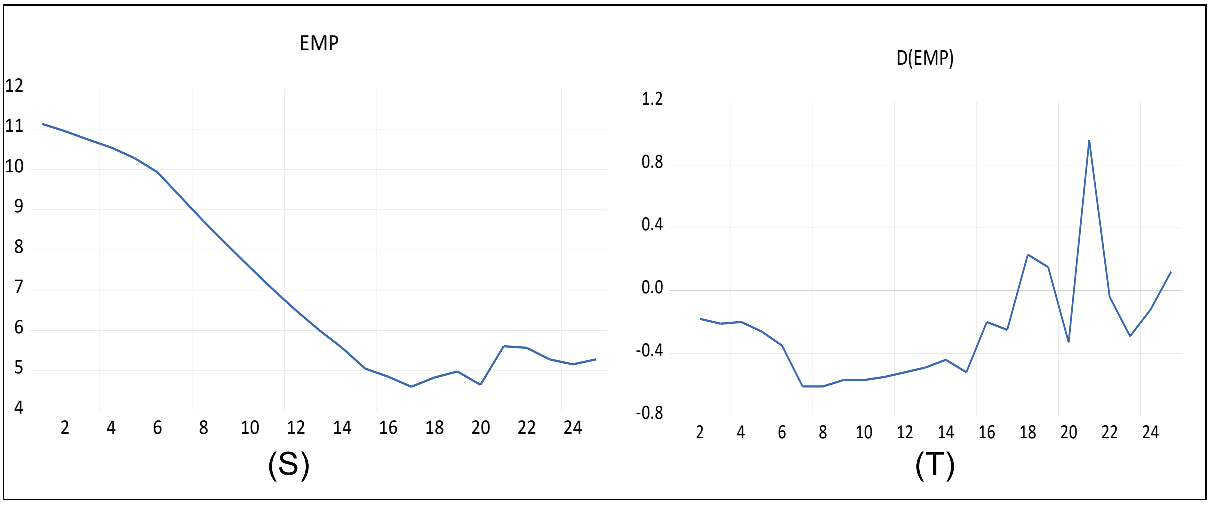
Figure 5.9 Private investment in agriculture in Namibia



Source: Author's construction using EViews 12

Agriculture employment is nonstationary at levels, as seen in Figure 1.10 (S) above, where the variable is trending away from the mean of zero and downward with time. Agriculture employment was changed once to create stationarity. Because of the stationarity that is created in Figure 1.10(T) above, employment appears to be trending over time along the mean of zero.

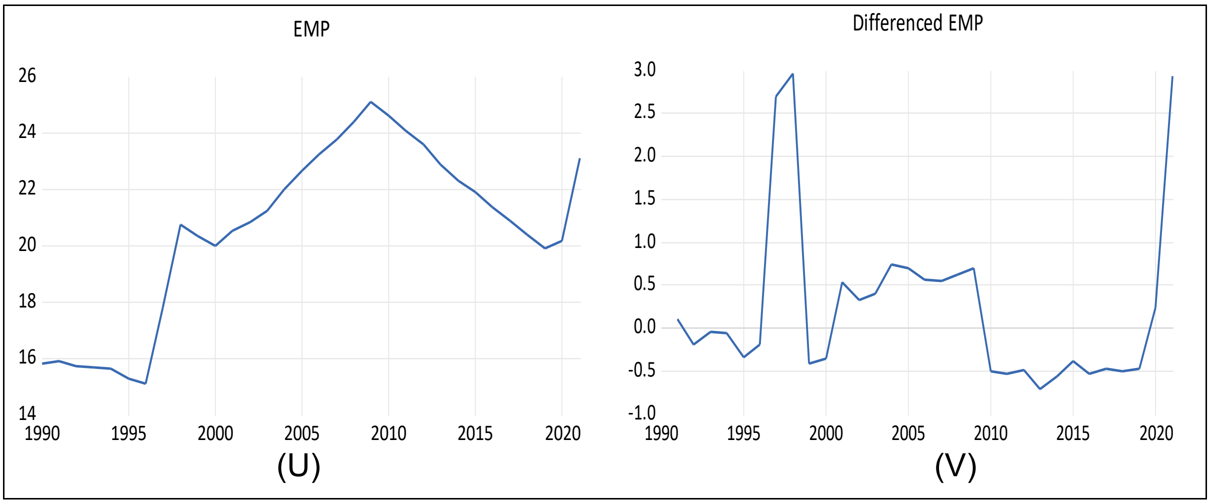
Figure 5.10 Employment in agriculture South Africa



Source: Author's construction using EViews 12

The value of employment in agriculture of Botswana is represented by Figure 5.11 above. Employment in agriculture for Botswana looks nonstationary at level as it is trending upwards away from the mean of zero. However, the differenced employment in agriculture of Botswana becomes stationary at first difference. This is concluded as the data seems to be trending around the mean of zero. These results will further be confirmed by the Augmented dickey fuller test results in Table 5.2 below.

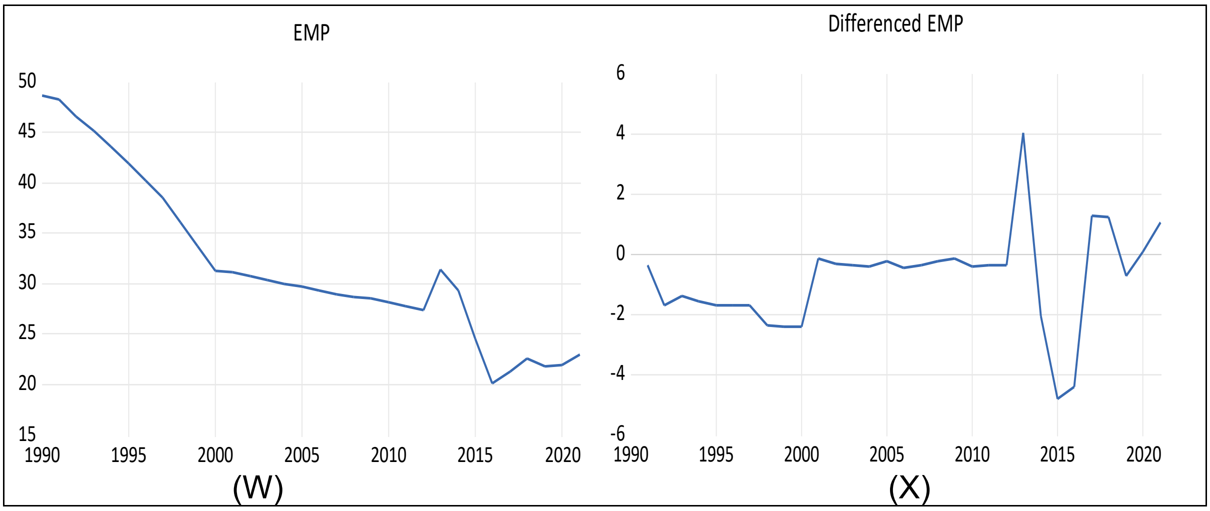
Figure 5.11 Employment in agriculture in Botswana



Source: Author’s construction using EViews 12

Figure 5.12 represent employment in the agricultural sector of Namibia at I(0) and I(1) for the estimated period of the study. The results indicate that employment in agricultural sector of Namibia is not stationary at I(0). However, employment in agriculture of Namibia becomes stationary at I(1).

Figure 5.12 Employment in agriculture in Namibia



Source: Author’s construction using EViews 12

5.2.1.2 ADF-unit root test results

The findings of the unit root test from the Augmented Dickey Fuller (ADF) test are summarised in Table 5.1 to Table 5.3. The findings of the formal testing of unit root, which is regarded as the initial stage in the model estimation. Despite not requiring that all variables be integrated in the same order, the ARDL bound testing approach does not apply to variables whose order of integration is higher than or equal to I(2). In order to make sure that no variables are integrated at I(2), the sequence of integration will be tested. This is carried out because the ARDL approach would yield false findings if variables with the integration of order I(2) were used (Gujarati, 2009). Appendix B provides comprehensive results for the unit root tests.

Table 5.1 shows the levels (0) and initial difference I (1) at which the Augmented Dickey Fuller tests were run. The study performed the unit root test to prevent false positives and to make sure that the ARDL estimator does not contain any second difference I(2) variables.

Table 5.1 results show that all variables including the independent variable, the value of agricultural output were discovered to be stationary only after 1st difference and thus, integrated of the same order of I(1). As a result, the investigation disproves the null hypothesis that variables have a unit root.

Table 5.1 ADF-unit root test results for South Africa

variables	intercept	Trend & intercept	none	conclusion
Loutput	0.3156	0.7421	0.6221	Non stationary
D(loutput)	0.0818*	0.0000***	0.0000***	stationary
LGCF	0.6181	0.4624	0.9847	Non stationary
D(LGCF)	0.0007***	0.0024***	0.0002***	stationary
GOV	0.0697*	0.0410**	0.2609	Non stationary
D(GOV)	0.0000***	0.0000***	0.0000***	stationary
EMP	0.4055	0.0860*	0.0000***	Non stationary
D(EMP)	0.0170**	0.0241**	0.0104**	stationary

***significant at 1%, **significant at 5%, *significant at 10%

Source: Author’s calculations using E-views 12

Table 5.2 shows that at level all variables in Botswana, including the independent variable, the value of agricultural production, were shown to exhibit nonstationary behavior; however, after the initial differentiation I (1), all variables adopted stationary behavior. The study's evidence that the variables are integrated at the same order of integration (I(1)) serves as its conclusion. The research rejects the null hypothesis that variables have unit roots.

Table 5.2 ADF-unit root test results for Botswana

variables	intercept	Trend& intercept	none	conclusion
Loutput	0.5000	0.4002	0.8741	Non stationary
D(loutput)	0.0000***	0.0000***	0.0000***	stationary
LGCF	0.9964	0.9790	0.9155	Non stationary
D(LGCF)	0.0008***	0.0001***	0.0001***	stationary
GOV	0.0697*	0.0410**	0. 2809	Non stationary
D(GOV)	0.0000***	0.0000***	0.0000***	stationary
EMP	0.1049	0.0110**	0.8741***	Non stationary
D(EMP)	0.0170**	0.0241**	0.0154**	stationary

***significant at 1%, **significant at 5%, *significant at 10%

Source: Author’s calculations using E-views 12

Table 5.3 results show that all variables in Namibia, including the independent variable, the value of agricultural output, were shown to exhibit nonstationary behavior at level (0) and underwent a change to stationary behavior following the initial differentiation I (1). In order to demonstrate that the variables are integrated at the same order of integration (I(1)), the investigation comes to a conclusion. Considering this, the study rejects the null hypothesis that variables have unit roots.

Table 5.3 ADF-unit root test results for Namibia

variables	intercept	Trend& intercept	none	conclusion
Loutput	0.0402**	0.0860*	0.5723	Non stationary
D(loutput)	0.0000***	0.0000***	0.0000***	stationary
LGCF	0.2647	0.5066	0.7107	Non stationary
D(LGCF)	0.0000***	0.0001***	0.0000***	stationary
GOV	0.0790*	0.0611*	0. 3871	Non stationary
D(GOV)	0.0000***	0.0000***	0.0000***	stationary
EMP	0.2178	0.3623	0.0074**	Non stationary
D(EMP)	0.0022**	0.0040**	0.0022**	stationary

***significant at 1%, **significant at 5%, *significant at 10%

Source: Author's calculations using E-views 12

5.2.2 ARDL Bounds Test Results

Using the Akaike Information Criterion (AIC), E-views 12 automatically chooses the best lag length for the model, and for this investigation, a lag length of 3 was used for the relevant variables. In this model, there are three explanatory variables (k=3). These are reflected in Table 5.4.

Table 5.4 ARDL Bounds test results for South Africa

Equation	F-statistic	K	Lower bound I0 AT 1%	Upper bound I1 at 1%	Outcome
$output_t = f(gov_t, emp_t, gfc_{t,})$	6.710348	3	3.65**	4.66**	Cointegration

Significance	Lower bound (0)	Upper bound (1)
10%	2.37**	3.2**
5%	2.79**	3.67**
1%	3.65**	4.66**

***significant at 1%, **significant at 5%, *significant at 10%

Source: Author's calculations using *EViews 12*

The calculated F-statistic of 6.710348 in Table 5.4 above is greater than the lower bounds critical value of 3.65 and the upper bounds critical value of 4.66 at the 1% level of significance, according to the results of the ARDL Bounds test. This means that the variables being tested are likely to move together in the long run, i.e., they have a stable long-term relationship despite any shock or intervention. The study rejects the null hypothesis that there is no cointegration. These results are in line with those of Ngobeni and Muchopa (2022) who examined the effect of government expenditure in agriculture and other selected variables on the value of agricultural production in South Africa during the period 1983 to 2019 using the vector autoregressive approach. The cointegration result implies that changes in government expenditure, Private investment and employment have a long-term impact on agricultural output and vice versa.

Using the Akaike Information Criterion (AIC), E-views 12 automatically chooses the best lag length for the model, and for this investigation, a lag length of 3 was used for the relevant variables. In this model, there are three explanatory variables (k=3). Table 5.5 indicate these finding.

Table 5.5 ARDL Bounds Test Results for Botswana

Equation	F-statistic	K	Lower bound I0 AT 1%	Upper bound I1 at 1%	Outcome
$output_t = f(gov_t, emp_t, gfc_{t,})$	7.497874	3	5.17*	6.36*	Cointegration

Significance	Lower bound (0)	Upper bound (1)
10%	3.47**	4.45**
5%	4.01**	5.07**
1%	5.17**	6.36**

***significant at 1%, **significant at 5%, *significant at 10%

Source: Author's calculations using E-views 12

The results of the ARDL Bounds test show that the estimated F-statistic in Table 5.5 above is greater than the lower bounds critical value of 5.17 and the upper bounds critical value of 6.36 at the 1% level of significance. This means that the variables being tested are likely to move together in the long run, i.e., they have a stable long-run relationship. The study rejects the null hypothesis that there is no cointegration and finds that the relevant variables have an equilibrium condition that maintains their proportionality throughout time. The findings are in line with those of (Jambo, 2017), whose study investigated how public spending affected agricultural growth in

Malawi, South Africa, Tanzania, and Zambia. The research found a long-term relationship between the variables used.

Using the Akaike Information Criterion (AIC), E-views 12 automatically chooses the best lag length for the model, and for this investigation, a lag length of 3 was used for the relevant variables. In this model, there are three explanatory variables (k=3) this is reflected by Table 5.6.

Table 5.6 ARDL Bounds Test Results for Namibia.

Equation	F-statistic	K	Lower bound I0 AT 1%	Upper bound I1 at 1%	Outcome
$output_t = f(gov_t, emp_t, gfc_{t,})$	7.497874	3	3.65**	4.66**	Cointegration

Significance	Lower bound (0)	Upper bound (1)
10%	2.37**	3.2**
5%	2.79**	3.67**
1%	3.65**	4.66**

***significant at 1%, **significant at 5%, *significant at 10%

Source: Author’s calculations using Eviews 12

The results of the ARDL Bounds test show that the estimated F-statistic in Table 5.6 above is greater than the lower bounds critical value of 3.65 and the upper bounds critical value of 4.66 at the 1% level of significance. This means that the variables being tested are likely to move together in the long run, i.e., they have a stable long-term relationship despite any shock or intervention. The study rejects the null hypothesis that there is no cointegration and finds that the relevant variables have an equilibrium condition that maintains their proportionality throughout time. These results are consistent with Chandio, Jiang, Rehman, and Jingdong (2016) analysis of the effects of government spending on Pakistan's agriculture industry and economic growth. The Johansen cointegration test was used to examine whether there was a long-term correlation between government spending on agriculture and output.

The study then moves on to estimate the short and long run cointegrating equations and the stated model's coefficients because the bounds’ testing approach has sufficiently demonstrated a long run relationship between the variables in the growth model.

5.2.3 ARDL Long-run Results

The estimated model's autoregressive distributive lag of long-run coefficients in South Africa is displayed in Table 5.7. The ARDL long-run coefficients are used to demonstrate the long run coefficients estimations after the Bounds tests have shown evidence for the long run relationship.

Table 5.7 show that agricultural output and government spending on agriculture have a positive, significant long-term relationship. This means that if government spending on agriculture grows by 1%, the value of agricultural output would increase by 0.5%. The study also shows that these results are significant at 5%. These results in Table 5.7 are consistent with the study's initial hypotheses, which were outlined in the Keynesian growth model in Chapter 2. The results also align with those of Okpara (2017), who examined the impact of government spending on agriculture and agricultural output on the growth of the Nigerian economy from 1980 to 2015 and found a positive relationship. The positive relationship indicates that government spending is an important tool for economic growth in South Africa. Policymakers can consider using fiscal stimulus (through higher government expenditure) to combat economic downturns or low growth periods. The positive relationship between government expenditure and economic performance suggests that fiscal policy should remain proactive, especially during economic downturns. South Africa may need to consider higher public investments in infrastructure, social services, and education to support long-term growth.

Table 5.7 further indicate that LGCF the coefficient of 6.795211 with a p-value of 0.0182 suggests that gross capital formation (a measure of investment in physical assets like infrastructure, machinery, etc.) also has a positive and significant long-run impact, on agriculture at 5% significance level. The relatively high coefficient (6.795211) suggests that each unit increase in gross capital formation has a large impact on the economy. This suggests that investments in the long term are crucial for sustainable growth and development. The government and private sector need to prioritize investment, especially in the sector. Efforts to improve the investment climate, such as reducing business barriers or increasing access to finance, could boost long-term economic growth. Sesele and Alhassan (2017) agree with the notion that private investment in agriculture has a favourable impact on agricultural output as the study suggests. For South Africa, increasing investment in agriculture could address issues like infrastructure deficits, improve industrial capacity, and support economic diversification.

According to the Keynesian growth model, labour is essential to the production process and positively affects productivity. The positive (*0.268769)* and highly significant (0.0000) coefficient for employment indicates that higher employment levels directly contribute to better economic performance. In other words, increasing employment will lead to higher agricultural output. This finding has significant policy and economic implications. Employment is a key driver of consumer demand, as more employed people have disposable income to spend on goods and services. This, in turn, supports overall economic activity and growth. The very low p-value (0.0000) shows a robust and statistically significant relationship, emphasizing that job creation is critical to fostering higher agricultural output.

The ARDL long-run results for South Africa point to the critical importance of government spending, investment (capital formation), and employment in driving long-term economic growth. The positive and statistically significant coefficients for all three variables suggest that policies aimed at increasing public investment, fostering private sector investment, and creating jobs can play a crucial role in achieving sustained economic development and addressing key challenges like unemployment and inequality in South Africa.

Table 5.7 ARDL Long Run Results for South Africa.

Variable	**Coefficient**	**P-value**
GOV	*0.523785*	*0.0319***
LGCF	*6.795211*	*0.0182***
EMP	*0.268769*	*0.0000****
C	*-0.808560*	*0.3252*

****significant at 1%, **significant at 5%, *significant at 10%*

Source: Author’s calculations using E-views 12

Table 5.8 shows the autoregressive distributive lag of the long-run coefficients for Botswana for the estimated model.

Table 5.8 indicate a negative coefficient of government expenditure (GOV) suggests that an increase in government spending is associated with a decrease in the agricultural output, but this result is not statistically significant at any conventional level (1%, 5%, or 10%). A non-significant p-value of 0.5092 means that the study cannot reject the null hypothesis that government expenditure has no impact on economic performance in the long run. This runs contrary to the Malabo 2003 position that expected agricultural spending to have a beneficial impact on growth. This is in line with the findings of Thabane and Lebina (2016), who showed that government spending cannot spur higher agricultural output growth in Lesotho. Contrary to what Selvanathan, Selvanathan, and Jayasinghe (2021) found, agriculture expenditure and growth were positively correlated Sri Lanka. Despite the theoretical expectation that government spending should boost economic performance (through public investment, welfare, or infrastructure), this result indicates that government expenditure does not have a meaningful or reliable effect on the economy in Botswana, at least in the long run. This could be due to factors like inefficiency in public spending, corruption, or issues with how public resources are allocated.

The negative (-3.938296) and significant coefficient of gross capital formation (LGCF) suggests that an increase in investment (capital formation) is associated with a decrease in the dependent variable, which in this case seems counterintuitive. A negative relationship between capital formation and economic performance in Botswana might be surprising, but it could be due to several factors. If the investments are not yielding productive returns (e.g., poorly targeted infrastructure or inefficient projects), they might not translate into higher economic growth in the agricultural sector. There could be instances where capital is invested in projects that do not directly contribute to economic development or may even lead to capital outflows or inefficiencies in the agricultural sector. Policymakers may need to re-evaluate the types of investments being made and prioritize those that have a clear and positive impact on long-term productivity and growth. The negative relationship between investment (gross capital formation) and agricultural output a potential issue with the quality of investments. The Keynesian theory that government spending and private investment in the agriculture sector could promote economic growth in Botswana is invalidated by these findings.

Labour is crucial to the manufacturing process and has a beneficial impact on productivity, according to the Keynesian growth model. The study results in Table 5.8 found a negative and significant relationship between employment (EMP) and the agricultural output suggests that an increase in employment levels is associated with a decrease in economic performance, which also seems counterintuitive. According to the figure of -0.230729, a 1% increase in agricultural employment would result in a 0.3% decrease in the value of agricultural output. This negative relationship could be driven by several factors. If employment growth is in low-productivity projects (e.g., informal labour), it may not lead to improvements in overall economic performance of the sector. Additionally, In an economy with structural issues, adding more workers to a system without adequate infrastructure, skills training, or investment in productive projects could actually reduce economic efficiency, leading to negative long-term effects. The results suggest that Botswana may need to focus on quality employment, improving skills matching, and promoting job creation in more productive sectors of the economy, such as technology, manufacturing, or high-value services.

The long-run ARDL results for Botswana show that government expenditure does not appear to have a significant positive impact on economic performance, while investment (gross capital formation) and employment are negatively related to the dependent variable. These findings suggest that there may be structural inefficiencies in the economy, such as misallocated investments, low-quality employment, and potentially inefficient public spending. For Botswana to achieve sustainable growth, policymakers should focus on improving the efficiency of investment, creating productive employment opportunities, and addressing structural weaknesses in the economy.

Table 5.8 ARDL Long Run Results for Botswana.

Variable	Coefficient	P-value
GOV	-0.207703	0.5092
LGCF	-3.938296	0.0049***
EMP	-0.230729	0.0050***
C	23.58451	0.0010***

***significant at 1%, **significant at 5%, *significant at 10%

Source: Author’s calculations using E-views 12

Table 5.9 shows the estimated model's autoregressive distributive lag of long-run coefficients for Namibia.

The coefficient for government expenditure (GOV) is positive, indicating that an increase in government spending is associated with a small rise in agricultural output (0.22%). However, the p-value of 0.5165 is much higher than typical significance thresholds (e.g., 0.05 or 0.01), meaning that the relationship is not statistically significant. This implies that, in the long run, changes in government spending in Namibia's agricultural sector do not have a statistically reliable effect on agricultural output. This result challenges the expectation that increased government agricultural spending will directly spur economic growth in the agricultural sector. In particular, it contradicts the Malabo Declaration (2003), which anticipated that rising agricultural expenditure would boost productivity and output in African agriculture. The non-significance of government expenditure may reflect issues such as inefficient allocation of resources, poor implementation of agricultural policies, or even mismanagement of public funds. These are potential explanations for why government spending is not yielding expected returns in Namibia's agricultural sector. The non-significant relationship between government spending and agricultural output in Namibia mirrors findings in Botswana, where public spending did not have the expected positive effect. This suggests systemic issues with public sector spending on agriculture in Southern Africa. These results reject the Keynesian view that government spending can stimulate economic output, at least in Namibia's agricultural sector. Instead, they may support the view that public sector inefficiencies, such as misallocation or corruption, are undermining the impact of government spending.

The positive coefficient for private investment (LGCF) suggests that an increase in private sector investment by 1% would lead to an increase in agricultural output by approximately 0.27%. The p-value of 0.0747 is marginally significant at the 10% level, which indicates that there is some evidence, although not as strong as at the 5% level, that private investment positively affects agricultural productivity. The positive relationship between private investment and agricultural output suggests that investment in the agriculture sector such as in infrastructure, technology, and modern farming techniques could boost productivity and growth. This finding underscores the importance of fostering a conducive environment for private sector participation in agriculture. Given the significance at the 10% level, policymakers may want to focus on incentivizing private investments through policies that improve access to financing, reduce bureaucratic hurdles, and promote technology adoption in agriculture. Investment in physical capital, such as irrigation systems, machinery, or value-added production processes, could contribute significantly to long-term growth in agricultural output. This highlights the role of capital formation in raising agricultural productivity, especially in economies where agriculture plays a crucial role in employment and GDP.

The negative coefficient for agricultural employment suggests that an increase in agricultural employment by 1% would be associated with a decrease in agricultural output by about 0.25%. Since the p-value is 0.0423, this relationship is statistically significant at the 5% level. This negative relationship indicates that, in the long run, more employment in agriculture does not necessarily equate to higher output. Additionally, several factors could explain this. If agricultural employment is concentrated in low productivity or subsistence farming, it may not contribute effectively to increasing agricultural output. In fact, overemployment in agriculture, especially in informal or unskilled labour, may lead to diminishing returns in terms of output. The results suggest a potential mismatch between labour and agricultural technology. In a country like Namibia, with limited access to advanced agricultural technology or knowledge, more workers may not directly translate into increased productivity. Structural challenges such as poor rural infrastructure, limited access to financing, and over-reliance on traditional farming methods may prevent the agricultural labour force from increasing output efficiently. Policymakers in Namibia may need to focus on improving labour productivity in agriculture by providing better access to training, education, and technology. Programs that upskill the agricultural workforce, promote agribusiness, and focus on agricultural streamlining could be more effective in boosting output than simply increasing the number of agricultural workers. There may also be a need for urbanisation and diversification away from agriculture into other sectors to address overpopulation in rural areas.

The results for Namibia underscore the importance of targeting private investment and improving labour productivity rather than relying on government spending to drive agricultural growth. While government expenditure may not be significantly effective in boosting agricultural output, there is clear evidence that private sector involvement and improved labour efficiency can play a more substantial role in enhancing agricultural productivity in the long run.

Table 5.9 ARDL long run results for Namibia.

Variable	Coefficient	P-value
GOV	0.221883	0.5165
LGCF	0.272166	0.0747*
EMP	-0.251142	0.0423**
C	26.51213	0.0298**

***significant at 1%, **significant at 5%, *significant at 10%

Source: Author’s calculations using E-views 12

5.2.4 ARDL Short-run Results

As a result of the bounds test proving a long run relationship between the variables in the growth model, the study now proceeds to estimate the short and long run cointegrating equations as well as the stated model's coefficients.

Table 5.10 shows the ARDL short run relationship results in South Africa between agricultural output and the variables employed for the purpose of the study.

The ARDL short-run results for South Africa presented in Table 5.10 reveal key insights into the dynamics of agricultural output, government expenditure, private investment, and the speed of adjustment toward long-run equilibrium. These findings are significant for understanding the short-term impacts of various economic variables on agricultural performance.

The positive coefficient of 0.507650 for lagged agricultural output (LOUTPUT(-1)) indicates a strong, positive relationship between the agricultural output of the previous year and the current year’s output. Specifically, a 1% increase in agricultural output from the previous year leads to a 0.51% increase in agricultural output in the current year. This result suggests that agricultural output has significant path dependence meaning that the performance of the sector in the previous period influences its performance in the current period. This finding aligns with Ngobeni & Muchopa (2022), who found a similar relationship between past agricultural performance and current output. It reflects that agricultural growth has a momentum effect, where good performance in one period tends to carry over to the next. This could be driven by factors like agricultural practices, crop cycles, and market conditions that build upon previous gains. Despite its delayed effect, government spending on agriculture is shown to be a useful tool for stimulating output in the medium to long run. However, policymakers need to focus on ensuring efficient and targeted spending to maximize the returns on public investment.

The coefficient for government agricultural expenditure (GOV(-3)) suggests that a 1% increase in government spending on agriculture (lagged by three years) results in a 0.0977% increase in agricultural output. The positive and statistically significant relationship implies that, in the short run, government expenditure in the agricultural sector can positively affect agricultural output, though with a time lag of about three years. This finding supports Keynesian theory, which posits that government spending can stimulate economic activity. Although the effect is delayed (taking about three years to materialize), it suggests that investment in agriculture (through subsidies, infrastructure, or research) can have a positive impact on output. However, policymakers should recognize that the impact of government spending is not instantaneous and requires time to influence agricultural productivity. The result is also consistent with the findings of Ngobeni and Muchopa (2022), who found that government expenditures on agriculture have a positive effect on agricultural output, albeit with a time lag. This finding emphasizes the importance of sustained and strategic public investment in agriculture, which can have long-term benefits.

The coefficient for private agricultural investment (LGCF) is 5.575035, suggesting a strong and positive relationship between private investment and agricultural output. Specifically, a 1% increase in private investment in agriculture results in a 5.58% increase in agricultural output. This finding highlights the crucial role of private sector investment in enhancing agricultural productivity. The substantial impact of private investment on output underscores the importance of creating an environment that attracts and encourages private sector involvement in agriculture. Investments in technology, infrastructure, and modern farming practices can have a direct and substantial effect on productivity. This finding suggests that policies should focus on improving access to financing, reducing barriers to investment, and creating incentives for private investment in agriculture. These efforts could stimulate long-term growth in the sector.

The negative and statistically significant coefficient of -0.6968204 for the Error Correction Term (ECT) indicates the speed at which the system returns to equilibrium after a shock or deviation from the long-run relationship. In this case, the ECT coefficient of -0.6968 implies that the system corrects itself at a rate of 69.68% per year. The negative sign of the ECT confirms that the model is correctly specified, as the adjustment process should correct deviations from long-run equilibrium. The speed of adjustment at nearly 70% per year is relatively fast, suggesting that any short-run disequilibrium in agricultural output caused by shocks or changes in the variables (e.g., government spending or investment) will be corrected within a year. This is a relatively rapid response, indicating that agricultural output in South Africa is responsive to adjustments in key economic variables. The significant and relatively quick adjustment to equilibrium highlights the importance of stable economic policies that foster investment and ensure long-term growth. Short-term disturbances in agricultural output (such as external shocks or policy changes) will be corrected fairly quickly, which is a positive sign for the resilience of the sector.

The short-run ARDL results for South Africa underscore the importance of both public and private investment in agriculture, with private investment showing the largest short-term effect on agricultural output. Moreover, the rapid adjustment to long-run equilibrium indicates that the agricultural sector is adaptive and can recover from short-term shocks relatively quickly. The study’s findings are consistent with Keynesian economics and emphasize the need for a balanced approach to government spending and private sector involvement to ensure sustainable agricultural growth.

Table 5.10: ARDL Short-Run Results for South Africa

Variable	**Coefficient**	**P-value**
D (LOUTPUT (-1))	*0.507650*	0.0002***
D (GOV (-3))	*0.097695*	0.0346**
D(LGCF)	*5.575035*	0.0007***
CointEq(-1)	-0.6968204	0.0000***

****significant at 1%, **significant at 5%, *significant at 10%*

Source: Author’s calculations using E-views 12

Table 5.11 shows the ARDL short run relationship results in Botswana between agricultural output and the variables employed for the purpose of the study.

Table 5.11: ARDL Short-Run Results for Botswana.

Variable	Coefficient	P-value
D (EMP (-3))	*-0.352404*	0.0315**
D(LGCF)	*3.141220*	0.0549*
CointEq(-1)	-0.993755	0.0000

****significant at 1%, **significant at 5%, *significant at 10%*

Source: Author's calculations using E-views 12

Table 5.11 shows a negative coefficient for lagged agricultural employment (EMP(-3)) which indicates a negative relationship between past agricultural employment and current agricultural output. Specifically, a 1% increase in agricultural employment (lagged by 3 years) leads to a 0.35% decrease in agricultural output. This result suggests that increasing agricultural employment in the past (within the three-year lag) does not contribute positively to agricultural productivity. This finding is somewhat counterintuitive to classical economic theories, like Adam Smith's classical growth theory, which posit that labor is a fundamental factor of production that should positively affect output. However, the negative relationship between agricultural employment and output may be due to several factors. In recent years, agriculture in Botswana, like many other countries, has likely become more technologically advanced. This means that technological progress might reduce the need for more work, and an increase in employment in the sector could be associated with lower productivity, especially if work is being deployed inefficiently or in low-productivity roles. The negative effect could also reflect issues such as underemployment or the fact that increased labor in agriculture, without accompanying technological investment or training, may lead to diminishing returns. This finding suggests that simply increasing agricultural employment is not sufficient for boosting productivity in Botswana's agricultural sector, and more attention may need to be given to improving labour quality through training and technological adoption rather than increasing the number of agricultural workers.

The positive coefficient for private agricultural investment (LGCF) suggests that private sector investment has a significant impact on agricultural output. Specifically, a 1% increase in private agricultural investment results in a 3.14% increase in agricultural output. This result highlights the important role of private investment in improving agricultural productivity in Botswana. The positive relationship between private investment and output reflects that capital inflows, whether through technology, infrastructure, or other investments in the agricultural sector, can significantly improve output. This is consistent with the findings from South Africa and studies by Meyer and Sanusi (2019) and Wami (2022), which emphasize that domestic investment is a key driver of agricultural growth.

The Error Correction Term (ECT) is negative and significant, with a coefficient of -0.993755, indicating that the model is adjusting toward the long-run equilibrium at a rate of 99.38% per year. The rapid adjustment to equilibrium at 99.38% per year suggests that any short-term disequilibrium or deviation in agricultural output will quickly be corrected. This is an indication that Botswana's agricultural sector has a strong capacity to adjust to shocks or changes in policy or market conditions and will return to its long-term growth path relatively quickly. The fast pace of adjustment in the agricultural sector implies that short-term disturbances (such as changes in agricultural policy or external shocks) will not have a lasting impact on the long-run agricultural performance. This is positive, as it indicates resilience in the agricultural sector. However, it also suggests that policies should aim to maintain stability and foster conditions that support long-term growth to avoid short-term volatility.

The short-run ARDL results for Botswana reveal important insights into the dynamics of employment, private investment, and the speed of adjustment in agricultural output. The findings suggest that increasing agricultural employment without corresponding improvements in efficiency or technology may negatively impact output, while private investment remains a key driver of agricultural growth. The fast adjustment to long-term equilibrium demonstrates the resilience of Botswana’s agricultural sector, suggesting that policies fostering investment and stability will be crucial for sustaining long-term growth.

Table 5.12 shows the ARDL short run relationship results in Namibia between agricultural output and the variables employed for the purpose of the study.

The positive and statistically significant coefficient of 0.647883 for the lagged agricultural output (LOUTPUT(-1)) implies that past agricultural performance has a significant influence on current agricultural output. Specifically, a 1% increase in agricultural output from the previous year results in a 0.65% increase in the current year's agricultural output. This result highlights the path dependence of agricultural production, where previous output levels influence current performance. It suggests that growth in agricultural output tends to be cumulative, and positive growth from the previous year carries over into the current year. This could be due to factors like agriculture’s seasonal cycles, planting and harvesting schedules, or the effect of last year's growth on the market or technology adoption in the sector.

The negative coefficient for government agricultural expenditure (GOV(-3)) suggests a negative relationship between past government spending on agriculture and current agricultural output. Specifically, a 1% increase in government agricultural expenditure (lagged by 3 years) results in a 0.51% decrease in agricultural output. These results run counter to Keynesian economic theory, which typically argues that government spending, especially in the short run, stimulates economic activity. The negative relationship observed here indicates that past government spending may not have been efficiently allocated or effectively targeted to boost agricultural production. Instead, it may reflect issues like misallocation of funds, inefficiencies in public sector spending, or delayed impacts from government projects. This result is consistent with Thabane and Lebina (2016), who found that government expenditure did not effectively spur growth in Lesotho’s agricultural sector. Conversely, it contrasts with findings from studies like Shuaib et al. (2015) and Selvanathan et al. (2021), where government spending was positively correlated with agricultural growth in Nigeria and Sri Lanka respectively.

The positive coefficient for agricultural employment (EMP(-1)) indicates that employment in agriculture has a favourable effect on agricultural output. Specifically, a 1% increase in agricultural employment results in a 0.58% increase in agricultural output. This result supports the idea that increasing labour input in agriculture has a positive impact on output in Namibia. The statistical significance of this relationship at the 1% level suggests that employment is an important driver of agricultural productivity in the short run. This could be due to the fact that as more labour is involved in agricultural production, there is a corresponding increase in output from expanded cultivation or more intensive farming practices. However, this result also suggests that labour in Namibia's agricultural sector is being used efficiently, and additional workers can contribute to higher output.

The Error Correction Term (ECT) is negative and statistically significant, with a coefficient of -0.615374. This implies that the model adjusts to long-run equilibrium at a rate of 61.53% per year. The negative sign of the ECT confirms that the model is correctly specified, as the correction term should always be negative. The value of -0.615374 indicates that any short-term deviation from long-run equilibrium in agricultural output is corrected at a rate of 61.53% per year. This is a relatively moderate adjustment rate, suggesting that while Namibia's agricultural sector has some capacity for short-term corrections, it may take just over a year for significant adjustments to fully correct any disequilibrium. The error correction mechanism highlights the resilience of the agricultural sector in Namibia. Policymakers can be confident that short-term shocks or disturbances in the sector will be corrected fairly quickly, which may allow for greater stability in the long run. However, policies should still focus on maintaining long-term stability and sustainable growth to ensure that the sector continues to perform well over time.

The short-run ARDL results for Namibia show that agricultural output is strongly influenced by past performance, and that employment in agriculture has a significant positive impact on output. However, the findings also suggest that government expenditure in agriculture may not be having the desired effect, highlighting potential issues with fund allocation or policy efficiency. The agricultural sector in Namibia appears resilient, with the ability to adjust to short-term shocks. Moving forward, policymakers should focus on improving government spending efficiency, encouraging labour participation, and promoting long-term investment in the sector to ensure sustainable agricultural growth.

Table 5.12: ARDL Short-Run Results for Namibia.

Variable	**Coefficient**	**P-value**
D (LOUTPUT (-1))	*0.647883*	0.0504*
D (GOV (-3))	*-0.512422*	0.0975*
D (EMP (-1))	*0.577555*	0.0073***
CointEq(-1)	-0.615374	0.0021

***significant at 1%, **significant at 5%, *significant at 10%

Source: Author's calculations using E-views 12

5.2.5 Granger Causality Test Results

Building on the previously established evidence of a cointegration relationship among the value of agricultural output, government agricultural expenditure, and private agricultural investment, a deeper exploration of the causal relationship among these variables is conducted using the Granger causality test. The findings are displayed in Tables 5.13 to 5.15 below.

The estimated Granger causality findings in South Africa from the study are shown in the Table 5.13.

The study accepts the null hypothesis that government spending in the agriculture sector does not directly affect agricultural output. The South African government distributes roughly 1% of its revenue to the agricultural sector, as mentioned in Chapter 1. Government spending on agriculture in South Africa is still allotted considerably less than the agreed-upon 10% in terms of CAASP, which is likely why it hasn't had much of an impact on the value of agricultural output. According to Nguyeng and Luong (2021) who conducted a study in India found that ineffective resource allocation can make it difficult to achieve economic objectives such as the fiscal policy. The study by Nguyeng and Luong (2021) also found that the main variables under the study are cointegrated in the short run, therefore the results above do not prove that there is no relationship between government spending on agriculture and agricultural output in South Africa. The results may indicate that government spending on agriculture has a negligibly small or perhaps non-existent impact.

Given that the association between private investment in agriculture and agricultural output and vice versa South Africa is provided as the null hypothesis and is statistically insignificant at 10% in Table 5.13 the study does not reject the findings. However, given that private investment in agriculture can be categorised as capital in the industry and is anticipated to be positively correlated with agricultural output, these results do not agree with the Keynesian model. The cointegration outcomes in Table 5.3 indicate a long-term association between private agricultural investment and agricultural output. However, these results contradict the Granger causality findings shown in Table 5.13. This is in line with the study by Megbowon, Saul, Nsikak, and Oluwabunmi (2019), who found no causal link between private agricultural investment and agricultural output when they investigated the effect of government spending on agricultural productivity in South Africa.

The proposed hypothesis in Table 5.13 relates to agricultural output and employment in the agricultural sector and vice versa in South Africa. Due to the results presented in Table 5.13 which indicate that the proposed granger causality hypothesis is statistically insignificant at 10%, respectively. Therefore, the study does not reject the null hypotheses. However, as mentioned in Chapter 3 of the Keynesian theory, these results do not match the prior expectation. Ngobeni and Muchopa (2022) also discovered that agricultural productivity in South Africa is not directly correlated with population increase, which is used as a proxy for employment in agriculture. Additionally, the study accept hypothesis that suggest that GOV does not granger cause LGCF.

This study in Table 5.13 rejects the null hypothesis that private investment in the agricultural sector does not granger cause the value of agricultural output, because the results reveal that this is statistically significance at 10. These results make sense from prior expectation as stated in Chapter 2, in the Keynesian theory, government intervention is only for the short run and the long run is financed by means of private investment. The study rejects the null hypothesis that LGCF does not granger cause GOV. This decision is due to the probability value of the relationship presented by the study at 0.0237, this is statistically significant at 10%.

This study rejects the null hypothesis that EMP does not granger course LGCF, this is statistically significant at 10% with the probability value of 0.0500. Additionally, the study accepts that LGCF does not granger cause EMP, this relationship is calculated at a probability value of 0.8550, meaning that it is statistically insignificant.

Table 5.13 Granger Causality test results for South Africa

Null hypothesis	Obs.	F-stat.	Prob.	Decision
GOV does not Granger Cause LOUTPUT	30	1.01056	0.3784	Accept
LOUTPUT does not Granger Cause GOV	30	2.88457	0.0746	Reject
LGCF does not Granger Cause LOUTPUT	30	0.38589	0.6838	Accept
LOUTPUT does not Granger Cause LGCF	30	0.47470	0.6276	Accept
EMP does not Granger Cause LOUTPUT	30	0.01206	0.9880	Accept
LOUTPUT does not Granger Cause EMP	30	0.26594	0.7686	Accept
LGCF does not Granger Cause GOV	30	4.36481	0.0237	Reject
GOV does not Granger Cause LGCF	30	0.37420	0.6916	Accept
EMP does not Granger Cause GOV	30	1.04589	0.3663	Accept
GOV does not Granger Cause EMP	30	1.22109	0.3119	Accept
EMP does not Granger Cause LGCF	30	1.04589	0.0500	Reject
LGCF does not Granger Cause EMP	30	1.22109	0.8550	Accept

Source: Author's calculations using E-views 12

The estimated Granger causality findings in Botswana from the study are shown in the Table 5.14.

The Granger causality test is used to identify whether one time series variable can predict (or "cause") another, or whether a causal relationship exists between the variables. In the case of Botswana's agricultural sector, the test examines the relationship between key variables: private agricultural investment (LGCF), government agricultural expenditure (GOV), and agricultural output (LOUTPUT).

The test shows no causal relationship from private agricultural investment (LGCF) to agricultural output (LOUTPUT) in Botswana. In other words, private investment in agriculture does not Granger cause an increase in agricultural output. This finding suggests that, in the short run, private investments in agriculture may not immediately translate into higher agricultural productivity. It may imply that other factors such as technology, infrastructure, or market access are more important in boosting productivity. Furthermore, it could indicate that investment decisions in agriculture are not being translated into the expected growth in agricultural output.

There is no causal relationship from agricultural output (LOUTPUT) to private agricultural investment (LGCF). Agricultural output does not Granger cause private investment in the sector. This result suggests that increases in agricultural output do not necessarily lead to higher levels of private investment in Botswana's agricultural sector. It could indicate that private investors may not view past agricultural performance as a key determinant when deciding to invest in the sector. Factors such as policy stability, market potential, and investment climate might be more decisive in driving private investments.

There is no causal relationship from government agricultural expenditure (GOV) to agricultural output (LOUTPUT), meaning government spending does not Granger cause increased agricultural output in Botswana. The lack of causality between government spending and agricultural output reinforces the earlier finding from other tables that government expenditure has not been effective in stimulating agricultural growth in Botswana. This result aligns with the negative impact of government spending on agricultural output (from the long-run results), suggesting that inefficiencies in public spending, misallocation of funds, or poor targeting might explain the lack of positive effects from government expenditure on agricultural productivity.

The test shows no causal relationship from agricultural employment (EMP) to agricultural output (LOUTPUT). This result suggests that increases in agricultural employment do not automatically lead to higher agricultural output in Botswana. This may indicate that labour in agriculture is not being utilized efficiently, or that technological barriers, resource constraints, or lack of skills limit the productivity of additional labour in the sector.

There is no causal relationship from private agricultural investment (LGCF) to government agricultural expenditure (GOV). This finding suggests that private investment in agriculture does not influence the level of government spending in the sector. It may reflect that government agricultural budgets are not directly responsive to private sector activities, or that government spending is more influenced by political priorities or other macroeconomic factors rather than private sector performance.

There is no causal relationship from government agricultural expenditure (GOV) to private agricultural investment (LGCF). The lack of causality from government spending to private investment indicates that public expenditure on agriculture does not have a direct effect on the level of private investment in the sector. This could suggest that private investors may not perceive government spending as a reliable signal of growth potential in the sector, or that private sector decisions are driven by other factors, such as market opportunities, risk assessments, or policy stability.

There is a unidirectional causal relationship from agricultural employment (EMP) to government agricultural expenditure (GOV). This means that changes in agricultural employment may influence government spending on agriculture. The finding that agricultural employment Granger causes government expenditure suggests that the level of employment in agriculture may influence the government's decision to allocate more funds to the sector. Higher employment could signal the need for more support, policy intervention, or subsidies for agricultural programs, which could lead to increased government spending in the sector.

Table 5.14: Granger Causality test results for Botswana

Null hypothesis	Obs.	F-stat.	Prob.	Decision
LGCF does not Granger Cause LOUTPUT	30	0.58356	0.5653	Don.t reject
LOUTPUT does not Granger Cause LGC	30	1.85562	0.1773	Don’t reject
GOV does not Granger Cause LOUTPUT	30	1.73442	0.1971	Don’t reject
LOUTPUT does not Granger Cause GOV	30	1.51184	0.2400	Don’t reject
EMP does not Granger Cause LOUTPUT	30	0.16659	0.8475	Don’t reject
LOUTPUT does not Granger Cause EMP	30	1.77607	0.1900	Don’t reject
GOV does not Granger Cause LGCF	30	0.52573	0.5975	Don’t reject
LGCF does not Granger Cause GOV	30	2.37273	0.1139	Dont reject
EMP does not Granger Cause LGCF	30	0.81476	0.4542	Don’t reject
LGCF does not Granger Cause EMP	30	0.31373	0.7336	Don’t reject
EMP does not Granger Cause GOV	30	4.18705	0.0270	Reject
GOV does not Granger Cause EMP	30	0.48562	0.6210	Don’t reject

Source: Author’s calculations using E-views 12

The estimated Granger causality findings in Namibia from the study are shown in the Table 5.15. The Granger causality test in Namibia aims to explore the potential causal relationships between government agricultural expenditure (GOV), private agricultural investment (LGCF), and agricultural output (LOUTPUT). Based on the findings in Table 5.15, the results provide insights into how these key variables interact over time.

No Causal Relationship: The results indicate that government expenditure on agriculture does not Granger cause agricultural output in Namibia. In other words, changes in government spending do not lead to changes in agricultural productivity in the short run. Furthermore, agricultural output does not Granger cause government expenditure, suggesting that increases in agricultural productivity do not trigger higher government spending in the sector. This outcome highlights the ineffectiveness of government spending in driving agricultural growth in Namibia, a finding that aligns with similar results in Botswana. Policymakers may need to reassess the efficiency of government agricultural spending and investigate potential inefficiencies or misallocation of funds. Simply increasing public expenditure may not be the most effective way to stimulate agricultural growth. A more targeted approach might be necessary, focusing on improving public sector management, transparency, and accountability in agricultural programs.

Causal Relationship from Agricultural Output to Private Investment: There is a unidirectional causal relationship between agricultural output and private agricultural investment. Specifically, the value of agricultural output Granger causes private investment in the sector, meaning that higher agricultural productivity encourages more private investment. However, private agricultural investment does not Granger cause agricultural output, implying that private investments are more likely to follow improvements in productivity rather than directly drive increases in output. The positive relationship from agricultural output to private investment suggests that private investors respond to productivity improvements in the agricultural sector. This finding underscores the importance of creating an environment where agricultural productivity can thrive for example, by improving market access, technology, and infrastructure as these improvements will attract further investment into the sector. This also indicates that boosting agricultural output should be a priority for policymakers to attract the necessary private capital to sustain sectoral growth.

No Causal Relationship: The test finds no causal link between agricultural employment and agricultural output, both in terms of employment driving output or output driving employment. Essentially, employment in agriculture does not directly influence agricultural productivity in Namibia, and vice versa. This finding suggests that increasing employment in the agricultural sector may not necessarily lead to increased productivity. It may indicate underutilization of labour or low efficiency in the sector. Given that agriculture is often labour-intensive, policymakers need to focus on skills training, technology adoption, and improving labour productivity rather than simply expanding employment numbers. Investments in human capital and agricultural innovation are essential to ensure that the labour force contributes meaningfully to sectoral growth.

No Causal Relationship: There is no causal relationship between private agricultural investment and government expenditure. This means that private investment in agriculture does not influence government spending decisions in the sector, nor does government spending drive private investment. The lack of causality suggests that the public and private sectors operate independently in terms of financial commitments to agriculture. Policymakers may need to strengthen coordination between the public and private sectors, ensuring that government spending creates an environment conducive to private investment. This could include policy reforms to enhance public-private partnerships, ensuring that government spending aligns with the needs of private investors in agriculture.

There is a causal relationship were agricultural employment influences government expenditure on agriculture. This suggests that changes in the employment levels within the agricultural sector can lead to changes in the amount of government spending allocated to agriculture. This relationship highlights the policy sensitivity of government expenditure to changes in agricultural employment. If employment in agriculture increases, the government may respond by increasing its agricultural budget. This finding suggests that employment policies targeting the agricultural sector can have broader implications for government spending decisions. Policymakers could use employment growth as a signal to increase support for the sector, potentially through targeted subsidies, grants, or infrastructure development.

The causal dynamics in Namibia's agricultural sector suggest that government spending, while important, is not the primary driver of agricultural productivity. Instead, private sector investment and productivity improvements seem to be more critical for fostering growth. The findings call for a shift in focus towards creating an enabling environment for private investment and improving labour productivity, while reforming government expenditure strategies to ensure they are better targeted and more effective.

Table 5.15 Granger Causality test results for Namibia

Null hypothesis	Obs.	F-stat.	Prob.	Decision
GOV does not Granger Cause LOUTPUT	30	2.05789	0.1488	Don't reject
LOUTPUT does not Granger Cause GOV	30	2.25496	0.1258	Accept
LGCF does not Granger Cause LOUTPUT	30	0.34367	0.7125	Accept
LOUTPUT does not Granger Cause LGCF	30	4.55421	0.0206	reject
EMP does not Granger Cause LOUTPUT	30	0.02555	0.9748	Accept
LOUTPUT does not Granger Cause EMP	30	0.29474	0.7473	Accept
LGCF does not Granger Cause GOV	30	0.24730	0.9748	Accept
GOV does not Granger Cause LGCF	30	4.54190	0.7473	Accept
EMP does not Granger Cause GOV	30	3.23709	0.0562	Reject
GOV does not Granger Cause EMP	30	1.76942	0.1911	Accept
EMP does not Granger Cause LGCF	30	1.04589	0.7750	Accept
LGCF does not Granger Cause EMP	30	1.22109	0.9444	Accept

Source: Author's calculations using E-views 12

5.2.6 Diagnostic Tests Results

Table 5.16 indicate the diagnostic test results for South Africa and they were used to diagnose if any of the Ordinary Least Square's assumptions has been violated and examining if the model is relatively stable.

As indicated in Table 5.16, the Jarque-Bera test for normal distribution reveals that the residuals are normally distributed. The null hypothesis was rejected when the LM Test was employed to check for serial correlation, and it was discovered that there was none. The ARCH Test was applied to determine if the variance of the errors is stable over time. It was discovered that the model is not heteroscedastic.

Table 5.16: Diagnostic tests result for South Africa

Test	**Null hypothesis (Ho)**	**p-value**	**Decision**
Jarque-Bera	Residuals are normally distributed	0.8117	Accept H0. Residuals are normally distributed
Breusch-Godfrey LM test	No serial correlation	0.4465	Accept H0- no serial correlation
ARCH Test	No Heteroscedasticity	0.8321	Accept H0. No Heteroscedasticity

Source: Author's calculations using E-views 12

Table 5.17 indicate the diagnostic test results for Botswana and they were used to diagnose if any of the Ordinary Least Square's assumptions has been violated and examining if the model is relatively stable.

The Jarque-Bera test for normal distribution demonstrates that the residuals are normally distributed, as shown in Table 5.17. When the LM Test was used to look for serial correlation, it was found that there was none, hence the null hypothesis was rejected. In order to determine whether the variance of the errors is constant over time, the ARCH Test was utilised. It was found that the model is not heteroscedastic.

Table 5.17 Diagnostic tests results for Botswana

Test	**Null hypothesis (Ho)**	**p-value**	**Decision**
Jarque-Bera	Residuals are normally distributed	0.936126	Accept H0. Residuals are normally distributed
Breusch-Godfrey LM test	No serial correlation	0.6147	Accept H0- no serial correlation
ARCH Test	No Heteroscedasticity	0.4012	Accept H0. No Heteroscedasticity

Source: Author's calculations using E-views 12

Table 5.18 indicate the diagnostic test results for Namibia and they were used to diagnose if any of the Ordinary Least Square's assumptions has been violated and examining if the model is relatively stable.

The residuals are normally distributed, as shown in Table 5.18, according to the Jarque-Bera test for normal distribution. The null hypothesis was rejected when the LM Test was used to check for serial correlation because it failed to find any. The ARCH Test was used to test whether the variance of the errors is constant throughout time. The model was discovered to be homoscedastic.

Table 5.18: Diagnostic tests result for Namibia

Test	**Null hypothesis (Ho)**	**p-value**	**Decision**
Jarque-Bera	Residuals are normally distributed	0.2403	Accept H0. Residuals are normally distributed
Breusch-Godfrey LM test	No serial correlation	0.3832	Accept H0- no serial correlation
ARCH Test	No Heteroscedasticity	0.6368	Accept H0. No Heteroscedasticity

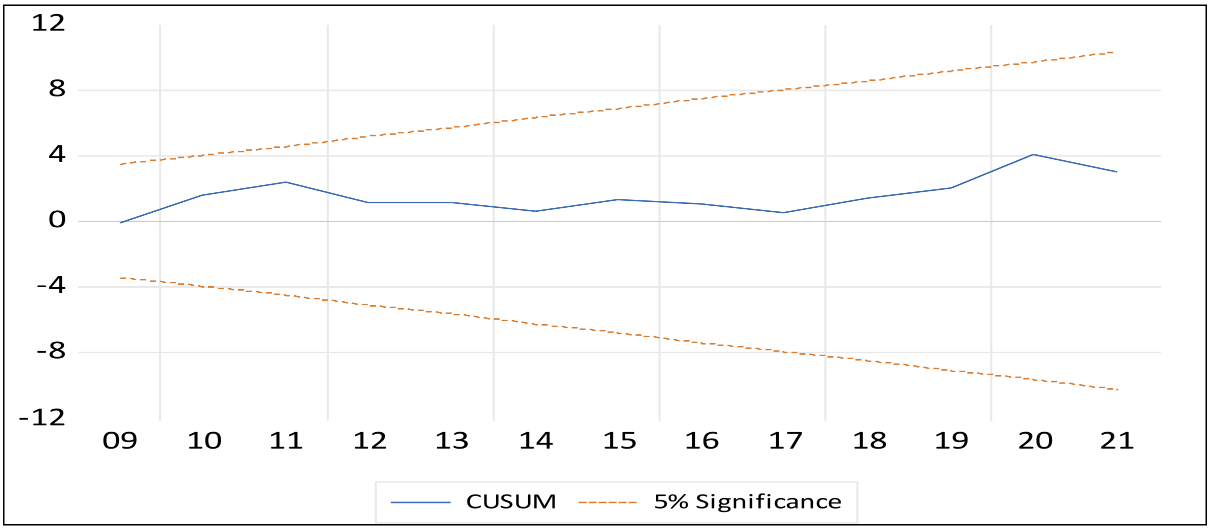
Source: Author's calculations using E-views 12

5.2.7 Stability Tests Results

5.2.7.1 CUSUM test results

The parameters must fall under the 5% level of significance critical line for the CUSUM to be categorised as stable. For the entirety of the sampled data/period in South Africa, the parameters are estimated inside the critical lines of the 5% level of significance, providing sufficient evidence to draw the conclusion that the estimated model is stable, as shown in the Figure 5.13.

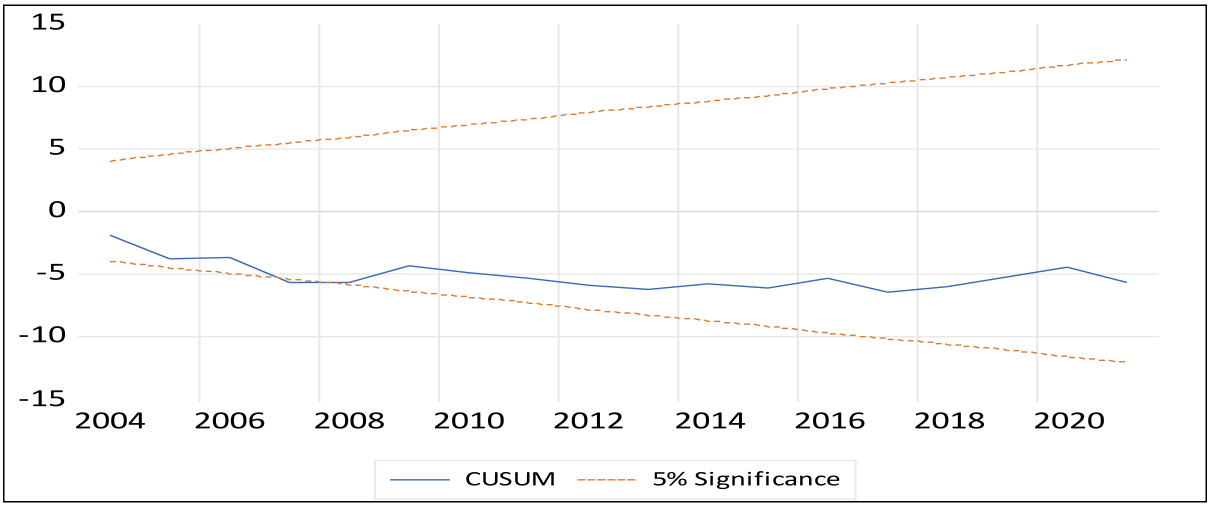
Figure 5.13 CUSUM test results for South Africa



Source: Author's construction using EViews 12

Figure 5.14 reveals that for the entirety of the sampled period in Botswana except between the year 2006 and 2008 the parameters are estimated inside the critical lines of the 5% level of significance, providing sufficient evidence to draw the conclusion that the estimated model is stable, as shown in the Figure 5.14.

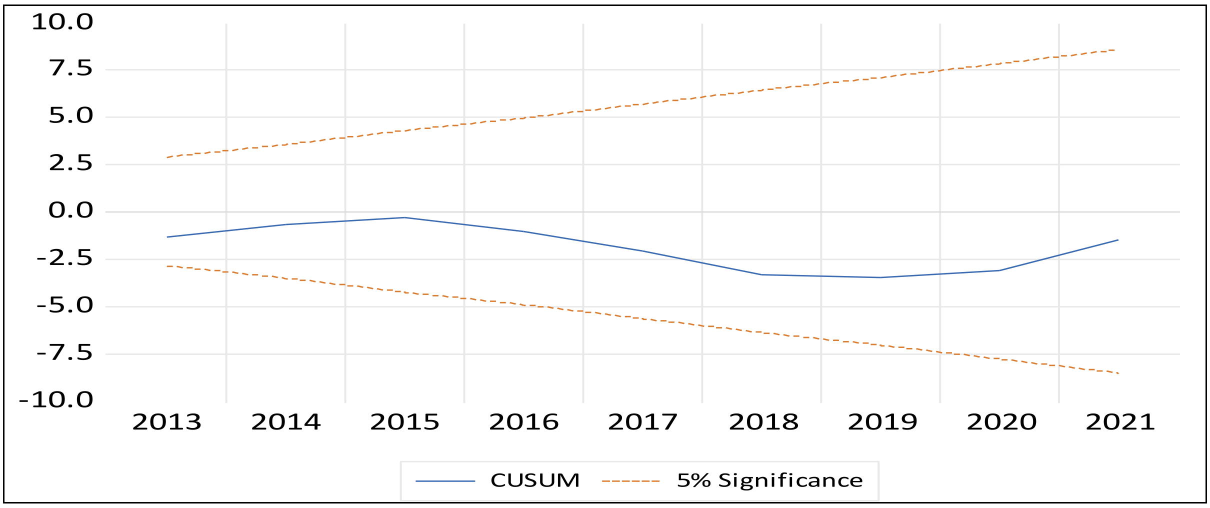
Figure 5.14 CUSUM test results for Botswana



Source: Author’s construction using EViews 12

For the entirety of the sampled data/period in Namibia, the parameters are estimated inside the critical lines of the 5% level of significance, providing sufficient evidence to draw the conclusion that the estimated model is stable, as shown in Figure .5.15.

Figure 5.15 CUSUM test results for Namibia

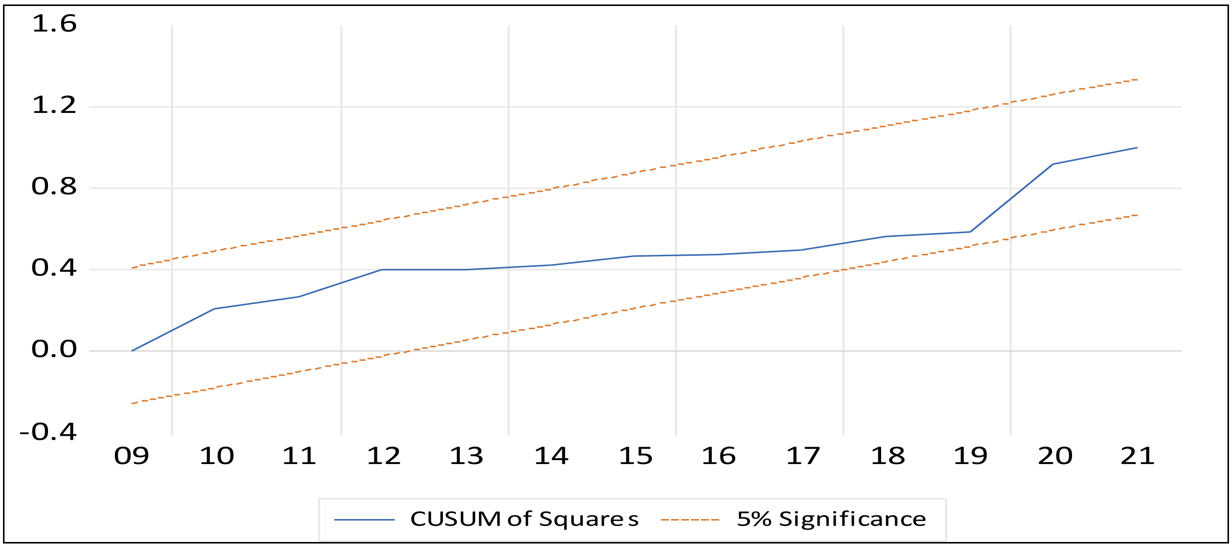


Source: Author’s construction using EViews 12

5.2.7.2 CUSUM of squares test results

The South African model's cumulative sum of squares recursive residuals (CUSUMQ) plot, shown in Figure 5.16. Figure 5.16 shows that the coefficients have remained stable across the sample period since they have remained within the critical boundaries, as determined by the 5% level of significance.

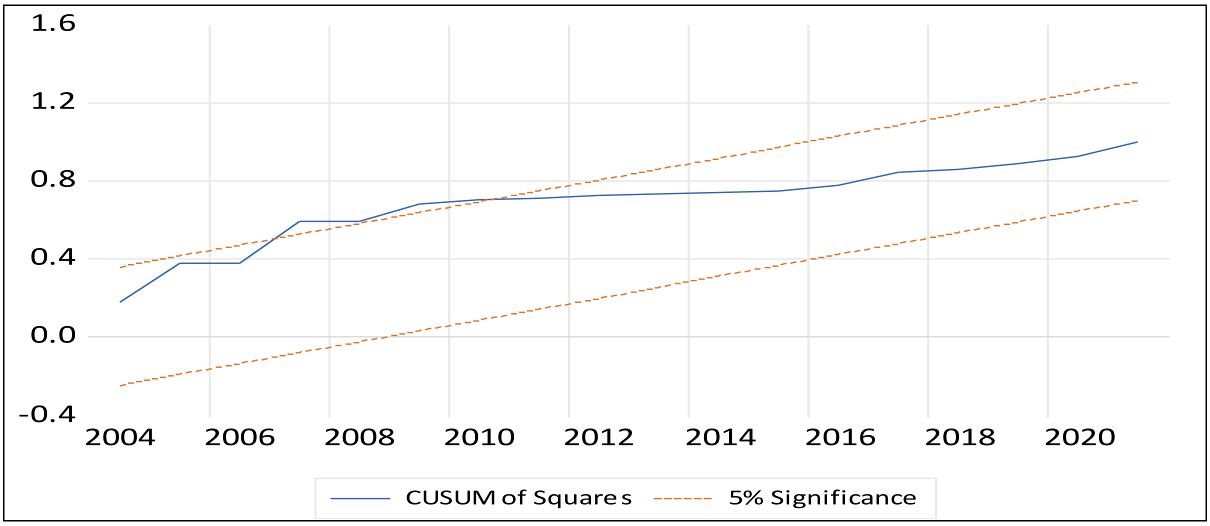
Figure 5.16 CUSUM of squares test results for South Africa



Source: Author’s construction using EViews 12

The Botswana model's cumulative sum of squares recursive residuals (CUSUMQ) plot, shown in Figure 5.17, shows that the coefficients are stable during the years 2004 (prior). The sample becomes unstable between the year 2007 until 2010 but becomes stable after across the remaining sample period. This means that the data remain within the critical boundaries, as determined by the 5% level of significance.

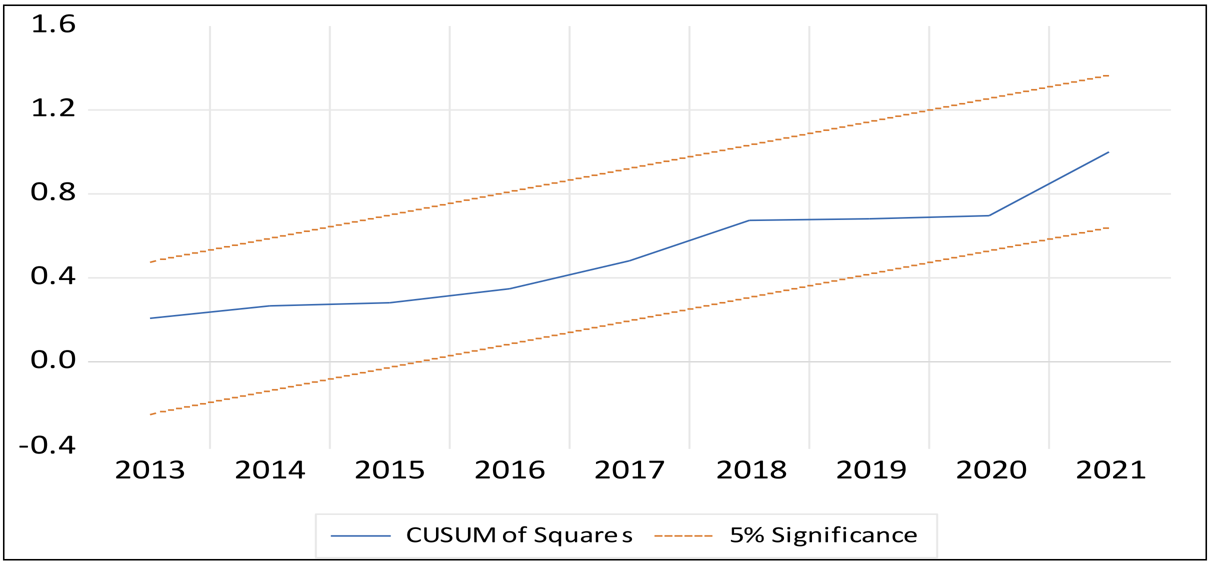
Figure 5.17 CUSUM of squares test results for Botswana



Source: Author’s construction using EViews 12

The Namibia model's cumulative sum of squares recursive residuals (CUSUMQ) plot, shown in Figure 5.18, shows that the coefficients have remained stable across the sample period since they have remained within the critical boundaries, as determined by the 5% level of significance.

Figure 5.18 CUSUM of squares test results for Namibia



Source: Author’s construction using EViews 12

5.3 SUMMARY

The results were presented in this chapter based on the methodology described in chapter 4 of the study. The time series features of the data were examined in order to visually confirm whether the variables are stationary before beginning the ADF unit root testing. The ARDL Bounds tests was applied for cointegration. Both the short run and long run growth models applied the ARDL method. Stability tests were used to complete up the chapter.

CHAPTER 6

SUMMARY, RECOMMENDATIONS, CONCLUSION

6.1 INTRODUCTION

The findings of the study are summarised in this chapter. Together with the information and policy suggestions, the chapter also offers conclusions. The chapter also offers suggestions for future research.

6.2 SUMMARY OF FINDINGS

The study's aim was to determine how government spending and private investment affect SACU's agricultural industry. This required figuring out if public and private spending would raise the value of agricultural output and boost employment in the agricultural industry. This would demonstrate whether the selected SACU countries would achieve the SDGs set forth by the UN as well as the Malabo declaration by the AU. The ARDL methodology was applied on time series data spanning the period 1995 to 2021 to achieve this aim.

Government expenditure in agriculture

The research identified a positive correlation between government spending on agriculture and agricultural output. This suggests that in South Africa, government investment in agriculture has the potential to stimulate and enhance the agricultural sector in both the short and long term. The theories of Wegner and Keynesian were validated. The Granger causality test demonstrated a unidirectional relationship from agricultural output to government spending in the agricultural sector.

The findings showed an insignificantly positive relationship for Botswana and a negative one for Namibia between government spending on agriculture and agricultural output. This indicated that in both countries, neither Wegner's nor Keynesian theories were applicable. Furthermore, the Granger causality test found no causal link between these variables in either country.

Private investment in agriculture

The ARDL test results found that in South Africa and Namibia, private investment in agriculture positively and significantly affects agricultural output and thus confirming the Keynesian theory. Nonetheless, the research discovered a significant yet negative correlation between private agricultural investment and agricultural output in Botswana, thereby confirming that the Keynesian theory is not applicable.

The granger causality test showed no causal relationship exists between government expenditure in agriculture and agricultural output in South Africa and Botswana. However, agricultural output was found to influence private investment in the agricultural sector of Namibia.

Employment in Agriculture

From the ARDL test, a positive relationship was found between employment in the agricultural sector and the agricultural output in South Africa. However, employment in the agricultural sector was found to have a detrimental but significant effect on agricultural output in Botswana and Namibia.

Granger Causality

The Granger causality results provide important insights into the mechanisms through which government policy, private investment, and employment influence agricultural output. For both Botswana and Namibia, improving the efficiency and targeting of government spending is crucial for stimulating growth in the agricultural sector. Meanwhile, private investment is more responsive to improvements in agricultural output, highlighting the importance of productivity-driven growth strategies.

6.3 RECOMMENDATIONS

The aim of the study was to examine the impact of government expenditure and private investment on the agricultural sector for selected SACU member states.

The research discovered a meaningful and positive correlation between government spending and the production of agriculture in South Africa. This has several policy implications which are outlined below:

- There are many competing interests that the government is funding on a yearly basis and also the fact that on average (as outlined in chapter 2), governments in SADC spend less than 2% of their revenue on the agricultural sector. The study recommends an increase of at least 1% of state revenue to be allocated to the agricultural sector each year, so that at some point it will be in line with the Malabo declaration which recommends that governments spend at least 10% of state revenue in the agricultural sector.

  Despite the findings for the other two countries in the study showing no correlation between government spending on agriculture and agricultural output, the suggestion of a yearly increase of 1% can still be implemented. This is not only applicable to these two countries, but also to all member states of SACU and SADC. This approach will aid in sustaining enhanced agricultural productivity while also ensuring a long-term provision of affordable food to impoverished communities. This is particularly important given the recent surge in global food prices, which poses a serious threat to both rural and urban consumers. Elevating government expenditure can enable the agricultural sector to carry out more advanced research and enhance cutting-edge, efficient technology. The goal is to amplify and stabilize agricultural yield. This is crucial to maintain agriculture as the mainstay of the economies of the Southern African Customs Union (SACU) members.

- Furthermore, for this 1% yearly increase in agricultural spending to be effective, the study recommends that the government carries out proper planning before carrying out budget process as this will ensure that priority is given to specific areas in the agricultural sector for proper funds allocations. This entails funding research in the area of climate-smart agriculture. Climate-smart technologies can reduce carbon dioxide emissions and raised rainfall, which is advantageous for the farming industry.

- The results found that in South Africa and Namibia, private investment in agriculture positively and significantly affects agricultural output and thus the study recommends effective policies and adequate regulations that will ensure a conducive environment for both private and public investment while eliminating the crowding out effect. Even though, Botswana was found to have a significant and negative relationship between the variables, however, the same is recommended.

- Additionally, the research suggests the establishment of a transparent and foreseeable legal and regulatory structure, efficient administration, and simplified processes for business registration and permit applications. This will encourage companies to function and grow in the agricultural sector of SACU.

- Establishing a stable, transparent, and inclusive financial system with reliable financial institutions is crucial. This includes facilitating corporate credit access, expanding capital markets, and promoting venture capital investments. These measures will foster the creation of new businesses and simplify the financing of private investments in the agricultural sector of the SACU countries.

- The study found that employment in the agricultural sector of South Africa had a positive influence in relation to agricultural output. However, it was not the same in Botswana and Namibia this could be due to the small size of the population of these two countries. Therefore, the study recommends that the government of South Africa takes into consideration, issues of land reform (i.e., The expropriation of land without compensation) as this will ensure improvement of equality in land ownership, promotion of farm efficiency, increased sustainable employment and improved wealth creation in the rural areas.

6.4 AREA FOR FUTURE RESEARCH

Subsequent studies could investigate the influence of other elements such as rainfall, interest rates, policy changes, land, temperature, the net export value, and fuel costs to enrich our understanding of agricultural output's value. Future research should also focus on forecasting the technical efficiency and distributional effectiveness of the SACU agricultural government spending.

6.5 LIMITATIONS OF THE STUDY

Due to inadequate data accessibility and time, the research may not have concentrated on all nations and factors which influence the value of agricultural output in SACU, particularly in Swaziland and Lesotho. Because statistics were unavailable. This study solely looked at the effects of government expenditure and private investment in the agriculture sector of three SACU nations (South Africa, Botswana, and Namibia). The study used agricultural output as a point of comparison because there is little research on the value of agricultural output in SACU. In terms of examining the particular variable of agricultural value, this implies that this research could contribute to the currently insufficient body of knowledge.

6.6 CONCLUSION

The chapter highlighted the findings of the study from which recommendations were drawn. Additionally, areas for future research were emphasised together with the limitations of the study.

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APPENDICES

Appendix A: DATA

South Africa

years	GOV	GCF	EMP	OUTPUT	LGFC
1990	2,4	1770,6	12,45	3,777056	3,24812
1991	2,3	1430,3	12,32	3,743505	3,155427
1992	2,5	1352,5	12,14	3,14921	3,131137
1993	4,4	2087,5	11,95	3,422575	3,319626
1994	2,3	3251,3	11,29	3,755448	3,512057
1995	1,9	3780,1	11,13	3,121585	3,577503
1996	2	4589,8	10,95	3,416588	3,661794
1997	1,7	4382,4	10,74	3,265895	3,641712
1998	1,6	3847,9	10,54	3,03418	3,585224
1999	1,5	3217,8	10,28	2,846399	3,507559
2000	1,4	3789	9,93	2,614748	3,578525
2001	1,5	4595,3	9,32	2,812452	3,662314
2002	1,6	6805,9	8,71	2,956972	3,832886
2003	1,6	6327,3	8,14	2,653978	3,801218
2004	1,7	7818,8	7,57	2,411716	3,89314
2005	1,4	6746,1	7,02	2,085118	3,829053
2006	1,8	7856,2	6,5	2,050977	3,895213
2007	1,7	9117,6	6,01	2,355914	3,959881
2008	2	11533,2	5,57	2,572489	4,06195
2009	1,9	10258,6	5,05	2,399496	4,011088
2010	1,6	9274,5	4,85	2,107787	3,967291
2011	1,7	11934,6	4,6	2,043893	4,076808
2012	1,6	13806,3	4,83	1,97671	4,140077
2013	1,6	13922,1	4,98	1,926849	4,143705
2014	1,6	14922	4,65	2,125749	4,173827
2015	1,5	11852,5	5,61	2,233978	4,07381
2016	1,3	12130,5	5,57	2,414186	4,083879
2017	1,4	16118,8	5,28	2,493799	4,207333

2018	1,2	17023,8	5,16	2,275252	4,231057
2019	1,2	15042,9	5,28	1,964302	4,177332
2020	1,4	16033,35	5,22	2,527584	4,205024
2021	1,4	16243,56	5,48	2,65	4,210681

Botswana

years	GOV	GCF	EMP	OUTPUT	LGCF
1990	5,4	5900	15,8	4,526151	3,770852
1991	4,91	4010	15,9	4,376896	3,603144
1992	4,67	3867	15,7	4,632785	3,587374
1993	5,54	3850	15,66	4,521193	3,585461
1994	3,92	3800	15,6	3,756144	3,579784
1995	4,13	3750	15,26	4,637721	3,574031
1996	5,47	3700	15,07	3,690994	3,568202
1997	5,78	3669	17,76	3,542706	3,564548
1998	4,65	3357	20,73	3,166864	3,525951
1999	3,56	3648	20,32	2,990765	3,562055
2000	4,49	2688	19,96	2,7947	3,429429
2001	5,6	3165	20,49	2,590291	3,500374
2002	4,90	3133	20,82	2,425616	3,49596
2003	5,59	2957	21,22	2,722387	3,470851
2004	4,58	3068	21,96	2,259585	3,486855
2005	3,11	2913	22,66	1,828381	3,46434
2006	4,49	2816	23,22	2,048365	3,449633
2007	3,65	2835	23,77	2,240733	3,452553
2008	3,40	3371	24,39	2,526018	3,527759
2009	4,26	3759	25,09	2,819082	3,575072
2010	3,00	4589,8	24,59	2,488038	3,661794
2011	2,88	4382,4	24,06	2,510918	3,641712
2012	3,17	3847,9	23,57	2,69527	3,585224
2013	3,05	3217,8	22,86	2,298593	3,507559
2014	4,19	3789	22,29	1,798135	3,578525

2015	4,15	4595,3	21,9	1,940901	3,662314
2016	5,07	6805,9	21,36	1,975876	3,832886
2017	2,22	6327,3	20,88	1,843897	3,801218
2018	3,46	6746,1	20,37	2,055351	3,829053
2019	4,43	9117,6	19,9	2,088655	3,959881
2020	3,66	9274,5	20,14	2,130881	3,967291
2021	3,78	16118,8	23,07	2,432615	4,207333

Namibia

years	GOV	GCF	EMP	OUTPUT
1990	2,89	23,42324	48,64	9,055375
1991	3,43	22,01081	48,28	9,973327
1992	4,56	23,50601	46,58	7,083253
1993	3,98	25,38663	45,19	7,420324
1994	3,78	26,71966	43,62	10,12916
1995	4,23	26,03854	41,9	9,447366
1996	3,46	23,603	40,21	9,32986
1997	2,67	25,05927	38,49	8,510224
1998	4,57	25,04294	36,12	8,588565
1999	3,96	24,98371	33,71	8,766234
2000	3,61	24,51114	31,28	10,73102
2001	5,26	25,07728	31,14	9,675466
2002	5,24	23,96159	30,79	10,03914
2003	4,97	23,28838	30,41	10,21534
2004	4,76	22,04949	29,97	8,939779
2005	5,14	22,75504	29,74	10,36849
2006	4,35	20,76656	29,29	9,646471
2007	4,67	19,66452	28,92	8,440714
2008	2,61	19,84066	28,68	7,531687
2009	3,33	23,8619	28,52	8,148145
2010	3,26	21,79636	28,11	8,455369
2011	4,04	23,85852	27,73	8,113627

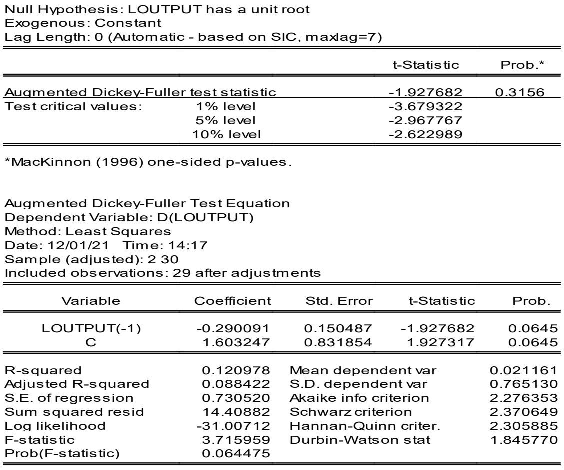
2012	3,23	25,5541	27,37	8,054475
2013	2,80	23,18895	31,39	7,821465
2014	2,23	24,97081	29,32	8,138936
2015	2,04	28,01463	24,48	6,650427
2016	4,45	27,90401	20,07	6,720118
2017	3,98	27,38085	21,35	7,676156
2018	3,32	27,12996	22,59	7,768298
2019	2,08	25,91218	21,85	7,083257
2020	2,23	25,83824	21,92	9,18601
2021	2,25	25,91279	22,96	9,396955

Appendix B: ADF Test Results

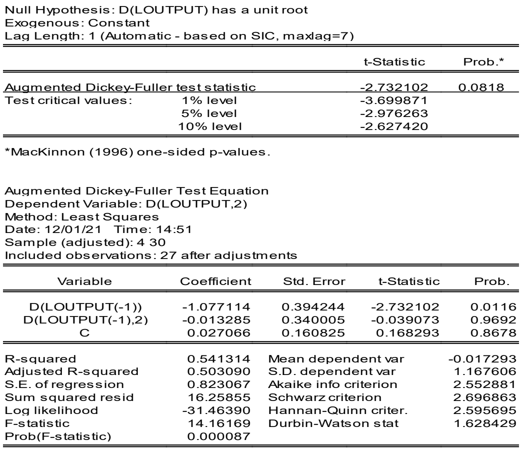
South Africa

Agricultural Output (LOUTPUT)

LOUTPUT at constant

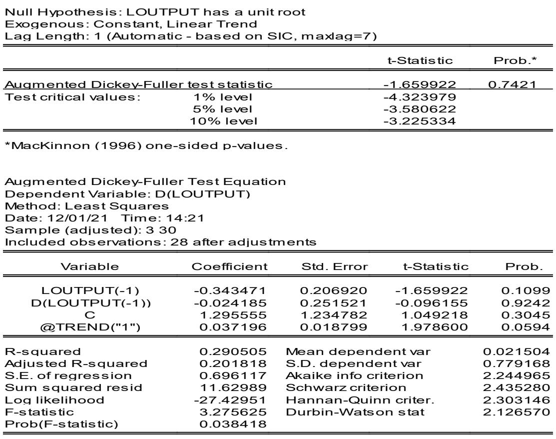


```
Null Hypothesis: LOUTPUT has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=7)

                                             t-Statistic    Prob.*

Augmented Dickey-Fuller test statistic       -1.927682      0.3156
Test critical values:        1% level        -3.679322
                             5% level        -2.967767
                             10% level       -2.622989

*MacKinnon (1996) one-sided p-values.


Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LOUTPUT)
Method: Least Squares
Date: 12/01/21   Time: 14:17
Sample (adjusted): 2 30
Included observations: 29 after adjustments

    Variable         Coefficient   Std. Error   t-Statistic    Prob.

   LOUTPUT(-1)        -0.290091     0.150487    -1.927682     0.0645
        C              1.603247     0.831854     1.927317     0.0645

R-squared              0.120978   Mean dependent var       0.021161
Adjusted R-squared     0.088422   S.D. dependent var       0.765130
S.E. of regression     0.730520   Akaike info criterion    2.276353
Sum squared resid      14.40882   Schwarz criterion        2.370649
Log likelihood        -31.00712   Hannan-Quinn criter.     2.305885
F-statistic            3.715959   Durbin-Watson stat       1.845770
Prob(F-statistic)      0.064475
```

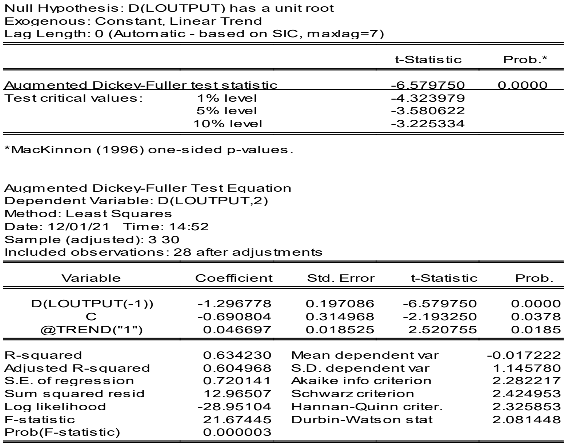


```
Null Hypothesis: D(LOUTPUT) has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on SIC, maxlag=7)

                                             t-Statistic    Prob.*

Augmented Dickey-Fuller test statistic       -2.732102      0.0818
Test critical values:        1% level        -3.699871
                             5% level        -2.976263
                             10% level       -2.627420

*MacKinnon (1996) one-sided p-values.


Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LOUTPUT,2)
Method: Least Squares
Date: 12/01/21   Time: 14:51
Sample (adjusted): 4 30
Included observations: 27 after adjustments

    Variable         Coefficient   Std. Error   t-Statistic    Prob.

  D(LOUTPUT(-1))      -1.077114     0.394244    -2.732102     0.0116
 D(LOUTPUT(-1),2)     -0.013285     0.340005    -0.039073     0.9692
        C              0.027066     0.160825     0.168293     0.8678

R-squared              0.541314   Mean dependent var      -0.017293
Adjusted R-squared     0.503090   S.D. dependent var       1.167606
S.E. of regression     0.823067   Akaike info criterion    2.552881
Sum squared resid      16.25855   Schwarz criterion        2.696863
Log likelihood        -31.46390   Hannan-Quinn criter.     2.595695
F-statistic            14.16169   Durbin-Watson stat       1.628429
Prob(F-statistic)      0.000087
```

LOUTPUT at Intercept and Trend

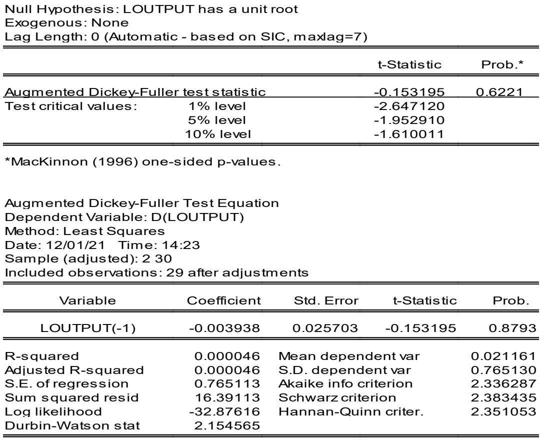


```
Null Hypothesis: LOUTPUT has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 1 (Automatic - based on SIC, maxlag=7)
==========================================================================
                                                   t-Statistic    Prob.*
==========================================================================
Augmented Dickey-Fuller test statistic              -1.659922     0.7421
Test critical values:          1% level             -4.323979
                               5% level             -3.580622
                              10% level             -3.225334
==========================================================================
*MacKinnon (1996) one-sided p-values.


Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LOUTPUT)
Method: Least Squares
Date: 12/01/21   Time: 14:21
Sample (adjusted): 3 30
Included observations: 28 after adjustments
==========================================================================
        Variable          Coefficient   Std. Error   t-Statistic    Prob.
==========================================================================
     LOUTPUT(-1)           -0.343471     0.206920    -1.659922     0.1099
   D(LOUTPUT(-1))          -0.024185     0.251521    -0.096155     0.9242
          C                 1.295555     1.234782     1.049218     0.3045
     @TREND("1")            0.037196     0.018799     1.978600     0.0594
==========================================================================
R-squared                   0.290505   Mean dependent var         0.021504
Adjusted R-squared          0.201818   S.D. dependent var         0.779168
S.E. of regression          0.696117   Akaike info criterion      2.244965
Sum squared resid           11.62989   Schwarz criterion          2.435280
Log likelihood             -27.42951   Hannan-Quinn criter.       2.303146
F-statistic                 3.275625   Durbin-Watson stat         2.126570
Prob(F-statistic)           0.038418
==========================================================================
```

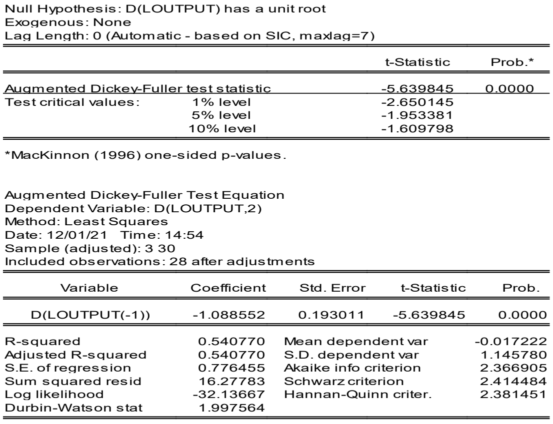


```
Null Hypothesis: D(LOUTPUT) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=7)
==========================================================================
                                                   t-Statistic    Prob.*
==========================================================================
Augmented Dickey-Fuller test statistic              -6.579750     0.0000
Test critical values:          1% level             -4.323979
                               5% level             -3.580622
                              10% level             -3.225334
==========================================================================
*MacKinnon (1996) one-sided p-values.


Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LOUTPUT,2)
Method: Least Squares
Date: 12/01/21   Time: 14:52
Sample (adjusted): 3 30
Included observations: 28 after adjustments
==========================================================================
        Variable          Coefficient   Std. Error   t-Statistic    Prob.
==========================================================================
   D(LOUTPUT(-1))          -1.296778     0.197086    -6.579750     0.0000
          C                -0.690804     0.314968    -2.193250     0.0378
     @TREND("1")            0.046697     0.018525     2.520755     0.0185
==========================================================================
R-squared                   0.634230   Mean dependent var        -0.017222
Adjusted R-squared          0.604968   S.D. dependent var         1.145780
S.E. of regression          0.720141   Akaike info criterion      2.282217
Sum squared resid           12.96507   Schwarz criterion          2.424953
Log likelihood             -28.95104   Hannan-Quinn criter.       2.325853
F-statistic                 21.67445   Durbin-Watson stat         2.081448
Prob(F-statistic)           0.000003
==========================================================================
```

LOUTPUT at none



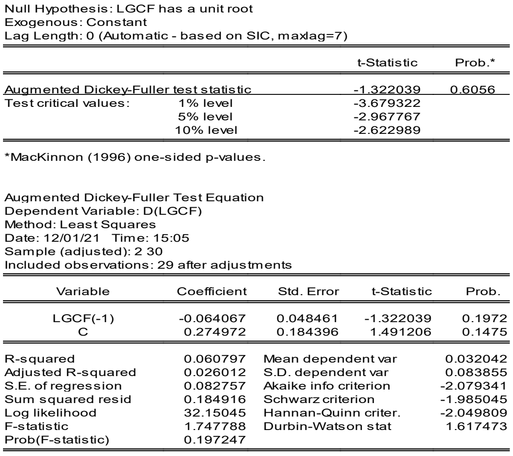
```
Null Hypothesis: LOUTPUT has a unit root
Exogenous: None
Lag Length: 0 (Automatic - based on SIC, maxlag=7)
==========================================================================
                                                   t-Statistic    Prob.*
==========================================================================
Augmented Dickey-Fuller test statistic              -0.153195     0.6221
Test critical values:          1% level             -2.647120
                               5% level             -1.952910
                              10% level             -1.610011
==========================================================================
*MacKinnon (1996) one-sided p-values.


Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LOUTPUT)
Method: Least Squares
Date: 12/01/21   Time: 14:23
Sample (adjusted): 2 30
Included observations: 29 after adjustments
==========================================================================
        Variable          Coefficient   Std. Error   t-Statistic    Prob.
==========================================================================
     LOUTPUT(-1)           -0.003938     0.025703    -0.153195     0.8793
==========================================================================
R-squared                   0.000046   Mean dependent var         0.021161
Adjusted R-squared          0.000046   S.D. dependent var         0.765130
S.E. of regression          0.765113   Akaike info criterion      2.336287
Sum squared resid           16.39113   Schwarz criterion          2.383435
Log likelihood             -32.87616   Hannan-Quinn criter.       2.351053
Durbin-Watson stat          2.154565
==========================================================================
```



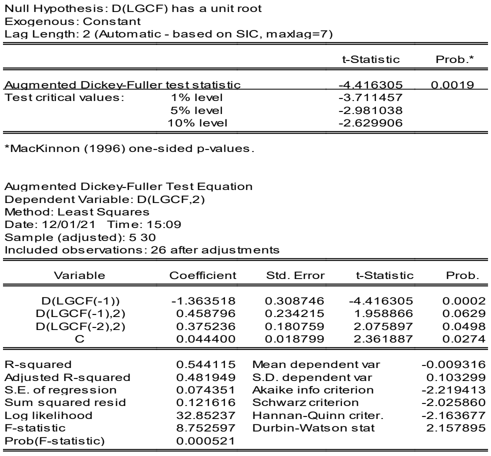
```
Null Hypothesis: D(LOUTPUT) has a unit root
Exogenous: None
Lag Length: 0 (Automatic - based on SIC, maxlag=7)
==========================================================================
                                                   t-Statistic    Prob.*
==========================================================================
Augmented Dickey-Fuller test statistic              -5.639845     0.0000
Test critical values:          1% level             -2.650145
                               5% level             -1.953381
                              10% level             -1.609798
==========================================================================
*MacKinnon (1996) one-sided p-values.


Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LOUTPUT,2)
Method: Least Squares
Date: 12/01/21   Time: 14:54
Sample (adjusted): 3 30
Included observations: 28 after adjustments
==========================================================================
        Variable          Coefficient   Std. Error   t-Statistic    Prob.
==========================================================================
   D(LOUTPUT(-1))          -1.088552     0.193011    -5.639845     0.0000
==========================================================================
R-squared                   0.540770   Mean dependent var        -0.017222
Adjusted R-squared          0.540770   S.D. dependent var         1.145780
S.E. of regression          0.776455   Akaike info criterion      2.366905
Sum squared resid           16.27783   Schwarz criterion          2.414484
Log likelihood             -32.13667   Hannan-Quinn criter.       2.381451
Durbin-Watson stat          1.997564
==========================================================================
```

Private Investment in Agriculture (LGFC)

LGCF at intercept

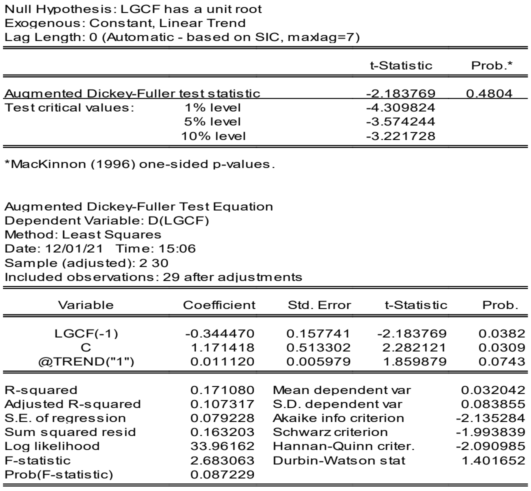


```
Null Hypothesis: LGCF has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=7)
==========================================================================
                                                   t-Statistic    Prob.*
==========================================================================
Augmented Dickey-Fuller test statistic              -1.322039     0.6056
Test critical values:          1% level             -3.679322
                               5% level             -2.967767
                              10% level             -2.622989
==========================================================================
*MacKinnon (1996) one-sided p-values.


Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LGCF)
Method: Least Squares
Date: 12/01/21   Time: 15:05
Sample (adjusted): 2 30
Included observations: 29 after adjustments
==========================================================================
        Variable          Coefficient   Std. Error   t-Statistic    Prob.
==========================================================================
       LGCF(-1)            -0.064067     0.048461    -1.322039     0.1972
          C                 0.274972     0.184396     1.491206     0.1475
==========================================================================
R-squared                   0.060797   Mean dependent var         0.032042
Adjusted R-squared          0.026012   S.D. dependent var         0.083855
S.E. of regression          0.082757   Akaike info criterion     -2.079341
Sum squared resid           0.184916   Schwarz criterion         -1.985045
Log likelihood              32.15045   Hannan-Quinn criter.      -2.049809
F-statistic                 1.747788   Durbin-Watson stat         1.617473
Prob(F-statistic)           0.197247
==========================================================================
```

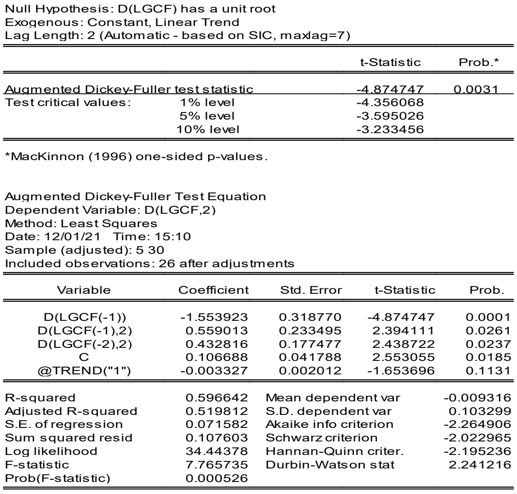


```
Null Hypothesis: D(LGCF) has a unit root
Exogenous: Constant
Lag Length: 2 (Automatic - based on SIC, maxlag=7)
==========================================================================
                                                   t-Statistic    Prob.*
==========================================================================
Augmented Dickey-Fuller test statistic              -4.416305     0.0019
Test critical values:          1% level             -3.711457
                               5% level             -2.981038
                              10% level             -2.629906
==========================================================================
*MacKinnon (1996) one-sided p-values.


Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LGCF,2)
Method: Least Squares
Date: 12/01/21   Time: 15:09
Sample (adjusted): 5 30
Included observations: 26 after adjustments
==========================================================================
        Variable          Coefficient   Std. Error   t-Statistic    Prob.
==========================================================================
      D(LGCF(-1))          -1.363518     0.308746    -4.416305     0.0002
     D(LGCF(-1),2)          0.458796     0.234215     1.958866     0.0629
     D(LGCF(-2),2)          0.375236     0.180759     2.075897     0.0498
          C                 0.044400     0.018799     2.361887     0.0274
==========================================================================
R-squared                   0.544115   Mean dependent var        -0.009316
Adjusted R-squared          0.481949   S.D. dependent var         0.103299
S.E. of regression          0.074351   Akaike info criterion     -2.219413
Sum squared resid           0.121616   Schwarz criterion         -2.025860
Log likelihood              32.85237   Hannan-Quinn criter.      -2.163677
F-statistic                 8.752597   Durbin-Watson stat         2.157895
Prob(F-statistic)           0.000521
==========================================================================
```

LGCF at trend

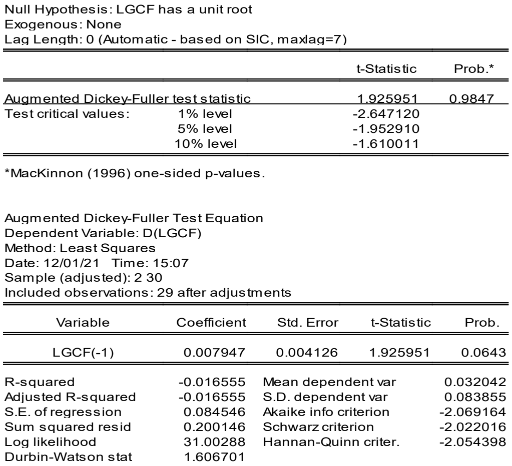


```
Null Hypothesis: LGCF has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=7)

                                              t-Statistic   Prob.*

Augmented Dickey-Fuller test statistic        -2.183769    0.4804
Test critical values:        1% level         -4.309824
                             5% level         -3.574244
                             10% level        -3.221728

*MacKinnon (1996) one-sided p-values.


Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LGCF)
Method: Least Squares
Date: 12/01/21   Time: 15:06
Sample (adjusted): 2 30
Included observations: 29 after adjustments

     Variable        Coefficient   Std. Error   t-Statistic   Prob.

     LGCF(-1)        -0.344470     0.157741     -2.183769     0.0382
        C             1.171418     0.513302      2.282121     0.0309
   @TREND("1")        0.011120     0.005979      1.859879     0.0743

R-squared              0.171080    Mean dependent var       0.032042
Adjusted R-squared     0.107317    S.D. dependent var       0.083855
S.E. of regression     0.079228    Akaike info criterion   -2.135284
Sum squared resid      0.163203    Schwarz criterion       -1.993839
Log likelihood         33.96162    Hannan-Quinn criter.    -2.090985
F-statistic            2.683063    Durbin-Watson stat       1.401652
Prob(F-statistic)      0.087229
```

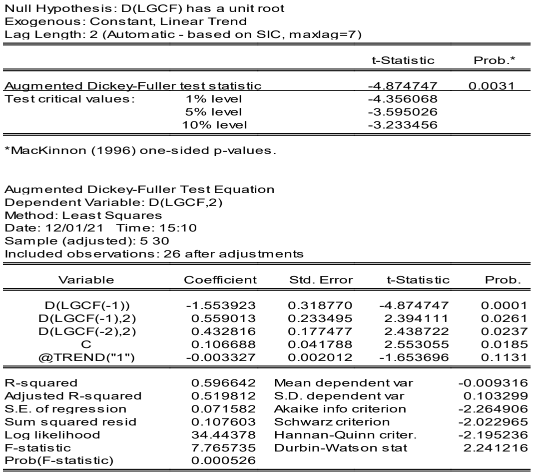


```
Null Hypothesis: D(LGCF) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 2 (Automatic - based on SIC, maxlag=7)

                                              t-Statistic   Prob.*

Augmented Dickey-Fuller test statistic        -4.874747    0.0031
Test critical values:        1% level         -4.356068
                             5% level         -3.595026
                             10% level        -3.233456

*MacKinnon (1996) one-sided p-values.


Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LGCF,2)
Method: Least Squares
Date: 12/01/21   Time: 15:10
Sample (adjusted): 5 30
Included observations: 26 after adjustments

     Variable        Coefficient   Std. Error   t-Statistic   Prob.

   D(LGCF(-1))       -1.553923     0.318770     -4.874747     0.0001
  D(LGCF(-1),2)       0.559013     0.233495      2.394111     0.0261
  D(LGCF(-2),2)       0.432816     0.177477      2.438722     0.0237
        C             0.106688     0.041788      2.553055     0.0185
   @TREND("1")       -0.003327     0.002012     -1.653696     0.1131

R-squared              0.596642    Mean dependent var      -0.009316
Adjusted R-squared     0.519812    S.D. dependent var       0.103299
S.E. of regression     0.071582    Akaike info criterion   -2.264906
Sum squared resid      0.107603    Schwarz criterion       -2.022965
Log likelihood         34.44378    Hannan-Quinn criter.    -2.195236
F-statistic            7.765735    Durbin-Watson stat       2.241216
Prob(F-statistic)      0.000526
```

LGCF at none



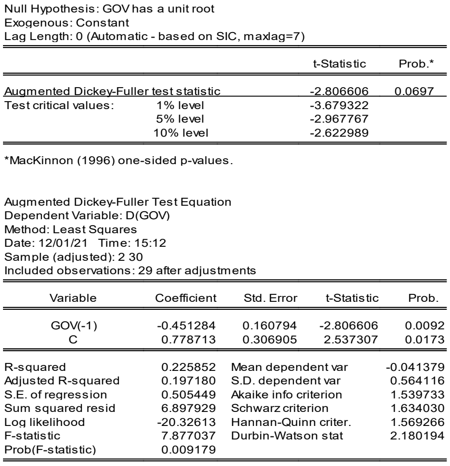
```
Null Hypothesis: LGCF has a unit root
Exogenous: None
Lag Length: 0 (Automatic - based on SIC, maxlag=7)

                                              t-Statistic   Prob.*

Augmented Dickey-Fuller test statistic         1.925951    0.9847
Test critical values:        1% level         -2.647120
                             5% level         -1.952910
                             10% level        -1.610011

*MacKinnon (1996) one-sided p-values.


Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LGCF)
Method: Least Squares
Date: 12/01/21   Time: 15:07
Sample (adjusted): 2 30
Included observations: 29 after adjustments

     Variable        Coefficient   Std. Error   t-Statistic   Prob.

     LGCF(-1)         0.007947     0.004126      1.925951     0.0643

R-squared             -0.016555    Mean dependent var       0.032042
Adjusted R-squared    -0.016555    S.D. dependent var       0.083855
S.E. of regression     0.084546    Akaike info criterion   -2.069164
Sum squared resid      0.200146    Schwarz criterion       -2.022016
Log likelihood         31.00288    Hannan-Quinn criter.    -2.054398
Durbin-Watson stat     1.606701
```



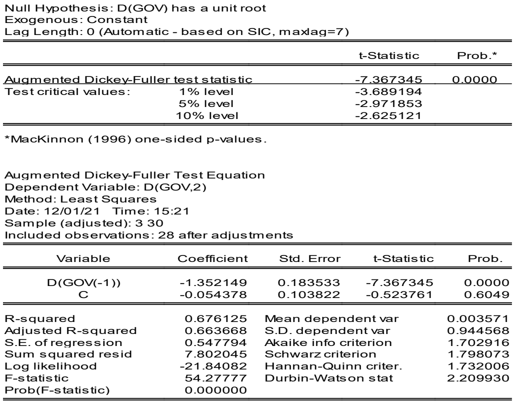
```
Null Hypothesis: D(LGCF) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 2 (Automatic - based on SIC, maxlag=7)

                                              t-Statistic   Prob.*

Augmented Dickey-Fuller test statistic        -4.874747    0.0031
Test critical values:        1% level         -4.356068
                             5% level         -3.595026
                             10% level        -3.233456

*MacKinnon (1996) one-sided p-values.


Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LGCF,2)
Method: Least Squares
Date: 12/01/21   Time: 15:10
Sample (adjusted): 5 30
Included observations: 26 after adjustments

     Variable        Coefficient   Std. Error   t-Statistic   Prob.

   D(LGCF(-1))       -1.553923     0.318770     -4.874747     0.0001
  D(LGCF(-1),2)       0.559013     0.233495      2.394111     0.0261
  D(LGCF(-2),2)       0.432816     0.177477      2.438722     0.0237
        C             0.106688     0.041788      2.553055     0.0185
   @TREND("1")       -0.003327     0.002012     -1.653696     0.1131

R-squared              0.596642    Mean dependent var      -0.009316
Adjusted R-squared     0.519812    S.D. dependent var       0.103299
S.E. of regression     0.071582    Akaike info criterion   -2.264906
Sum squared resid      0.107603    Schwarz criterion       -2.022965
Log likelihood         34.44378    Hannan-Quinn criter.    -2.195236
F-statistic            7.765735    Durbin-Watson stat       2.241216
Prob(F-statistic)      0.000526
```

Government Expenditure in Agriculture (GOV)

GOV at intercept

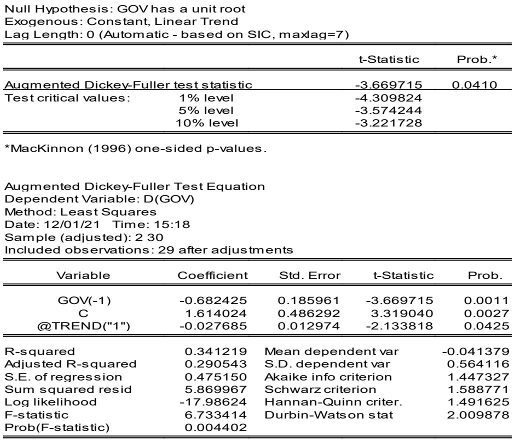


```
Null Hypothesis: GOV has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=7)

                                              t-Statistic   Prob.*

Augmented Dickey-Fuller test statistic        -2.806606    0.0697
Test critical values:        1% level         -3.679322
                             5% level         -2.967767
                             10% level        -2.622989

*MacKinnon (1996) one-sided p-values.


Augmented Dickey-Fuller Test Equation
Dependent Variable: D(GOV)
Method: Least Squares
Date: 12/01/21   Time: 15:12
Sample (adjusted): 2 30
Included observations: 29 after adjustments

     Variable        Coefficient   Std. Error   t-Statistic   Prob.

      GOV(-1)        -0.451284     0.160794     -2.806606     0.0092
        C             0.778713     0.306905      2.537307     0.0173

R-squared              0.225852    Mean dependent var      -0.041379
Adjusted R-squared     0.197180    S.D. dependent var       0.564116
S.E. of regression     0.505449    Akaike info criterion    1.539733
Sum squared resid      6.897929    Schwarz criterion        1.634030
Log likelihood        -20.32613    Hannan-Quinn criter.     1.569266
F-statistic            7.877037    Durbin-Watson stat       2.180194
Prob(F-statistic)      0.009179
```

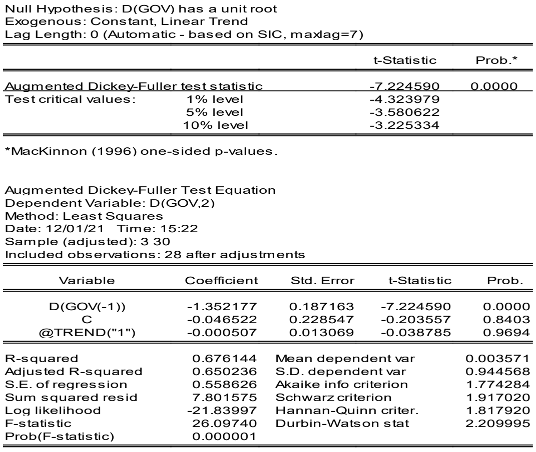


```
Null Hypothesis: D(GOV) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=7)

                                              t-Statistic   Prob.*

Augmented Dickey-Fuller test statistic        -7.367345    0.0000
Test critical values:        1% level         -3.689194
                             5% level         -2.971853
                             10% level        -2.625121

*MacKinnon (1996) one-sided p-values.


Augmented Dickey-Fuller Test Equation
Dependent Variable: D(GOV,2)
Method: Least Squares
Date: 12/01/21   Time: 15:21
Sample (adjusted): 3 30
Included observations: 28 after adjustments

     Variable        Coefficient   Std. Error   t-Statistic   Prob.

    D(GOV(-1))       -1.352149     0.183533     -7.367345     0.0000
        C            -0.054378     0.103822     -0.523761     0.6049

R-squared              0.676125    Mean dependent var       0.003571
Adjusted R-squared     0.663668    S.D. dependent var       0.944568
S.E. of regression     0.547794    Akaike info criterion    1.702916
Sum squared resid      7.802045    Schwarz criterion        1.798073
Log likelihood        -21.84082    Hannan-Quinn criter.     1.732006
F-statistic            54.27777    Durbin-Watson stat       2.209930
Prob(F-statistic)      0.000000
```

GOV at trend

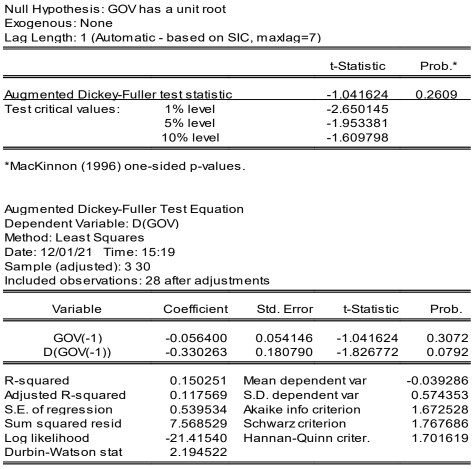


```
Null Hypothesis: GOV has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=7)

                                                  t-Statistic   Prob.*

Augmented Dickey-Fuller test statistic            -3.669715     0.0410
Test critical values:        1% level             -4.309824
                             5% level             -3.574244
                             10% level            -3.221728

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(GOV)
Method: Least Squares
Date: 12/01/21   Time: 15:18
Sample (adjusted): 2 30
Included observations: 29 after adjustments

Variable            Coefficient   Std. Error   t-Statistic   Prob.

GOV(-1)             -0.682425     0.185961     -3.669715     0.0011
C                    1.614024     0.486292      3.319040     0.0027
@TREND("1")         -0.027685     0.012974     -2.133818     0.0425

R-squared            0.341219   Mean dependent var       -0.041379
Adjusted R-squared   0.290543   S.D. dependent var        0.564116
S.E. of regression   0.475150   Akaike info criterion     1.447327
Sum squared resid    5.869967   Schwarz criterion         1.588771
Log likelihood      -17.98624   Hannan-Quinn criter.      1.491625
F-statistic          6.733414   Durbin-Watson stat        2.009878
Prob(F-statistic)    0.004402
```

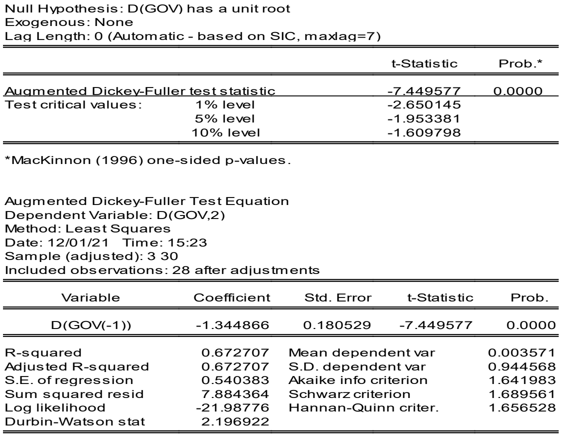


```
Null Hypothesis: D(GOV) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=7)

                                                  t-Statistic   Prob.*

Augmented Dickey-Fuller test statistic            -7.224590     0.0000
Test critical values:        1% level             -4.323979
                             5% level             -3.580622
                             10% level            -3.225334

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(GOV,2)
Method: Least Squares
Date: 12/01/21   Time: 15:22
Sample (adjusted): 3 30
Included observations: 28 after adjustments

Variable            Coefficient   Std. Error   t-Statistic   Prob.

D(GOV(-1))          -1.352177     0.187163     -7.224590     0.0000
C                   -0.046522     0.228547     -0.203557     0.8403
@TREND("1")         -0.000507     0.013069     -0.038785     0.9694

R-squared            0.676144   Mean dependent var        0.003571
Adjusted R-squared   0.650236   S.D. dependent var        0.944568
S.E. of regression   0.558626   Akaike info criterion     1.774284
Sum squared resid    7.801575   Schwarz criterion         1.917020
Log likelihood      -21.83997   Hannan-Quinn criter.      1.817920
F-statistic          26.09740   Durbin-Watson stat        2.209995
Prob(F-statistic)    0.000001
```

GOV at none



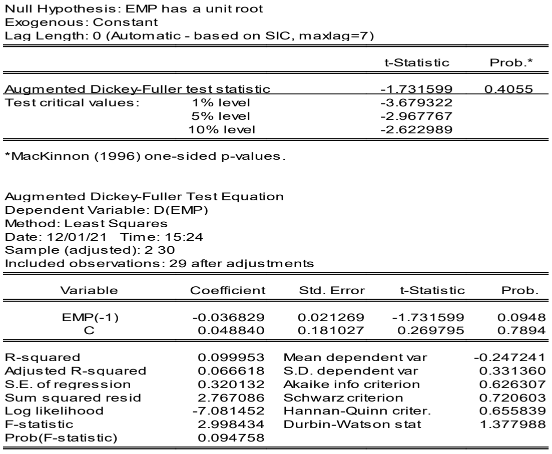
```
Null Hypothesis: GOV has a unit root
Exogenous: None
Lag Length: 1 (Automatic - based on SIC, maxlag=7)

                                                  t-Statistic   Prob.*

Augmented Dickey-Fuller test statistic            -1.041624     0.2609
Test critical values:        1% level             -2.650145
                             5% level             -1.953381
                             10% level            -1.609798

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(GOV)
Method: Least Squares
Date: 12/01/21   Time: 15:19
Sample (adjusted): 3 30
Included observations: 28 after adjustments

Variable            Coefficient   Std. Error   t-Statistic   Prob.

GOV(-1)             -0.056400     0.054146     -1.041624     0.3072
D(GOV(-1))          -0.330263     0.180790     -1.826772     0.0792

R-squared            0.150251   Mean dependent var       -0.039286
Adjusted R-squared   0.117569   S.D. dependent var        0.574353
S.E. of regression   0.539534   Akaike info criterion     1.672528
Sum squared resid    7.568529   Schwarz criterion         1.767686
Log likelihood      -21.41540   Hannan-Quinn criter.      1.701619
Durbin-Watson stat   2.194522
```



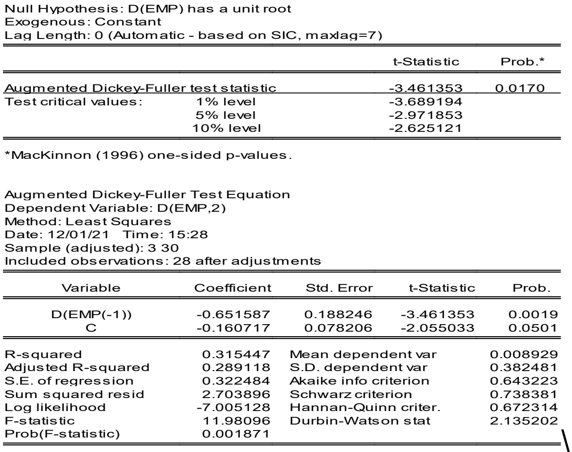
```
Null Hypothesis: D(GOV) has a unit root
Exogenous: None
Lag Length: 0 (Automatic - based on SIC, maxlag=7)

                                                  t-Statistic   Prob.*

Augmented Dickey-Fuller test statistic            -7.449577     0.0000
Test critical values:        1% level             -2.650145
                             5% level             -1.953381
                             10% level            -1.609798

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(GOV,2)
Method: Least Squares
Date: 12/01/21   Time: 15:23
Sample (adjusted): 3 30
Included observations: 28 after adjustments

Variable            Coefficient   Std. Error   t-Statistic   Prob.

D(GOV(-1))          -1.344866     0.180529     -7.449577     0.0000

R-squared            0.672707   Mean dependent var        0.003571
Adjusted R-squared   0.672707   S.D. dependent var        0.944568
S.E. of regression   0.540383   Akaike info criterion     1.641983
Sum squared resid    7.884364   Schwarz criterion         1.689561
Log likelihood      -21.98776   Hannan-Quinn criter.      1.656528
Durbin-Watson stat   2.196922
```

Employment

EMP at intercept



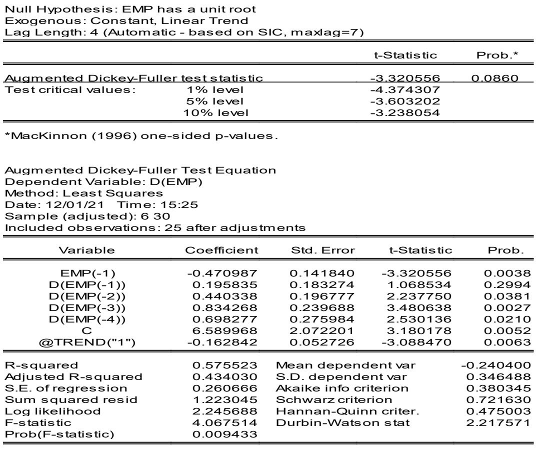
```
Null Hypothesis: EMP has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=7)

                                                  t-Statistic   Prob.*

Augmented Dickey-Fuller test statistic            -1.731599     0.4055
Test critical values:        1% level             -3.679322
                             5% level             -2.967767
                             10% level            -2.622989

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(EMP)
Method: Least Squares
Date: 12/01/21   Time: 15:24
Sample (adjusted): 2 30
Included observations: 29 after adjustments

Variable            Coefficient   Std. Error   t-Statistic   Prob.

EMP(-1)             -0.036829     0.021269     -1.731599     0.0948
C                    0.048840     0.181027      0.269795     0.7894

R-squared            0.099953   Mean dependent var       -0.247241
Adjusted R-squared   0.066618   S.D. dependent var        0.331360
S.E. of regression   0.320132   Akaike info criterion     0.626307
Sum squared resid    2.767086   Schwarz criterion         0.720603
Log likelihood      -7.081452   Hannan-Quinn criter.      0.655839
F-statistic          2.998434   Durbin-Watson stat        1.377988
Prob(F-statistic)    0.094758
```



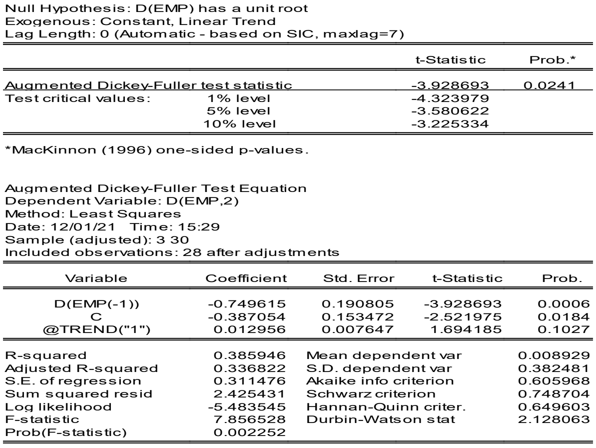
```
Null Hypothesis: D(EMP) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=7)

                                                  t-Statistic   Prob.*

Augmented Dickey-Fuller test statistic            -3.461353     0.0170
Test critical values:        1% level             -3.689194
                             5% level             -2.971853
                             10% level            -2.625121

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(EMP,2)
Method: Least Squares
Date: 12/01/21   Time: 15:28
Sample (adjusted): 3 30
Included observations: 28 after adjustments

Variable            Coefficient   Std. Error   t-Statistic   Prob.

D(EMP(-1))          -0.651587     0.188246     -3.461353     0.0019
C                   -0.160717     0.078206     -2.055033     0.0501

R-squared            0.315447   Mean dependent var        0.008929
Adjusted R-squared   0.289118   S.D. dependent var        0.382481
S.E. of regression   0.322484   Akaike info criterion     0.643223
Sum squared resid    2.703896   Schwarz criterion         0.738381
Log likelihood      -7.005128   Hannan-Quinn criter.      0.672314
F-statistic          11.98096   Durbin-Watson stat        2.135202
Prob(F-statistic)    0.001871
```

\

EMP at trend

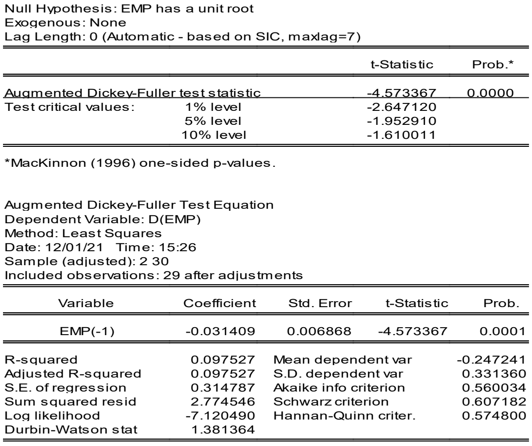


```
Null Hypothesis: EMP has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 4 (Automatic - based on SIC, maxlag=7)

                                          t-Statistic   Prob.*

Augmented Dickey-Fuller test statistic    -3.320556    0.0860
Test critical values:      1% level       -4.374307
                           5% level       -3.603202
                           10% level      -3.238054

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(EMP)
Method: Least Squares
Date: 12/01/21   Time: 15:25
Sample (adjusted): 6 30
Included observations: 25 after adjustments

Variable           Coefficient   Std. Error   t-Statistic   Prob.

EMP(-1)            -0.470987     0.141840     -3.320556     0.0038
D(EMP(-1))          0.195835     0.183274      1.068534     0.2994
D(EMP(-2))          0.440338     0.196777      2.237750     0.0381
D(EMP(-3))          0.834268     0.239688      3.480638     0.0027
D(EMP(-4))          0.698277     0.275984      2.530136     0.0210
C                   6.589968     2.072201      3.180178     0.0052
@TREND("1")        -0.162842     0.052726     -3.088470     0.0063

R-squared            0.575523   Mean dependent var      -0.240400
Adjusted R-squared   0.434030   S.D. dependent var       0.346488
S.E. of regression   0.260666   Akaike info criterion    0.380345
Sum squared resid    1.223045   Schwarz criterion        0.721630
Log likelihood       2.245688   Hannan-Quinn criter.     0.475003
F-statistic          4.067514   Durbin-Watson stat       2.217571
Prob(F-statistic)    0.009433
```

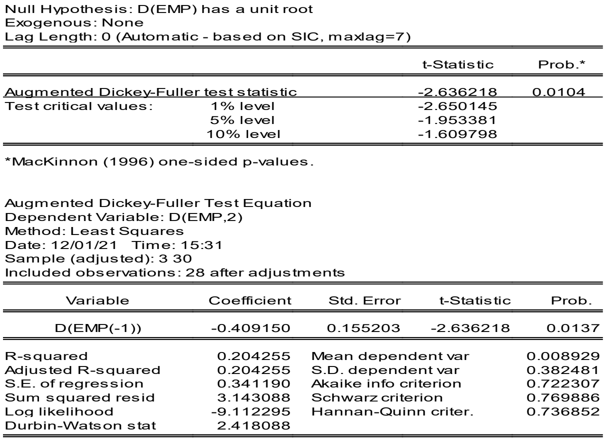


```
Null Hypothesis: D(EMP) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=7)

                                          t-Statistic   Prob.*

Augmented Dickey-Fuller test statistic    -3.928693    0.0241
Test critical values:      1% level       -4.323979
                           5% level       -3.580622
                           10% level      -3.225334

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(EMP,2)
Method: Least Squares
Date: 12/01/21   Time: 15:29
Sample (adjusted): 3 30
Included observations: 28 after adjustments

Variable           Coefficient   Std. Error   t-Statistic   Prob.

D(EMP(-1))         -0.749615     0.190805     -3.928693     0.0006
C                  -0.387054     0.153472     -2.521975     0.0184
@TREND("1")         0.012956     0.007647      1.694185     0.1027

R-squared            0.385946   Mean dependent var       0.008929
Adjusted R-squared   0.336822   S.D. dependent var       0.382481
S.E. of regression   0.311476   Akaike info criterion    0.605968
Sum squared resid    2.425431   Schwarz criterion        0.748704
Log likelihood      -5.483545   Hannan-Quinn criter.     0.649603
F-statistic          7.856528   Durbin-Watson stat       2.128063
Prob(F-statistic)    0.002252
```

EMP at none



```
Null Hypothesis: EMP has a unit root
Exogenous: None
Lag Length: 0 (Automatic - based on SIC, maxlag=7)

                                          t-Statistic   Prob.*

Augmented Dickey-Fuller test statistic    -4.573367    0.0000
Test critical values:      1% level       -2.647120
                           5% level       -1.952910
                           10% level      -1.610011

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(EMP)
Method: Least Squares
Date: 12/01/21   Time: 15:26
Sample (adjusted): 2 30
Included observations: 29 after adjustments

Variable           Coefficient   Std. Error   t-Statistic   Prob.

EMP(-1)            -0.031409     0.006868     -4.573367     0.0001

R-squared            0.097527   Mean dependent var      -0.247241
Adjusted R-squared   0.097527   S.D. dependent var       0.331360
S.E. of regression   0.314787   Akaike info criterion    0.560034
Sum squared resid    2.774546   Schwarz criterion        0.607182
Log likelihood      -7.120490   Hannan-Quinn criter.     0.574800
Durbin-Watson stat   1.381364
```

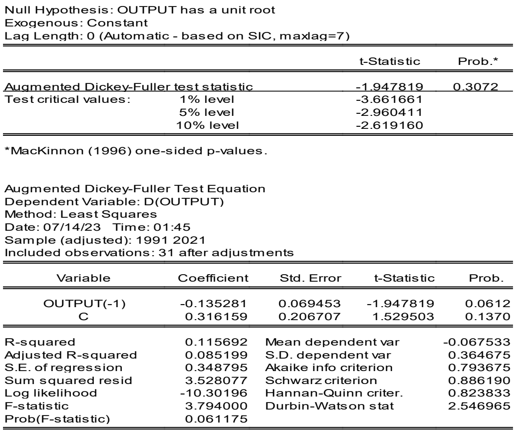


```
Null Hypothesis: D(EMP) has a unit root
Exogenous: None
Lag Length: 0 (Automatic - based on SIC, maxlag=7)

                                          t-Statistic   Prob.*

Augmented Dickey-Fuller test statistic    -2.636218    0.0104
Test critical values:      1% level       -2.650145
                           5% level       -1.953381
                           10% level      -1.609798

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(EMP,2)
Method: Least Squares
Date: 12/01/21   Time: 15:31
Sample (adjusted): 3 30
Included observations: 28 after adjustments

Variable           Coefficient   Std. Error   t-Statistic   Prob.

D(EMP(-1))         -0.409150     0.155203     -2.636218     0.0137

R-squared            0.204255   Mean dependent var       0.008929
Adjusted R-squared   0.204255   S.D. dependent var       0.382481
S.E. of regression   0.341190   Akaike info criterion    0.722307
Sum squared resid    3.143088   Schwarz criterion        0.769886
Log likelihood      -9.112295   Hannan-Quinn criter.     0.736852
Durbin-Watson stat   2.418088
```

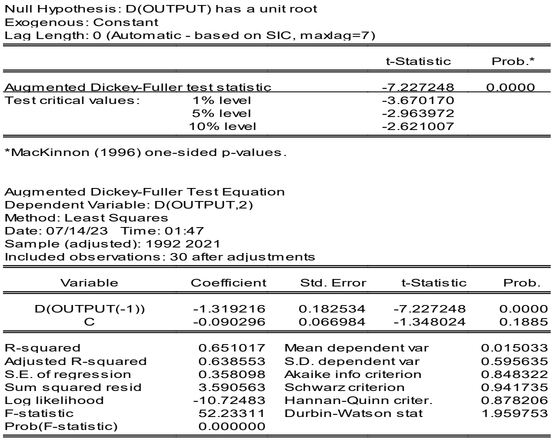
Botswana

Agricultural Output (LOUTPUT)

LOUTPUT at intercept

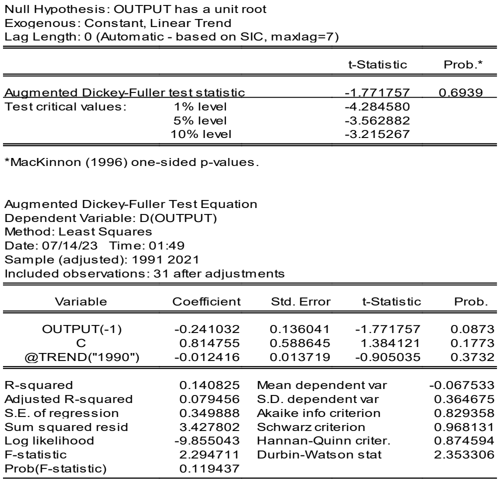


```
Null Hypothesis: OUTPUT has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=7)

                                          t-Statistic   Prob.*

Augmented Dickey-Fuller test statistic    -1.947819    0.3072
Test critical values:      1% level       -3.661661
                           5% level       -2.960411
                           10% level      -2.619160

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(OUTPUT)
Method: Least Squares
Date: 07/14/23   Time: 01:45
Sample (adjusted): 1991 2021
Included observations: 31 after adjustments

Variable           Coefficient   Std. Error   t-Statistic   Prob.

OUTPUT(-1)         -0.135281     0.069453     -1.947819     0.0612
C                   0.316159     0.206707      1.529503     0.1370

R-squared            0.115692   Mean dependent var      -0.067533
Adjusted R-squared   0.085199   S.D. dependent var       0.364675
S.E. of regression   0.348795   Akaike info criterion    0.793675
Sum squared resid    3.528077   Schwarz criterion        0.886190
Log likelihood      -10.30196   Hannan-Quinn criter.     0.823833
F-statistic          3.794000   Durbin-Watson stat       2.546965
Prob(F-statistic)    0.061175
```

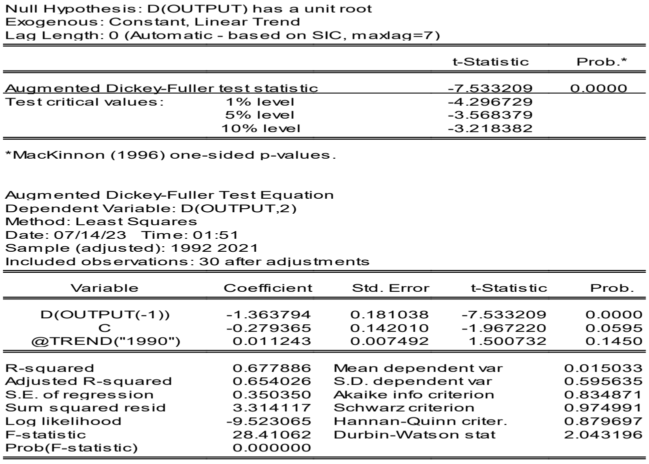


```
Null Hypothesis: D(OUTPUT) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=7)

                                          t-Statistic   Prob.*

Augmented Dickey-Fuller test statistic    -7.227248    0.0000
Test critical values:      1% level       -3.670170
                           5% level       -2.963972
                           10% level      -2.621007

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(OUTPUT,2)
Method: Least Squares
Date: 07/14/23   Time: 01:47
Sample (adjusted): 1992 2021
Included observations: 30 after adjustments

Variable           Coefficient   Std. Error   t-Statistic   Prob.

D(OUTPUT(-1))      -1.319216     0.182534     -7.227248     0.0000
C                  -0.090296     0.066984     -1.348024     0.1885

R-squared            0.651017   Mean dependent var       0.015033
Adjusted R-squared   0.638553   S.D. dependent var       0.595635
S.E. of regression   0.358098   Akaike info criterion    0.848322
Sum squared resid    3.590563   Schwarz criterion        0.941735
Log likelihood      -10.72483   Hannan-Quinn criter.     0.878206
F-statistic          52.23311   Durbin-Watson stat       1.959753
Prob(F-statistic)    0.000000
```

LOUTPUT at trend

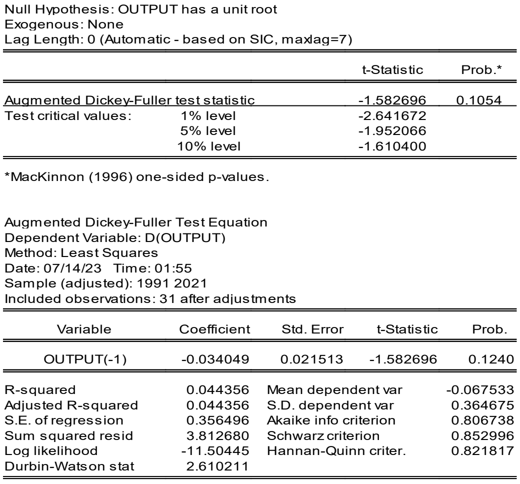


```
Null Hypothesis: OUTPUT has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=7)

                                             t-Statistic   Prob.*

Augmented Dickey-Fuller test statistic       -1.771757     0.6939
Test critical values:        1% level        -4.284580
                             5% level        -3.562882
                            10% level        -3.215267

*MacKinnon (1996) one-sided p-values.


Augmented Dickey-Fuller Test Equation
Dependent Variable: D(OUTPUT)
Method: Least Squares
Date: 07/14/23   Time: 01:49
Sample (adjusted): 1991 2021
Included observations: 31 after adjustments

      Variable        Coefficient   Std. Error   t-Statistic   Prob.

     OUTPUT(-1)        -0.241032     0.136041    -1.771757     0.0873
          C             0.814755     0.588645     1.384121     0.1773
   @TREND("1990")      -0.012416     0.013719    -0.905035     0.3732

R-squared               0.140825   Mean dependent var     -0.067533
Adjusted R-squared      0.079456   S.D. dependent var      0.364675
S.E. of regression      0.349888   Akaike info criterion   0.829358
Sum squared resid       3.427802   Schwarz criterion       0.968131
Log likelihood         -9.855043   Hannan-Quinn criter.    0.874594
F-statistic             2.294711   Durbin-Watson stat      2.353306
Prob(F-statistic)       0.119437
```

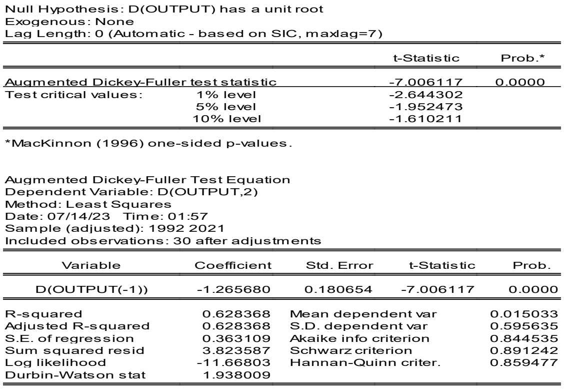


```
Null Hypothesis: D(OUTPUT) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=7)

                                             t-Statistic   Prob.*

Augmented Dickey-Fuller test statistic       -7.533209     0.0000
Test critical values:        1% level        -4.296729
                             5% level        -3.568379
                            10% level        -3.218382

*MacKinnon (1996) one-sided p-values.


Augmented Dickey-Fuller Test Equation
Dependent Variable: D(OUTPUT,2)
Method: Least Squares
Date: 07/14/23   Time: 01:51
Sample (adjusted): 1992 2021
Included observations: 30 after adjustments

      Variable        Coefficient   Std. Error   t-Statistic   Prob.

    D(OUTPUT(-1))      -1.363794     0.181038    -7.533209     0.0000
          C            -0.279365     0.142010    -1.967220     0.0595
   @TREND("1990")       0.011243     0.007492     1.500732     0.1450

R-squared               0.677886   Mean dependent var      0.015033
Adjusted R-squared      0.654026   S.D. dependent var      0.595635
S.E. of regression      0.350350   Akaike info criterion   0.834871
Sum squared resid       3.314117   Schwarz criterion       0.974991
Log likelihood         -9.523065   Hannan-Quinn criter.    0.879697
F-statistic             28.41062   Durbin-Watson stat      2.043196
Prob(F-statistic)       0.000000
```

LOUTPUT at none



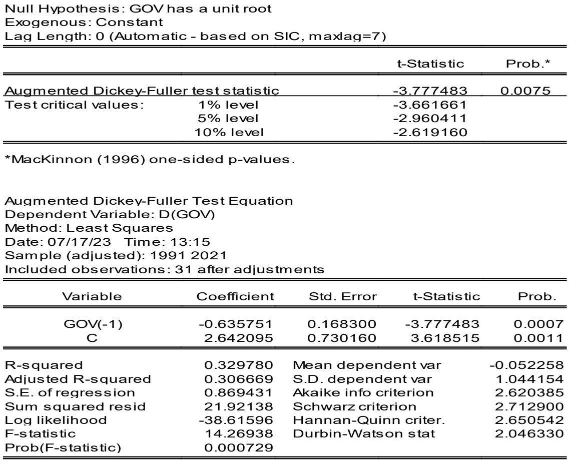
```
Null Hypothesis: OUTPUT has a unit root
Exogenous: None
Lag Length: 0 (Automatic - based on SIC, maxlag=7)

                                             t-Statistic   Prob.*

Augmented Dickey-Fuller test statistic       -1.582696     0.1054
Test critical values:        1% level        -2.641672
                             5% level        -1.952066
                            10% level        -1.610400

*MacKinnon (1996) one-sided p-values.


Augmented Dickey-Fuller Test Equation
Dependent Variable: D(OUTPUT)
Method: Least Squares
Date: 07/14/23   Time: 01:55
Sample (adjusted): 1991 2021
Included observations: 31 after adjustments

      Variable        Coefficient   Std. Error   t-Statistic   Prob.

     OUTPUT(-1)        -0.034049     0.021513    -1.582696     0.1240

R-squared               0.044356   Mean dependent var     -0.067533
Adjusted R-squared      0.044356   S.D. dependent var      0.364675
S.E. of regression      0.356496   Akaike info criterion   0.806738
Sum squared resid       3.812680   Schwarz criterion       0.852996
Log likelihood         -11.50445   Hannan-Quinn criter.    0.821817
Durbin-Watson stat      2.610211
```



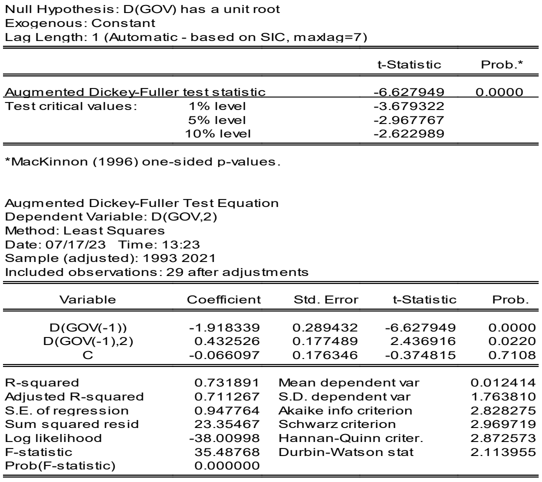
```
Null Hypothesis: D(OUTPUT) has a unit root
Exogenous: None
Lag Length: 0 (Automatic - based on SIC, maxlag=7)

                                             t-Statistic   Prob.*

Augmented Dickey-Fuller test statistic       -7.006117     0.0000
Test critical values:        1% level        -2.644302
                             5% level        -1.952473
                            10% level        -1.610211

*MacKinnon (1996) one-sided p-values.


Augmented Dickey-Fuller Test Equation
Dependent Variable: D(OUTPUT,2)
Method: Least Squares
Date: 07/14/23   Time: 01:57
Sample (adjusted): 1992 2021
Included observations: 30 after adjustments

      Variable        Coefficient   Std. Error   t-Statistic   Prob.

    D(OUTPUT(-1))      -1.265680     0.180654    -7.006117     0.0000

R-squared               0.628368   Mean dependent var      0.015033
Adjusted R-squared      0.628368   S.D. dependent var      0.595635
S.E. of regression      0.363109   Akaike info criterion   0.844535
Sum squared resid       3.823587   Schwarz criterion       0.891242
Log likelihood         -11.66803   Hannan-Quinn criter.    0.859477
Durbin-Watson stat      1.938009
```

Government Expenditure in Agriculture (GOV)

GOV at intercept

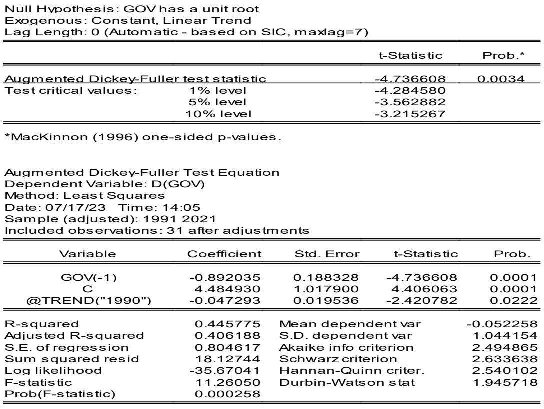


```
Null Hypothesis: GOV has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=7)

                                             t-Statistic   Prob.*

Augmented Dickey-Fuller test statistic       -3.777483     0.0075
Test critical values:        1% level        -3.661661
                             5% level        -2.960411
                            10% level        -2.619160

*MacKinnon (1996) one-sided p-values.


Augmented Dickey-Fuller Test Equation
Dependent Variable: D(GOV)
Method: Least Squares
Date: 07/17/23   Time: 13:15
Sample (adjusted): 1991 2021
Included observations: 31 after adjustments

      Variable        Coefficient   Std. Error   t-Statistic   Prob.

       GOV(-1)         -0.635751     0.168300    -3.777483     0.0007
          C             2.642095     0.730160     3.618515     0.0011

R-squared               0.329780   Mean dependent var     -0.052258
Adjusted R-squared      0.306669   S.D. dependent var      1.044154
S.E. of regression      0.869431   Akaike info criterion   2.620385
Sum squared resid       21.92138   Schwarz criterion       2.712900
Log likelihood         -38.61596   Hannan-Quinn criter.    2.650542
F-statistic             14.26938   Durbin-Watson stat      2.046330
Prob(F-statistic)       0.000729
```

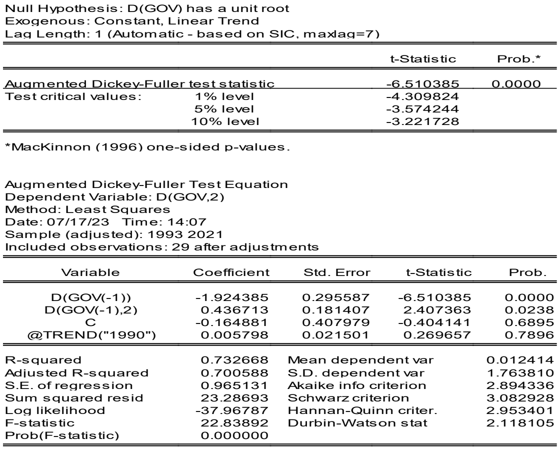


```
Null Hypothesis: D(GOV) has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on SIC, maxlag=7)

                                             t-Statistic   Prob.*

Augmented Dickey-Fuller test statistic       -6.627949     0.0000
Test critical values:        1% level        -3.679322
                             5% level        -2.967767
                            10% level        -2.622989

*MacKinnon (1996) one-sided p-values.


Augmented Dickey-Fuller Test Equation
Dependent Variable: D(GOV,2)
Method: Least Squares
Date: 07/17/23   Time: 13:23
Sample (adjusted): 1993 2021
Included observations: 29 after adjustments

      Variable        Coefficient   Std. Error   t-Statistic   Prob.

      D(GOV(-1))       -1.918339     0.289432    -6.627949     0.0000
     D(GOV(-1),2)       0.432526     0.177489     2.436916     0.0220
          C            -0.066097     0.176346    -0.374815     0.7108

R-squared               0.731891   Mean dependent var      0.012414
Adjusted R-squared      0.711267   S.D. dependent var      1.763810
S.E. of regression      0.947764   Akaike info criterion   2.828275
Sum squared resid       23.35467   Schwarz criterion       2.969719
Log likelihood         -38.00998   Hannan-Quinn criter.    2.872573
F-statistic             35.48768   Durbin-Watson stat      2.113955
Prob(F-statistic)       0.000000
```

GOV at trend



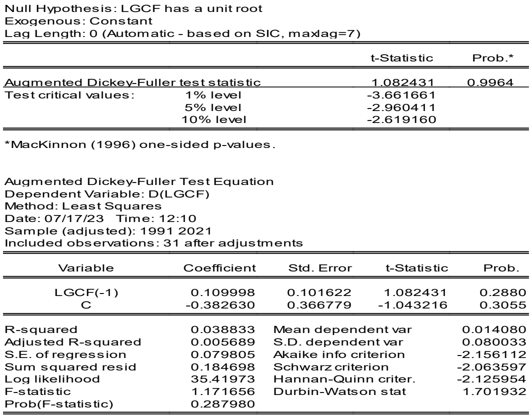
```
Null Hypothesis: GOV has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=7)

                                                   t-Statistic   Prob.*

Augmented Dickey-Fuller test statistic             -4.736608     0.0034
Test critical values:        1% level              -4.284580
                             5% level              -3.562882
                             10% level             -3.215267

*MacKinnon (1996) one-sided p-values.


Augmented Dickey-Fuller Test Equation
Dependent Variable: D(GOV)
Method: Least Squares
Date: 07/17/23   Time: 14:05
Sample (adjusted): 1991 2021
Included observations: 31 after adjustments

        Variable        Coefficient   Std. Error   t-Statistic   Prob.

        GOV(-1)         -0.892035     0.188328     -4.736608     0.0001
           C             4.484930     1.017900      4.406063     0.0001
   @TREND("1990")       -0.047293     0.019536     -2.420782     0.0222

R-squared                0.445775   Mean dependent var     -0.052258
Adjusted R-squared       0.406188   S.D. dependent var      1.044154
S.E. of regression       0.804617   Akaike info criterion   2.494865
Sum squared resid        18.12744   Schwarz criterion       2.633638
Log likelihood          -35.67041   Hannan-Quinn criter.    2.540102
F-statistic              11.26050   Durbin-Watson stat      1.945718
Prob(F-statistic)        0.000258
```



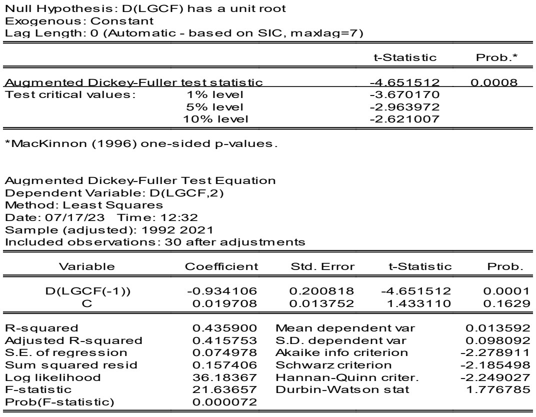
```
Null Hypothesis: D(GOV) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 1 (Automatic - based on SIC, maxlag=7)

                                                   t-Statistic   Prob.*

Augmented Dickey-Fuller test statistic             -6.510385     0.0000
Test critical values:        1% level              -4.309824
                             5% level              -3.574244
                             10% level             -3.221728

*MacKinnon (1996) one-sided p-values.


Augmented Dickey-Fuller Test Equation
Dependent Variable: D(GOV,2)
Method: Least Squares
Date: 07/17/23   Time: 14:07
Sample (adjusted): 1993 2021
Included observations: 29 after adjustments

        Variable        Coefficient   Std. Error   t-Statistic   Prob.

      D(GOV(-1))        -1.924385     0.295587     -6.510385     0.0000
     D(GOV(-1),2)        0.436713     0.181407      2.407363     0.0238
           C            -0.164881     0.407979     -0.404141     0.6895
   @TREND("1990")        0.005798     0.021501      0.269657     0.7896

R-squared                0.732668   Mean dependent var      0.012414
Adjusted R-squared       0.700588   S.D. dependent var      1.763810
S.E. of regression       0.965131   Akaike info criterion   2.894336
Sum squared resid        23.28693   Schwarz criterion       3.082928
Log likelihood          -37.96787   Hannan-Quinn criter.    2.953401
F-statistic              22.83892   Durbin-Watson stat      2.118105
Prob(F-statistic)        0.000000
```

Private Investment in Agriculture (LGCF)

LGCF at intercept

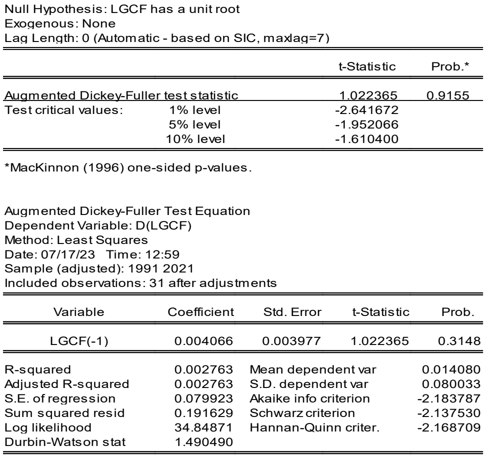


```
Null Hypothesis: LGCF has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=7)

                                                   t-Statistic   Prob.*

Augmented Dickey-Fuller test statistic              1.082431     0.9964
Test critical values:        1% level              -3.661661
                             5% level              -2.960411
                             10% level             -2.619160

*MacKinnon (1996) one-sided p-values.


Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LGCF)
Method: Least Squares
Date: 07/17/23   Time: 12:10
Sample (adjusted): 1991 2021
Included observations: 31 after adjustments

        Variable        Coefficient   Std. Error   t-Statistic   Prob.

        LGCF(-1)         0.109998     0.101622      1.082431     0.2880
           C            -0.382630     0.366779     -1.043216     0.3055

R-squared                0.038833   Mean dependent var      0.014080
Adjusted R-squared       0.005689   S.D. dependent var      0.080033
S.E. of regression       0.079805   Akaike info criterion  -2.156112
Sum squared resid        0.184698   Schwarz criterion      -2.063597
Log likelihood           35.41973   Hannan-Quinn criter.   -2.125954
F-statistic              1.171656   Durbin-Watson stat      1.701932
Prob(F-statistic)        0.287980
```

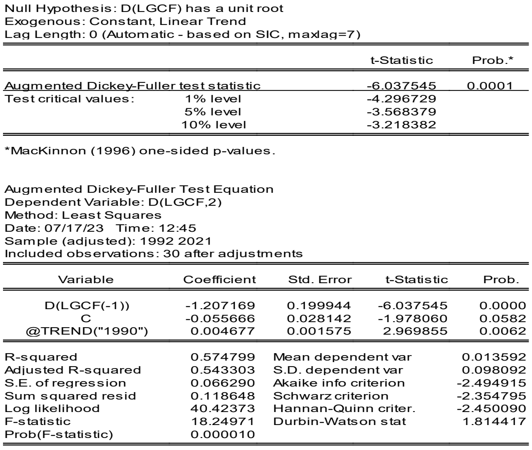


```
Null Hypothesis: D(LGCF) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=7)

                                                   t-Statistic   Prob.*

Augmented Dickey-Fuller test statistic             -4.651512     0.0008
Test critical values:        1% level              -3.670170
                             5% level              -2.963972
                             10% level             -2.621007

*MacKinnon (1996) one-sided p-values.


Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LGCF,2)
Method: Least Squares
Date: 07/17/23   Time: 12:32
Sample (adjusted): 1992 2021
Included observations: 30 after adjustments

        Variable        Coefficient   Std. Error   t-Statistic   Prob.

      D(LGCF(-1))       -0.934106     0.200818     -4.651512     0.0001
           C             0.019708     0.013752      1.433110     0.1629

R-squared                0.435900   Mean dependent var      0.013592
Adjusted R-squared       0.415753   S.D. dependent var      0.098092
S.E. of regression       0.074978   Akaike info criterion  -2.278911
Sum squared resid        0.157406   Schwarz criterion      -2.185498
Log likelihood           36.18367   Hannan-Quinn criter.   -2.249027
F-statistic              21.63657   Durbin-Watson stat      1.776785
Prob(F-statistic)        0.000072
```

LGCF at trend

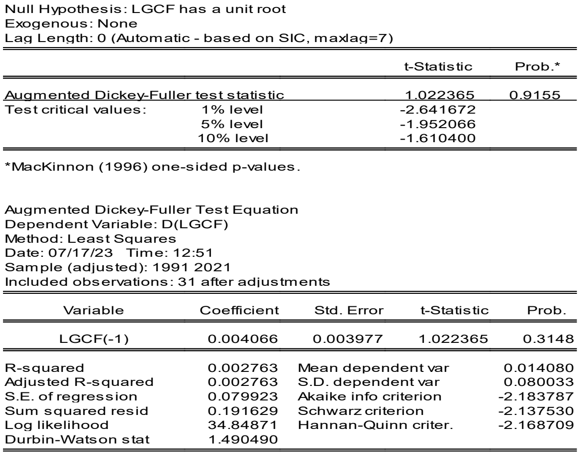


```
Null Hypothesis: LGCF has a unit root
Exogenous: None
Lag Length: 0 (Automatic - based on SIC, maxlag=7)

                                                   t-Statistic   Prob.*

Augmented Dickey-Fuller test statistic              1.022365     0.9155
Test critical values:        1% level              -2.641672
                             5% level              -1.952066
                             10% level             -1.610400

*MacKinnon (1996) one-sided p-values.


Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LGCF)
Method: Least Squares
Date: 07/17/23   Time: 12:59
Sample (adjusted): 1991 2021
Included observations: 31 after adjustments

        Variable        Coefficient   Std. Error   t-Statistic   Prob.

        LGCF(-1)         0.004066     0.003977      1.022365     0.3148

R-squared                0.002763   Mean dependent var      0.014080
Adjusted R-squared       0.002763   S.D. dependent var      0.080033
S.E. of regression       0.079923   Akaike info criterion  -2.183787
Sum squared resid        0.191629   Schwarz criterion      -2.137530
Log likelihood           34.84871   Hannan-Quinn criter.   -2.168709
Durbin-Watson stat       1.490490
```

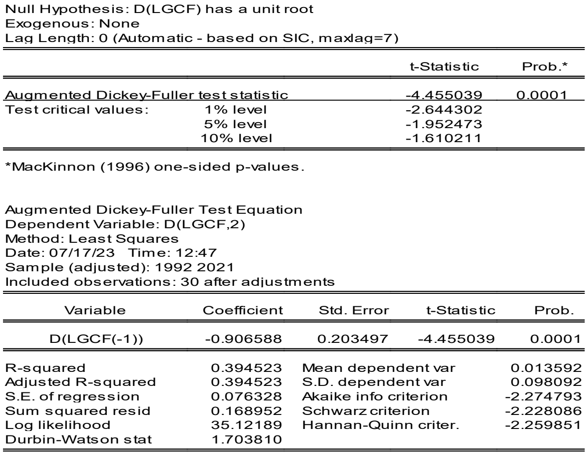


```
Null Hypothesis: D(LGCF) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=7)

                                                   t-Statistic   Prob.*

Augmented Dickey-Fuller test statistic             -6.037545     0.0001
Test critical values:        1% level              -4.296729
                             5% level              -3.568379
                             10% level             -3.218382

*MacKinnon (1996) one-sided p-values.


Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LGCF,2)
Method: Least Squares
Date: 07/17/23   Time: 12:45
Sample (adjusted): 1992 2021
Included observations: 30 after adjustments

        Variable        Coefficient   Std. Error   t-Statistic   Prob.

      D(LGCF(-1))       -1.207169     0.199944     -6.037545     0.0000
           C            -0.055666     0.028142     -1.978060     0.0582
   @TREND("1990")        0.004677     0.001575      2.969855     0.0062

R-squared                0.574799   Mean dependent var      0.013592
Adjusted R-squared       0.543303   S.D. dependent var      0.098092
S.E. of regression       0.066290   Akaike info criterion  -2.494915
Sum squared resid        0.118648   Schwarz criterion      -2.354795
Log likelihood           40.42373   Hannan-Quinn criter.   -2.450090
F-statistic              18.24971   Durbin-Watson stat      1.814417
Prob(F-statistic)        0.000010
```

LGCF at none



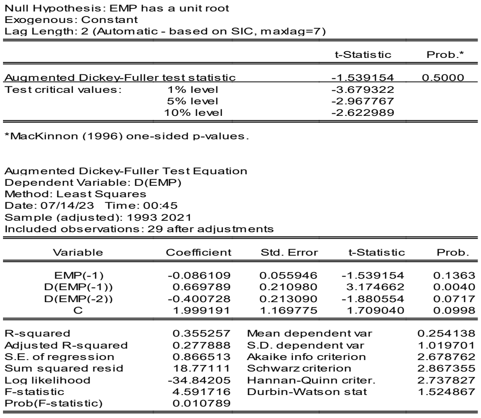
```
Null Hypothesis: LGCF has a unit root
Exogenous: None
Lag Length: 0 (Automatic - based on SIC, maxlag=7)
==========================================================================
                                              t-Statistic     Prob.*
==========================================================================
Augmented Dickey-Fuller test statistic         1.022365      0.9155
Test critical values:        1% level         -2.641672
                             5% level         -1.952066
                            10% level         -1.610400
==========================================================================
*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LGCF)
Method: Least Squares
Date: 07/17/23   Time: 12:51
Sample (adjusted): 1991 2021
Included observations: 31 after adjustments
==========================================================================
    Variable        Coefficient    Std. Error    t-Statistic     Prob.
==========================================================================
    LGCF(-1)         0.004066      0.003977      1.022365      0.3148
==========================================================================
R-squared             0.002763    Mean dependent var          0.014080
Adjusted R-squared    0.002763    S.D. dependent var          0.080033
S.E. of regression    0.079923    Akaike info criterion      -2.183787
Sum squared resid     0.191629    Schwarz criterion          -2.137530
Log likelihood        34.84871    Hannan-Quinn criter.       -2.168709
Durbin-Watson stat    1.490490
==========================================================================
```



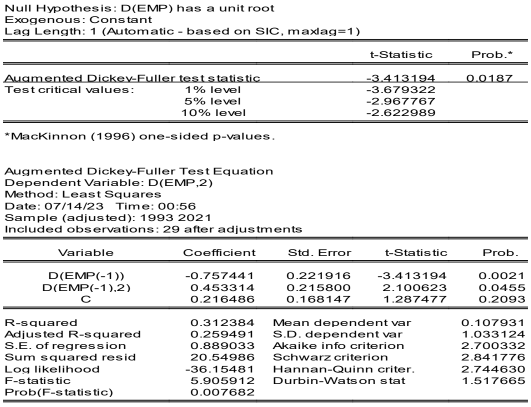
```
Null Hypothesis: D(LGCF) has a unit root
Exogenous: None
Lag Length: 0 (Automatic - based on SIC, maxlag=7)
==========================================================================
                                              t-Statistic     Prob.*
==========================================================================
Augmented Dickey-Fuller test statistic        -4.455039      0.0001
Test critical values:        1% level         -2.644302
                             5% level         -1.952473
                            10% level         -1.610211
==========================================================================
*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LGCF,2)
Method: Least Squares
Date: 07/17/23   Time: 12:47
Sample (adjusted): 1992 2021
Included observations: 30 after adjustments
==========================================================================
    Variable        Coefficient    Std. Error    t-Statistic     Prob.
==========================================================================
  D(LGCF(-1))       -0.906588      0.203497     -4.455039      0.0001
==========================================================================
R-squared             0.394523    Mean dependent var          0.013592
Adjusted R-squared    0.394523    S.D. dependent var          0.098092
S.E. of regression    0.076328    Akaike info criterion      -2.274793
Sum squared resid     0.168952    Schwarz criterion          -2.228086
Log likelihood        35.12189    Hannan-Quinn criter.       -2.259851
Durbin-Watson stat    1.703810
==========================================================================
```

Employment in Agriculture (EMP)

EMP at Intercept

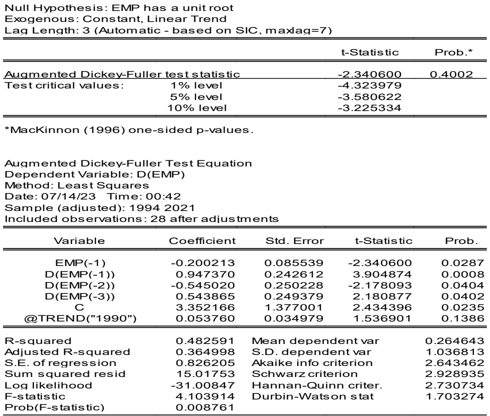


```
Null Hypothesis: EMP has a unit root
Exogenous: Constant
Lag Length: 2 (Automatic - based on SIC, maxlag=7)
==========================================================================
                                              t-Statistic     Prob.*
==========================================================================
Augmented Dickey-Fuller test statistic        -1.539154      0.5000
Test critical values:        1% level         -3.679322
                             5% level         -2.967767
                            10% level         -2.622989
==========================================================================
*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(EMP)
Method: Least Squares
Date: 07/14/23   Time: 00:45
Sample (adjusted): 1993 2021
Included observations: 29 after adjustments
==========================================================================
    Variable        Coefficient    Std. Error    t-Statistic     Prob.
==========================================================================
     EMP(-1)        -0.086109      0.055946     -1.539154      0.1363
   D(EMP(-1))        0.669789      0.210980      3.174662      0.0040
   D(EMP(-2))       -0.400728      0.213090     -1.880554      0.0717
        C            1.999191      1.169775      1.709040      0.0998
==========================================================================
R-squared             0.355257    Mean dependent var          0.254138
Adjusted R-squared    0.277888    S.D. dependent var          1.019701
S.E. of regression    0.866513    Akaike info criterion       2.678762
Sum squared resid     18.77111    Schwarz criterion           2.867355
Log likelihood       -34.84205    Hannan-Quinn criter.        2.737827
F-statistic           4.591716    Durbin-Watson stat          1.524867
Prob(F-statistic)     0.010789
==========================================================================
```

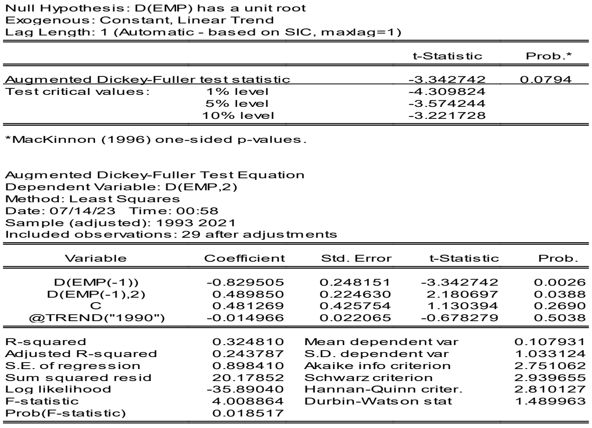


```
Null Hypothesis: D(EMP) has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on SIC, maxlag=1)
==========================================================================
                                              t-Statistic     Prob.*
==========================================================================
Augmented Dickey-Fuller test statistic        -3.413194      0.0187
Test critical values:        1% level         -3.679322
                             5% level         -2.967767
                            10% level         -2.622989
==========================================================================
*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(EMP,2)
Method: Least Squares
Date: 07/14/23   Time: 00:56
Sample (adjusted): 1993 2021
Included observations: 29 after adjustments
==========================================================================
    Variable        Coefficient    Std. Error    t-Statistic     Prob.
==========================================================================
   D(EMP(-1))       -0.757441      0.221916     -3.413194      0.0021
  D(EMP(-1),2)       0.453314      0.215800      2.100623      0.0455
        C            0.216486      0.168147      1.287477      0.2093
==========================================================================
R-squared             0.312384    Mean dependent var          0.107931
Adjusted R-squared    0.259491    S.D. dependent var          1.033124
S.E. of regression    0.889033    Akaike info criterion       2.700332
Sum squared resid     20.54986    Schwarz criterion           2.841776
Log likelihood       -36.15481    Hannan-Quinn criter.        2.744630
F-statistic           5.905912    Durbin-Watson stat          1.517665
Prob(F-statistic)     0.007682
==========================================================================
```

EMP at Trend and intercept

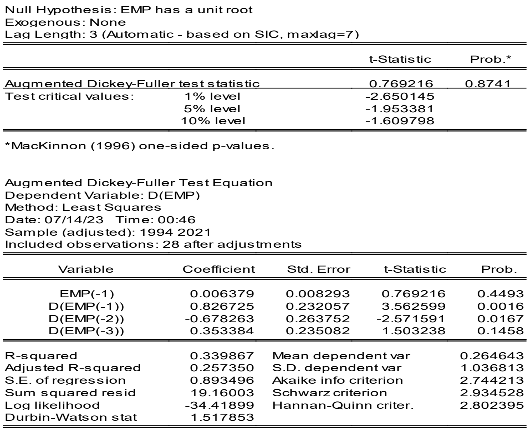


```
Null Hypothesis: EMP has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 3 (Automatic - based on SIC, maxlag=7)
==========================================================================
                                              t-Statistic     Prob.*
==========================================================================
Augmented Dickey-Fuller test statistic        -2.340600      0.4002
Test critical values:        1% level         -4.323979
                             5% level         -3.580622
                            10% level         -3.225334
==========================================================================
*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(EMP)
Method: Least Squares
Date: 07/14/23   Time: 00:42
Sample (adjusted): 1994 2021
Included observations: 28 after adjustments
==========================================================================
    Variable        Coefficient    Std. Error    t-Statistic     Prob.
==========================================================================
     EMP(-1)        -0.200213      0.085539     -2.340600      0.0287
   D(EMP(-1))        0.947370      0.242612      3.904874      0.0008
   D(EMP(-2))       -0.545020      0.250228     -2.178093      0.0404
   D(EMP(-3))        0.543865      0.249379      2.180877      0.0402
        C            3.352166      1.377001      2.434396      0.0235
 @TREND("1990")      0.053760      0.034979      1.536901      0.1386
==========================================================================
R-squared             0.482591    Mean dependent var          0.264643
Adjusted R-squared    0.364998    S.D. dependent var          1.036813
S.E. of regression    0.826205    Akaike info criterion       2.643462
Sum squared resid     15.01753    Schwarz criterion           2.928935
Log likelihood       -31.00847    Hannan-Quinn criter.        2.730734
F-statistic           4.103914    Durbin-Watson stat          1.703274
Prob(F-statistic)     0.008761
==========================================================================
```

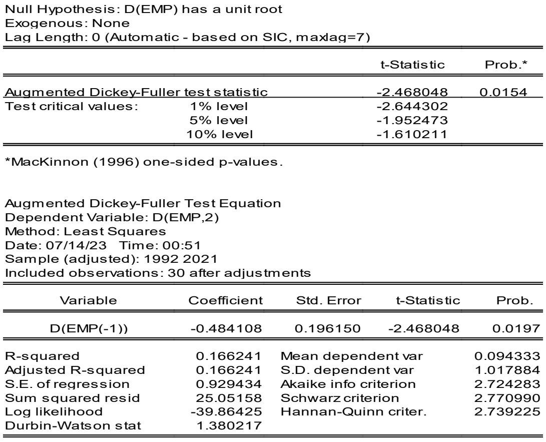


```
Null Hypothesis: D(EMP) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 1 (Automatic - based on SIC, maxlag=1)
==========================================================================
                                              t-Statistic     Prob.*
==========================================================================
Augmented Dickey-Fuller test statistic        -3.342742      0.0794
Test critical values:        1% level         -4.309824
                             5% level         -3.574244
                            10% level         -3.221728
==========================================================================
*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(EMP,2)
Method: Least Squares
Date: 07/14/23   Time: 00:58
Sample (adjusted): 1993 2021
Included observations: 29 after adjustments
==========================================================================
    Variable        Coefficient    Std. Error    t-Statistic     Prob.
==========================================================================
   D(EMP(-1))       -0.829505      0.248151     -3.342742      0.0026
  D(EMP(-1),2)       0.489850      0.224630      2.180697      0.0388
        C            0.481269      0.425754      1.130394      0.2690
 @TREND("1990")     -0.014966      0.022065     -0.678279      0.5038
==========================================================================
R-squared             0.324810    Mean dependent var          0.107931
Adjusted R-squared    0.243787    S.D. dependent var          1.033124
S.E. of regression    0.898410    Akaike info criterion       2.751062
Sum squared resid     20.17852    Schwarz criterion           2.939655
Log likelihood       -35.89040    Hannan-Quinn criter.        2.810127
F-statistic           4.008864    Durbin-Watson stat          1.489963
Prob(F-statistic)     0.018517
==========================================================================
```

EMP at none



```
Null Hypothesis: EMP has a unit root
Exogenous: None
Lag Length: 3 (Automatic - based on SIC, maxlag=7)

                                              t-Statistic   Prob.*

Augmented Dickey-Fuller test statistic         0.769216     0.8741
Test critical values:      1% level           -2.650145
                           5% level           -1.953381
                          10% level           -1.609798

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(EMP)
Method: Least Squares
Date: 07/14/23   Time: 00:46
Sample (adjusted): 1994 2021
Included observations: 28 after adjustments

     Variable        Coefficient   Std. Error   t-Statistic   Prob.

     EMP(-1)          0.006379     0.008293     0.769216     0.4493
    D(EMP(-1))        0.826725     0.232057     3.562599     0.0016
    D(EMP(-2))       -0.678263     0.263752    -2.571591     0.0167
    D(EMP(-3))        0.353384     0.235082     1.503238     0.1458

R-squared             0.339867   Mean dependent var       0.264643
Adjusted R-squared    0.257350   S.D. dependent var       1.036813
S.E. of regression    0.893496   Akaike info criterion    2.744213
Sum squared resid     19.16003   Schwarz criterion        2.934528
Log likelihood       -34.41899   Hannan-Quinn criter.     2.802395
Durbin-Watson stat    1.517853
```

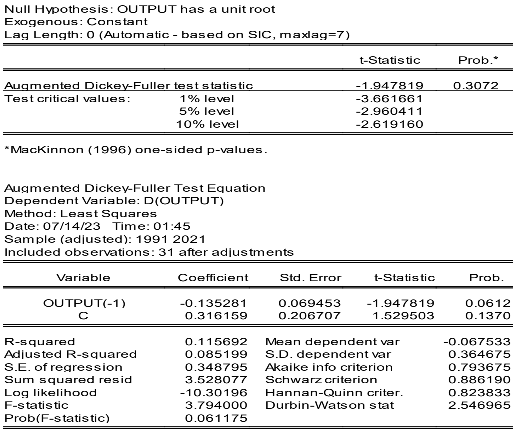


```
Null Hypothesis: D(EMP) has a unit root
Exogenous: None
Lag Length: 0 (Automatic - based on SIC, maxlag=7)

                                              t-Statistic   Prob.*

Augmented Dickey-Fuller test statistic        -2.468048     0.0154
Test critical values:      1% level           -2.644302
                           5% level           -1.952473
                          10% level           -1.610211

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(EMP,2)
Method: Least Squares
Date: 07/14/23   Time: 00:51
Sample (adjusted): 1992 2021
Included observations: 30 after adjustments

     Variable        Coefficient   Std. Error   t-Statistic   Prob.

    D(EMP(-1))       -0.484108     0.196150    -2.468048     0.0197

R-squared             0.166241   Mean dependent var       0.094333
Adjusted R-squared    0.166241   S.D. dependent var       1.017884
S.E. of regression    0.929434   Akaike info criterion    2.724283
Sum squared resid     25.05158   Schwarz criterion        2.770990
Log likelihood       -39.86425   Hannan-Quinn criter.     2.739225
Durbin-Watson stat    1.380217
```

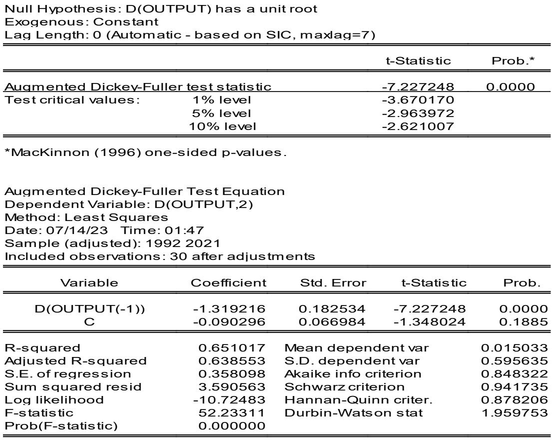
Namibia

Agricultural Output

LOUTPUT at intercept

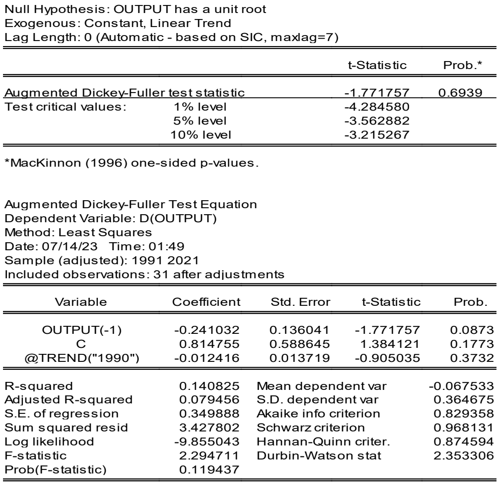


```
Null Hypothesis: OUTPUT has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=7)

                                              t-Statistic   Prob.*

Augmented Dickey-Fuller test statistic        -1.947819     0.3072
Test critical values:      1% level           -3.661661
                           5% level           -2.960411
                          10% level           -2.619160

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(OUTPUT)
Method: Least Squares
Date: 07/14/23   Time: 01:45
Sample (adjusted): 1991 2021
Included observations: 31 after adjustments

     Variable        Coefficient   Std. Error   t-Statistic   Prob.

    OUTPUT(-1)       -0.135281     0.069453    -1.947819     0.0612
        C             0.316159     0.206707     1.529503     0.1370

R-squared             0.115692   Mean dependent var      -0.067533
Adjusted R-squared    0.085199   S.D. dependent var       0.364675
S.E. of regression    0.348795   Akaike info criterion    0.793675
Sum squared resid     3.528077   Schwarz criterion        0.886190
Log likelihood       -10.30196   Hannan-Quinn criter.     0.823833
F-statistic           3.794000   Durbin-Watson stat       2.546965
Prob(F-statistic)     0.061175
```

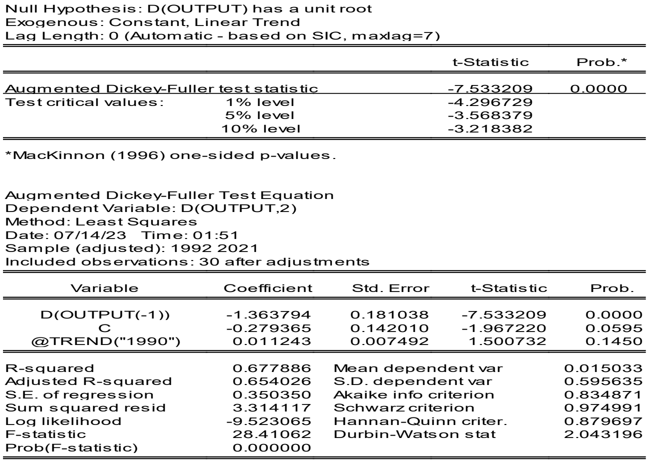


```
Null Hypothesis: D(OUTPUT) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=7)

                                              t-Statistic   Prob.*

Augmented Dickey-Fuller test statistic        -7.227248     0.0000
Test critical values:      1% level           -3.670170
                           5% level           -2.963972
                          10% level           -2.621007

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(OUTPUT,2)
Method: Least Squares
Date: 07/14/23   Time: 01:47
Sample (adjusted): 1992 2021
Included observations: 30 after adjustments

     Variable        Coefficient   Std. Error   t-Statistic   Prob.

  D(OUTPUT(-1))      -1.319216     0.182534    -7.227248     0.0000
        C            -0.090296     0.066984    -1.348024     0.1885

R-squared             0.651017   Mean dependent var       0.015033
Adjusted R-squared    0.638553   S.D. dependent var       0.595635
S.E. of regression    0.358098   Akaike info criterion    0.848322
Sum squared resid     3.590563   Schwarz criterion        0.941735
Log likelihood       -10.72483   Hannan-Quinn criter.     0.878206
F-statistic           52.23311   Durbin-Watson stat       1.959753
Prob(F-statistic)     0.000000
```

LOUTPUT at trend

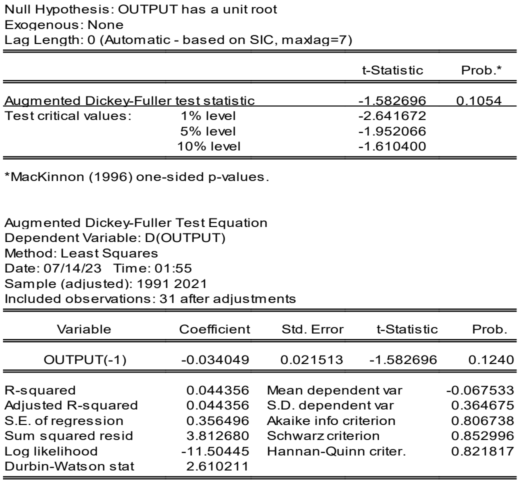


```
Null Hypothesis: OUTPUT has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=7)

                                              t-Statistic   Prob.*

Augmented Dickey-Fuller test statistic        -1.771757     0.6939
Test critical values:      1% level           -4.284580
                           5% level           -3.562882
                          10% level           -3.215267

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(OUTPUT)
Method: Least Squares
Date: 07/14/23   Time: 01:49
Sample (adjusted): 1991 2021
Included observations: 31 after adjustments

     Variable        Coefficient   Std. Error   t-Statistic   Prob.

    OUTPUT(-1)       -0.241032     0.136041    -1.771757     0.0873
        C             0.814755     0.588645     1.384121     0.1773
  @TREND("1990")     -0.012416     0.013719    -0.905035     0.3732

R-squared             0.140825   Mean dependent var      -0.067533
Adjusted R-squared    0.079456   S.D. dependent var       0.364675
S.E. of regression    0.349888   Akaike info criterion    0.829358
Sum squared resid     3.427802   Schwarz criterion        0.968131
Log likelihood       -9.855043   Hannan-Quinn criter.     0.874594
F-statistic           2.294711   Durbin-Watson stat       2.353306
Prob(F-statistic)     0.119437
```

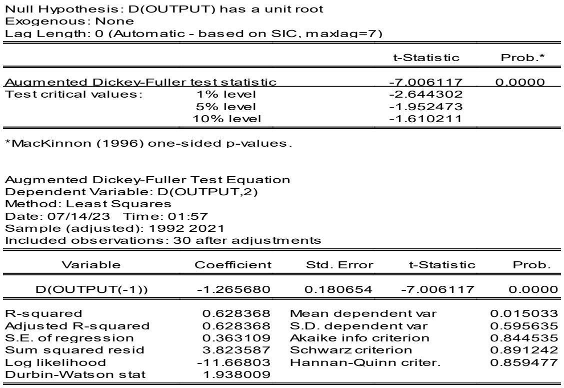


```
Null Hypothesis: D(OUTPUT) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=7)

                                              t-Statistic   Prob.*

Augmented Dickey-Fuller test statistic        -7.533209     0.0000
Test critical values:      1% level           -4.296729
                           5% level           -3.568379
                          10% level           -3.218382

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(OUTPUT,2)
Method: Least Squares
Date: 07/14/23   Time: 01:51
Sample (adjusted): 1992 2021
Included observations: 30 after adjustments

     Variable        Coefficient   Std. Error   t-Statistic   Prob.

  D(OUTPUT(-1))      -1.363794     0.181038    -7.533209     0.0000
        C            -0.279365     0.142010    -1.967220     0.0595
  @TREND("1990")      0.011243     0.007492     1.500732     0.1450

R-squared             0.677886   Mean dependent var       0.015033
Adjusted R-squared    0.654026   S.D. dependent var       0.595635
S.E. of regression    0.350350   Akaike info criterion    0.834871
Sum squared resid     3.314117   Schwarz criterion        0.974991
Log likelihood       -9.523065   Hannan-Quinn criter.     0.879697
F-statistic           28.41062   Durbin-Watson stat       2.043196
Prob(F-statistic)     0.000000
```

LOUTPUT at none

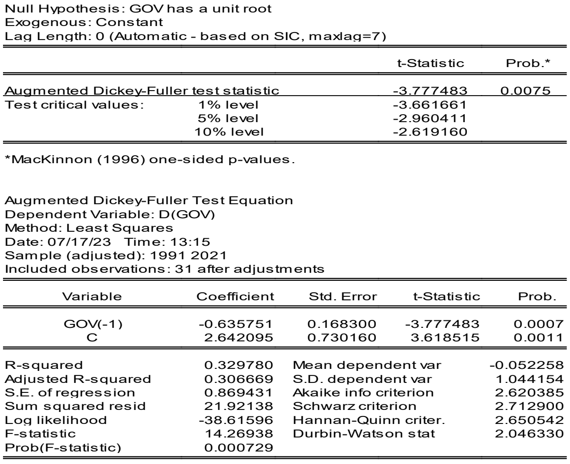


```
Null Hypothesis: OUTPUT has a unit root
Exogenous: None
Lag Length: 0 (Automatic - based on SIC, maxlag=7)
======================================================================
                                                t-Statistic   Prob.*
======================================================================
Augmented Dickey-Fuller test statistic          -1.582696     0.1054
Test critical values:       1% level            -2.641672
                            5% level            -1.952066
                            10% level           -1.610400
======================================================================
*MacKinnon (1996) one-sided p-values.


Augmented Dickey-Fuller Test Equation
Dependent Variable: D(OUTPUT)
Method: Least Squares
Date: 07/14/23   Time: 01:55
Sample (adjusted): 1991 2021
Included observations: 31 after adjustments
======================================================================
     Variable        Coefficient   Std. Error   t-Statistic    Prob.
======================================================================
    OUTPUT(-1)        -0.034049     0.021513    -1.582696     0.1240
======================================================================
R-squared              0.044356   Mean dependent var        -0.067533
Adjusted R-squared     0.044356   S.D. dependent var         0.364675
S.E. of regression     0.356496   Akaike info criterion      0.806738
Sum squared resid      3.812680   Schwarz criterion          0.852996
Log likelihood        -11.50445   Hannan-Quinn criter.       0.821817
Durbin-Watson stat     2.610211
======================================================================
```

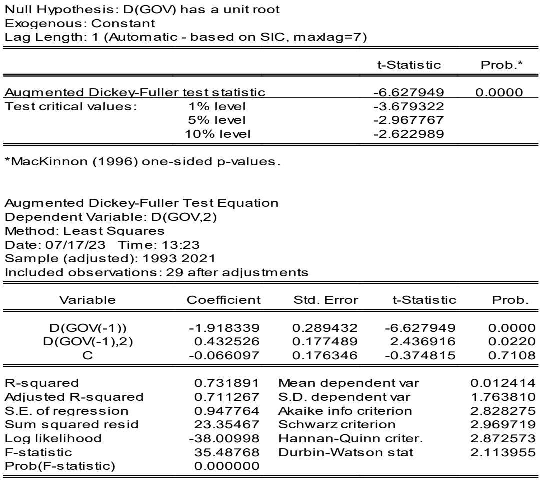


```
Null Hypothesis: D(OUTPUT) has a unit root
Exogenous: None
Lag Length: 0 (Automatic - based on SIC, maxlag=7)
======================================================================
                                                t-Statistic   Prob.*
======================================================================
Augmented Dickey-Fuller test statistic          -7.006117     0.0000
Test critical values:       1% level            -2.644302
                            5% level            -1.952473
                            10% level           -1.610211
======================================================================
*MacKinnon (1996) one-sided p-values.


Augmented Dickey-Fuller Test Equation
Dependent Variable: D(OUTPUT,2)
Method: Least Squares
Date: 07/14/23   Time: 01:57
Sample (adjusted): 1992 2021
Included observations: 30 after adjustments
======================================================================
     Variable        Coefficient   Std. Error   t-Statistic    Prob.
======================================================================
  D(OUTPUT(-1))       -1.265680     0.180654    -7.006117     0.0000
======================================================================
R-squared              0.628368   Mean dependent var         0.015033
Adjusted R-squared     0.628368   S.D. dependent var         0.595635
S.E. of regression     0.363109   Akaike info criterion      0.844535
Sum squared resid      3.823587   Schwarz criterion          0.891242
Log likelihood        -11.66803   Hannan-Quinn criter.       0.859477
Durbin-Watson stat     1.938009
======================================================================
```

GOV at intercept

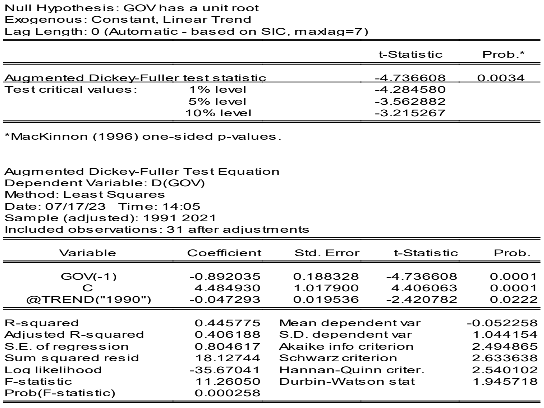


```
Null Hypothesis: GOV has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=7)
======================================================================
                                                t-Statistic   Prob.*
======================================================================
Augmented Dickey-Fuller test statistic          -3.777483     0.0075
Test critical values:       1% level            -3.661661
                            5% level            -2.960411
                            10% level           -2.619160
======================================================================
*MacKinnon (1996) one-sided p-values.


Augmented Dickey-Fuller Test Equation
Dependent Variable: D(GOV)
Method: Least Squares
Date: 07/17/23   Time: 13:15
Sample (adjusted): 1991 2021
Included observations: 31 after adjustments
======================================================================
     Variable        Coefficient   Std. Error   t-Statistic    Prob.
======================================================================
      GOV(-1)         -0.635751     0.168300    -3.777483     0.0007
         C             2.642095     0.730160     3.618515     0.0011
======================================================================
R-squared              0.329780   Mean dependent var        -0.052258
Adjusted R-squared     0.306669   S.D. dependent var         1.044154
S.E. of regression     0.869431   Akaike info criterion      2.620385
Sum squared resid      21.92138   Schwarz criterion          2.712900
Log likelihood        -38.61596   Hannan-Quinn criter.       2.650542
F-statistic            14.26938   Durbin-Watson stat         2.046330
Prob(F-statistic)      0.000729
======================================================================
```

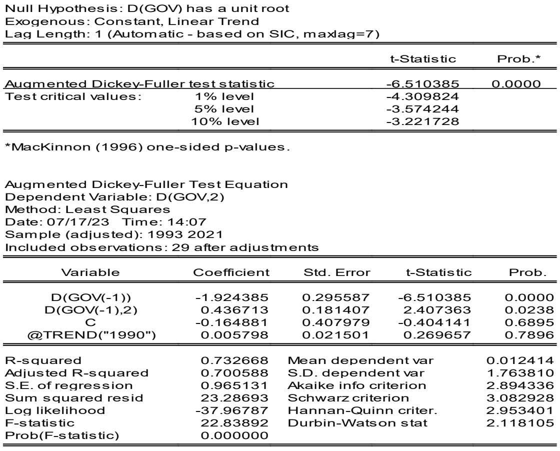


```
Null Hypothesis: D(GOV) has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on SIC, maxlag=7)
======================================================================
                                                t-Statistic   Prob.*
======================================================================
Augmented Dickey-Fuller test statistic          -6.627949     0.0000
Test critical values:       1% level            -3.679322
                            5% level            -2.967767
                            10% level           -2.622989
======================================================================
*MacKinnon (1996) one-sided p-values.


Augmented Dickey-Fuller Test Equation
Dependent Variable: D(GOV,2)
Method: Least Squares
Date: 07/17/23   Time: 13:23
Sample (adjusted): 1993 2021
Included observations: 29 after adjustments
======================================================================
     Variable        Coefficient   Std. Error   t-Statistic    Prob.
======================================================================
    D(GOV(-1))        -1.918339     0.289432    -6.627949     0.0000
   D(GOV(-1),2)        0.432526     0.177489     2.436916     0.0220
         C            -0.066097     0.176346    -0.374815     0.7108
======================================================================
R-squared              0.731891   Mean dependent var         0.012414
Adjusted R-squared     0.711267   S.D. dependent var         1.763810
S.E. of regression     0.947764   Akaike info criterion      2.828275
Sum squared resid      23.35467   Schwarz criterion          2.969719
Log likelihood        -38.00998   Hannan-Quinn criter.       2.872573
F-statistic            35.48768   Durbin-Watson stat         2.113955
Prob(F-statistic)      0.000000
======================================================================
```

GOV at trend



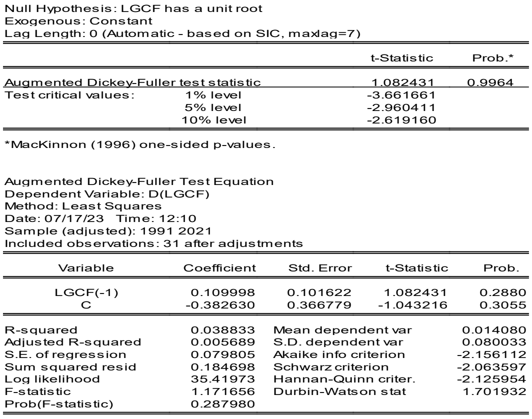
```
Null Hypothesis: GOV has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=7)
======================================================================
                                                t-Statistic   Prob.*
======================================================================
Augmented Dickey-Fuller test statistic          -4.736608     0.0034
Test critical values:       1% level            -4.284580
                            5% level            -3.562882
                            10% level           -3.215267
======================================================================
*MacKinnon (1996) one-sided p-values.


Augmented Dickey-Fuller Test Equation
Dependent Variable: D(GOV)
Method: Least Squares
Date: 07/17/23   Time: 14:05
Sample (adjusted): 1991 2021
Included observations: 31 after adjustments
======================================================================
     Variable        Coefficient   Std. Error   t-Statistic    Prob.
======================================================================
      GOV(-1)         -0.892035     0.188328    -4.736608     0.0001
         C             4.484930     1.017900     4.406063     0.0001
 @TREND("1990")       -0.047293     0.019536    -2.420782     0.0222
======================================================================
R-squared              0.445775   Mean dependent var        -0.052258
Adjusted R-squared     0.406188   S.D. dependent var         1.044154
S.E. of regression     0.804617   Akaike info criterion      2.494865
Sum squared resid      18.12744   Schwarz criterion          2.633638
Log likelihood        -35.67041   Hannan-Quinn criter.       2.540102
F-statistic            11.26050   Durbin-Watson stat         1.945718
Prob(F-statistic)      0.000258
======================================================================
```



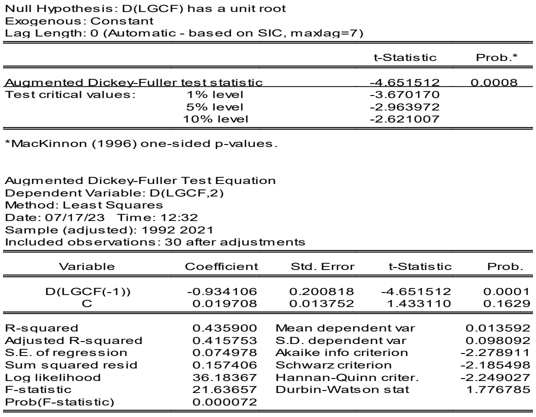
```
Null Hypothesis: D(GOV) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 1 (Automatic - based on SIC, maxlag=7)
======================================================================
                                                t-Statistic   Prob.*
======================================================================
Augmented Dickey-Fuller test statistic          -6.510385     0.0000
Test critical values:       1% level            -4.309824
                            5% level            -3.574244
                            10% level           -3.221728
======================================================================
*MacKinnon (1996) one-sided p-values.


Augmented Dickey-Fuller Test Equation
Dependent Variable: D(GOV,2)
Method: Least Squares
Date: 07/17/23   Time: 14:07
Sample (adjusted): 1993 2021
Included observations: 29 after adjustments
======================================================================
     Variable        Coefficient   Std. Error   t-Statistic    Prob.
======================================================================
    D(GOV(-1))        -1.924385     0.295587    -6.510385     0.0000
   D(GOV(-1),2)        0.436713     0.181407     2.407363     0.0238
         C            -0.164881     0.407979    -0.404141     0.6895
 @TREND("1990")        0.005798     0.021501     0.269657     0.7896
======================================================================
R-squared              0.732668   Mean dependent var         0.012414
Adjusted R-squared     0.700588   S.D. dependent var         1.763810
S.E. of regression     0.965131   Akaike info criterion      2.894336
Sum squared resid      23.28693   Schwarz criterion          3.082928
Log likelihood        -37.96787   Hannan-Quinn criter.       2.953401
F-statistic            22.83892   Durbin-Watson stat         2.118105
Prob(F-statistic)      0.000000
======================================================================
```

Private Investment in Agriculture (LGCF)

LGCF at intercept

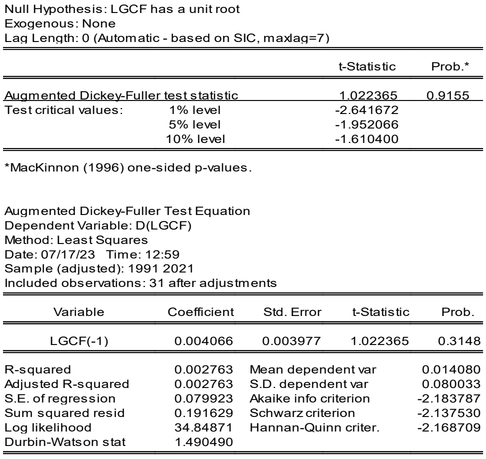


```
Null Hypothesis: LGCF has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=7)

                                             t-Statistic   Prob.*

Augmented Dickey-Fuller test statistic        1.082431    0.9964
Test critical values:      1% level          -3.661661
                           5% level          -2.960411
                          10% level          -2.619160

*MacKinnon (1996) one-sided p-values.


Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LGCF)
Method: Least Squares
Date: 07/17/23   Time: 12:10
Sample (adjusted): 1991 2021
Included observations: 31 after adjustments

     Variable        Coefficient   Std. Error   t-Statistic   Prob.

     LGCF(-1)         0.109998     0.101622     1.082431     0.2880
        C            -0.382630     0.366779    -1.043216     0.3055

R-squared             0.038833   Mean dependent var     0.014080
Adjusted R-squared    0.005689   S.D. dependent var     0.080033
S.E. of regression    0.079805   Akaike info criterion -2.156112
Sum squared resid     0.184698   Schwarz criterion     -2.063597
Log likelihood        35.41973   Hannan-Quinn criter.  -2.125954
F-statistic           1.171656   Durbin-Watson stat     1.701932
Prob(F-statistic)     0.287980
```

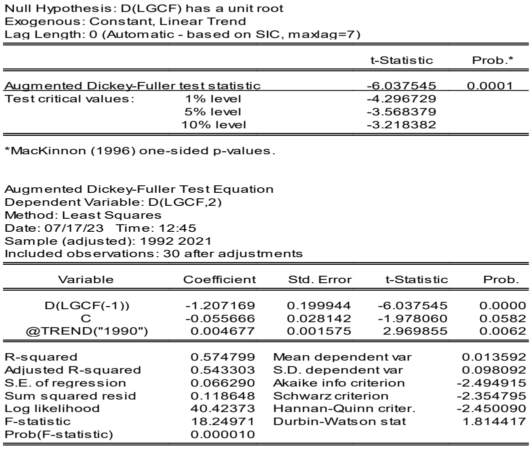


```
Null Hypothesis: D(LGCF) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=7)

                                             t-Statistic   Prob.*

Augmented Dickey-Fuller test statistic       -4.651512    0.0008
Test critical values:      1% level          -3.670170
                           5% level          -2.963972
                          10% level          -2.621007

*MacKinnon (1996) one-sided p-values.


Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LGCF,2)
Method: Least Squares
Date: 07/17/23   Time: 12:32
Sample (adjusted): 1992 2021
Included observations: 30 after adjustments

     Variable        Coefficient   Std. Error   t-Statistic   Prob.

    D(LGCF(-1))      -0.934106     0.200818    -4.651512     0.0001
        C             0.019708     0.013752     1.433110     0.1629

R-squared             0.435900   Mean dependent var     0.013592
Adjusted R-squared    0.415753   S.D. dependent var     0.098092
S.E. of regression    0.074978   Akaike info criterion -2.278911
Sum squared resid     0.157406   Schwarz criterion     -2.185498
Log likelihood        36.18367   Hannan-Quinn criter.  -2.249027
F-statistic           21.63657   Durbin-Watson stat     1.776785
Prob(F-statistic)     0.000072
```

LGCF at trend

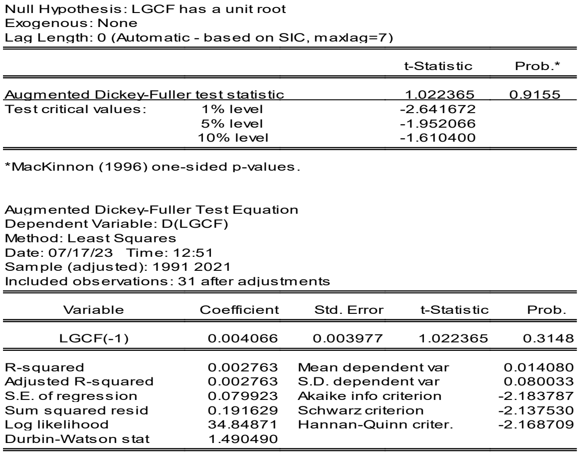


```
Null Hypothesis: LGCF has a unit root
Exogenous: None
Lag Length: 0 (Automatic - based on SIC, maxlag=7)

                                             t-Statistic   Prob.*

Augmented Dickey-Fuller test statistic        1.022365    0.9155
Test critical values:      1% level          -2.641672
                           5% level          -1.952066
                          10% level          -1.610400

*MacKinnon (1996) one-sided p-values.


Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LGCF)
Method: Least Squares
Date: 07/17/23   Time: 12:59
Sample (adjusted): 1991 2021
Included observations: 31 after adjustments

     Variable        Coefficient   Std. Error   t-Statistic   Prob.

     LGCF(-1)         0.004066     0.003977     1.022365     0.3148

R-squared             0.002763   Mean dependent var     0.014080
Adjusted R-squared    0.002763   S.D. dependent var     0.080033
S.E. of regression    0.079923   Akaike info criterion -2.183787
Sum squared resid     0.191629   Schwarz criterion     -2.137530
Log likelihood        34.84871   Hannan-Quinn criter.  -2.168709
Durbin-Watson stat    1.490490
```

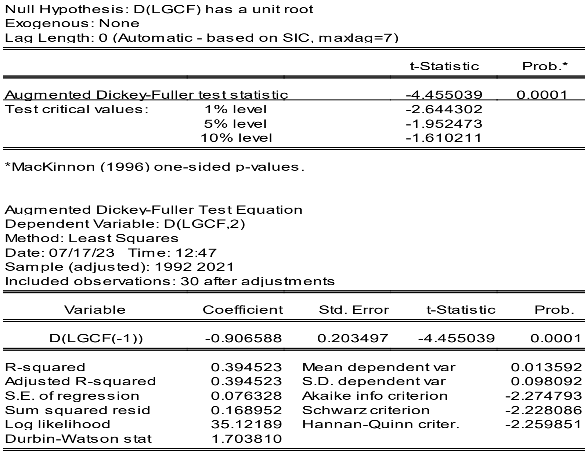


```
Null Hypothesis: D(LGCF) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=7)

                                             t-Statistic   Prob.*

Augmented Dickey-Fuller test statistic       -6.037545    0.0001
Test critical values:      1% level          -4.296729
                           5% level          -3.568379
                          10% level          -3.218382

*MacKinnon (1996) one-sided p-values.


Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LGCF,2)
Method: Least Squares
Date: 07/17/23   Time: 12:45
Sample (adjusted): 1992 2021
Included observations: 30 after adjustments

     Variable        Coefficient   Std. Error   t-Statistic   Prob.

    D(LGCF(-1))      -1.207169     0.199944    -6.037545     0.0000
        C            -0.055666     0.028142    -1.978060     0.0582
  @TREND("1990")      0.004677     0.001575     2.969855     0.0062

R-squared             0.574799   Mean dependent var     0.013592
Adjusted R-squared    0.543303   S.D. dependent var     0.098092
S.E. of regression    0.066290   Akaike info criterion -2.494915
Sum squared resid     0.118648   Schwarz criterion     -2.354795
Log likelihood        40.42373   Hannan-Quinn criter.  -2.450090
F-statistic           18.24971   Durbin-Watson stat     1.814417
Prob(F-statistic)     0.000010
```

LGCF at none



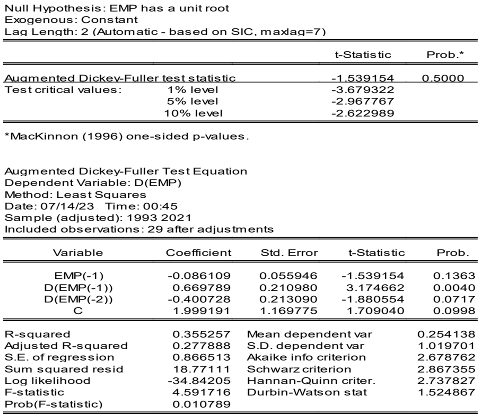
```
Null Hypothesis: LGCF has a unit root
Exogenous: None
Lag Length: 0 (Automatic - based on SIC, maxlag=7)

                                             t-Statistic   Prob.*

Augmented Dickey-Fuller test statistic        1.022365    0.9155
Test critical values:      1% level          -2.641672
                           5% level          -1.952066
                          10% level          -1.610400

*MacKinnon (1996) one-sided p-values.


Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LGCF)
Method: Least Squares
Date: 07/17/23   Time: 12:51
Sample (adjusted): 1991 2021
Included observations: 31 after adjustments

     Variable        Coefficient   Std. Error   t-Statistic   Prob.

     LGCF(-1)         0.004066     0.003977     1.022365     0.3148

R-squared             0.002763   Mean dependent var     0.014080
Adjusted R-squared    0.002763   S.D. dependent var     0.080033
S.E. of regression    0.079923   Akaike info criterion -2.183787
Sum squared resid     0.191629   Schwarz criterion     -2.137530
Log likelihood        34.84871   Hannan-Quinn criter.  -2.168709
Durbin-Watson stat    1.490490
```



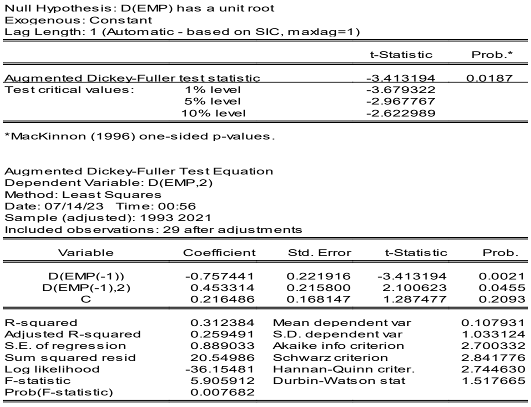
```
Null Hypothesis: D(LGCF) has a unit root
Exogenous: None
Lag Length: 0 (Automatic - based on SIC, maxlag=7)

                                             t-Statistic   Prob.*

Augmented Dickey-Fuller test statistic       -4.455039    0.0001
Test critical values:      1% level          -2.644302
                           5% level          -1.952473
                          10% level          -1.610211

*MacKinnon (1996) one-sided p-values.


Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LGCF,2)
Method: Least Squares
Date: 07/17/23   Time: 12:47
Sample (adjusted): 1992 2021
Included observations: 30 after adjustments

     Variable        Coefficient   Std. Error   t-Statistic   Prob.

    D(LGCF(-1))      -0.906588     0.203497    -4.455039     0.0001

R-squared             0.394523   Mean dependent var     0.013592
Adjusted R-squared    0.394523   S.D. dependent var     0.098092
S.E. of regression    0.076328   Akaike info criterion -2.274793
Sum squared resid     0.168952   Schwarz criterion     -2.228086
Log likelihood        35.12189   Hannan-Quinn criter.  -2.259851
Durbin-Watson stat    1.703810
```

Employment in Agriculture

EMP at Intercept

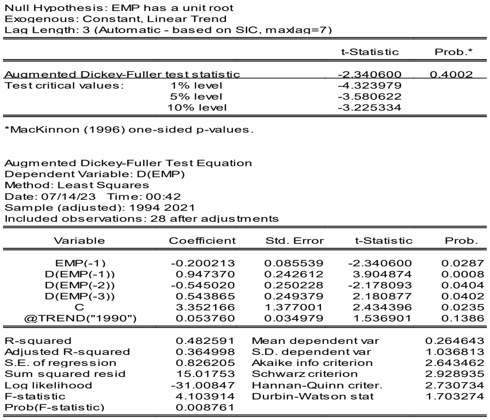


```
Null Hypothesis: EMP has a unit root
Exogenous: Constant
Lag Length: 2 (Automatic - based on SIC, maxlag=7)

                                              t-Statistic   Prob.*

Augmented Dickey-Fuller test statistic        -1.539154    0.5000
Test critical values:        1% level          -3.679322
                             5% level          -2.967767
                             10% level         -2.622989

*MacKinnon (1996) one-sided p-values.


Augmented Dickey-Fuller Test Equation
Dependent Variable: D(EMP)
Method: Least Squares
Date: 07/14/23   Time: 00:45
Sample (adjusted): 1993 2021
Included observations: 29 after adjustments

        Variable        Coefficient   Std. Error   t-Statistic   Prob.

         EMP(-1)         -0.086109     0.055946    -1.539154     0.1363
       D(EMP(-1))         0.669789     0.210980     3.174662     0.0040
       D(EMP(-2))        -0.400728     0.213090    -1.880554     0.0717
            C             1.999191     1.169775     1.709040     0.0998

R-squared                 0.355257   Mean dependent var       0.254138
Adjusted R-squared        0.277888   S.D. dependent var       1.019701
S.E. of regression        0.866513   Akaike info criterion    2.678762
Sum squared resid         18.77111   Schwarz criterion        2.867355
Log likelihood           -34.84205   Hannan-Quinn criter.     2.737827
F-statistic               4.591716   Durbin-Watson stat       1.524867
Prob(F-statistic)         0.010789
```

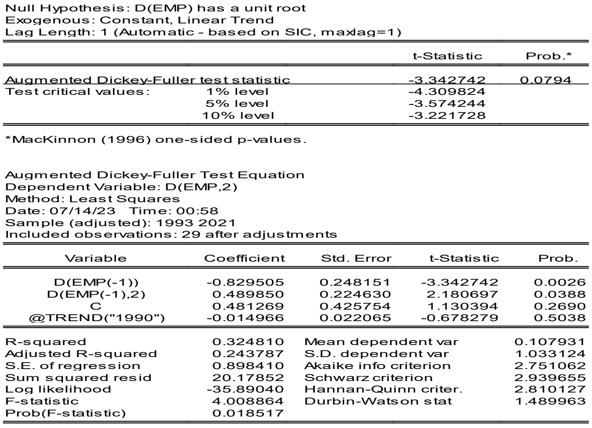


```
Null Hypothesis: D(EMP) has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on SIC, maxlag=1)

                                              t-Statistic   Prob.*

Augmented Dickey-Fuller test statistic        -3.413194    0.0187
Test critical values:        1% level          -3.679322
                             5% level          -2.967767
                             10% level         -2.622989

*MacKinnon (1996) one-sided p-values.


Augmented Dickey-Fuller Test Equation
Dependent Variable: D(EMP,2)
Method: Least Squares
Date: 07/14/23   Time: 00:56
Sample (adjusted): 1993 2021
Included observations: 29 after adjustments

        Variable        Coefficient   Std. Error   t-Statistic   Prob.

       D(EMP(-1))        -0.757441     0.221916    -3.413194     0.0021
      D(EMP(-1),2)        0.453314     0.215800     2.100623     0.0455
            C             0.216486     0.168147     1.287477     0.2093

R-squared                 0.312384   Mean dependent var       0.107931
Adjusted R-squared        0.259491   S.D. dependent var       1.033124
S.E. of regression        0.889033   Akaike info criterion    2.700332
Sum squared resid         20.54986   Schwarz criterion        2.841776
Log likelihood           -36.15481   Hannan-Quinn criter.     2.744630
F-statistic               5.905912   Durbin-Watson stat       1.517665
Prob(F-statistic)         0.007682
```

EMP at Trend and intercept

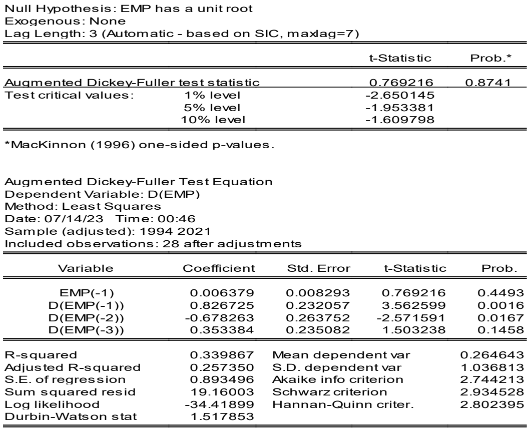


```
Null Hypothesis: EMP has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 3 (Automatic - based on SIC, maxlag=7)

                                              t-Statistic   Prob.*

Augmented Dickey-Fuller test statistic        -2.340600    0.4002
Test critical values:        1% level          -4.323979
                             5% level          -3.580622
                             10% level         -3.225334

*MacKinnon (1996) one-sided p-values.


Augmented Dickey-Fuller Test Equation
Dependent Variable: D(EMP)
Method: Least Squares
Date: 07/14/23   Time: 00:42
Sample (adjusted): 1994 2021
Included observations: 28 after adjustments

        Variable        Coefficient   Std. Error   t-Statistic   Prob.

         EMP(-1)         -0.200213     0.085539    -2.340600     0.0287
       D(EMP(-1))         0.947370     0.242612     3.904874     0.0008
       D(EMP(-2))        -0.545020     0.250228    -2.178093     0.0404
       D(EMP(-3))         0.543865     0.249379     2.180877     0.0402
            C             3.352166     1.377001     2.434396     0.0235
    @TREND("1990")        0.053760     0.034979     1.536901     0.1386

R-squared                 0.482591   Mean dependent var       0.264643
Adjusted R-squared        0.364998   S.D. dependent var       1.036813
S.E. of regression        0.826205   Akaike info criterion    2.643462
Sum squared resid         15.01753   Schwarz criterion        2.928935
Log likelihood           -31.00847   Hannan-Quinn criter.     2.730734
F-statistic               4.103914   Durbin-Watson stat       1.703274
Prob(F-statistic)         0.008761
```

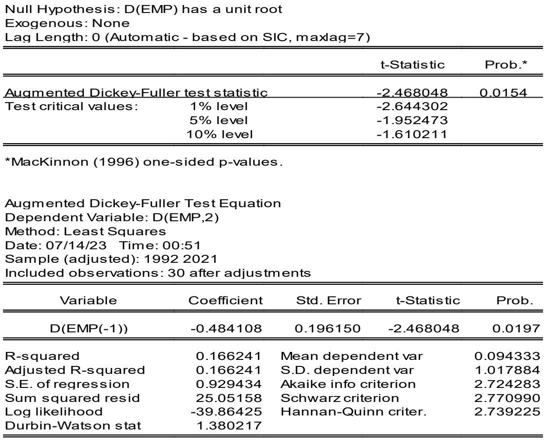


```
Null Hypothesis: D(EMP) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 1 (Automatic - based on SIC, maxlag=1)

                                              t-Statistic   Prob.*

Augmented Dickey-Fuller test statistic        -3.342742    0.0794
Test critical values:        1% level          -4.309824
                             5% level          -3.574244
                             10% level         -3.221728

*MacKinnon (1996) one-sided p-values.


Augmented Dickey-Fuller Test Equation
Dependent Variable: D(EMP,2)
Method: Least Squares
Date: 07/14/23   Time: 00:58
Sample (adjusted): 1993 2021
Included observations: 29 after adjustments

        Variable        Coefficient   Std. Error   t-Statistic   Prob.

       D(EMP(-1))        -0.829505     0.248151    -3.342742     0.0026
      D(EMP(-1),2)        0.489850     0.224630     2.180697     0.0388
            C             0.481269     0.425754     1.130394     0.2690
    @TREND("1990")       -0.014966     0.022065    -0.678279     0.5038

R-squared                 0.324810   Mean dependent var       0.107931
Adjusted R-squared        0.243787   S.D. dependent var       1.033124
S.E. of regression        0.898410   Akaike info criterion    2.751062
Sum squared resid         20.17852   Schwarz criterion        2.939655
Log likelihood           -35.89040   Hannan-Quinn criter.     2.810127
F-statistic               4.008864   Durbin-Watson stat       1.489963
Prob(F-statistic)         0.018517
```

EMP at none



```
Null Hypothesis: EMP has a unit root
Exogenous: None
Lag Length: 3 (Automatic - based on SIC, maxlag=7)

                                              t-Statistic   Prob.*

Augmented Dickey-Fuller test statistic         0.769216    0.8741
Test critical values:        1% level          -2.650145
                             5% level          -1.953381
                             10% level         -1.609798

*MacKinnon (1996) one-sided p-values.


Augmented Dickey-Fuller Test Equation
Dependent Variable: D(EMP)
Method: Least Squares
Date: 07/14/23   Time: 00:46
Sample (adjusted): 1994 2021
Included observations: 28 after adjustments

        Variable        Coefficient   Std. Error   t-Statistic   Prob.

         EMP(-1)          0.006379     0.008293     0.769216     0.4493
       D(EMP(-1))         0.826725     0.232057     3.562599     0.0016
       D(EMP(-2))        -0.678263     0.263752    -2.571591     0.0167
       D(EMP(-3))         0.353384     0.235082     1.503238     0.1458

R-squared                 0.339867   Mean dependent var       0.264643
Adjusted R-squared        0.257350   S.D. dependent var       1.036813
S.E. of regression        0.893496   Akaike info criterion    2.744213
Sum squared resid         19.16003   Schwarz criterion        2.934528
Log likelihood           -34.41899   Hannan-Quinn criter.     2.802395
Durbin-Watson stat        1.517853
```



```
Null Hypothesis: D(EMP) has a unit root
Exogenous: None
Lag Length: 0 (Automatic - based on SIC, maxlag=7)

                                              t-Statistic   Prob.*

Augmented Dickey-Fuller test statistic        -2.468048    0.0154
Test critical values:        1% level          -2.644302
                             5% level          -1.952473
                             10% level         -1.610211

*MacKinnon (1996) one-sided p-values.


Augmented Dickey-Fuller Test Equation
Dependent Variable: D(EMP,2)
Method: Least Squares
Date: 07/14/23   Time: 00:51
Sample (adjusted): 1992 2021
Included observations: 30 after adjustments

        Variable        Coefficient   Std. Error   t-Statistic   Prob.

       D(EMP(-1))        -0.484108     0.196150    -2.468048     0.0197

R-squared                 0.166241   Mean dependent var       0.094333
Adjusted R-squared        0.166241   S.D. dependent var       1.017884
S.E. of regression        0.929434   Akaike info criterion    2.724283
Sum squared resid         25.05158   Schwarz criterion        2.770990
Log likelihood           -39.86425   Hannan-Quinn criter.     2.739225
Durbin-Watson stat        1.380217
```

Appendix C: ARDL Bounds test, ECM and short run results.

South Africa

```
ARDL Error Correction Regression
Dependent Variable: D(AGRICULTURAL_OUTPUT__GDP)
Selected Model: ARDL(2, 4, 2, 0)
Case 2: Restricted Constant and No Trend
Date: 06/27/23   Time: 18:32
Sample: 1990 2021
Included observations: 28
==========================================================================
                               ECM Regression
                    Case 2: Restricted Constant and No Trend
==========================================================================
       Variable            Coefficient    Std. Error    t-Statistic   Prob.
==========================================================================

D(AGRICULTURAL_OU...        0.507650      0.106774      4.754447     0.0002
 D(GOVERNMENT_EXP...        0.439300      0.078572      5.591081     0.0000
 D(GOVERNMENT_EXP...        0.144607      0.053401      2.707932     0.0155
 D(GOVERNMENT_EXP...       -0.116463      0.053317     -2.184337     0.0442
 D(GOVERNMENT_EXP...        0.097695      0.042305      2.309290     0.0346
 D(AGRICULTURAL_MA...       5.58E-05      1.33E-05      4.177136     0.0007
 D(AGRICULTURAL_MA...      -6.29E-05      1.43E-05     -4.387917     0.0005
       CointEq(-1)*        -0.696804      0.107596     -6.476085     0.0000
==========================================================================

R-squared                   0.878180    Mean dependent var       -0.027592
Adjusted R-squared          0.835543    S.D. dependent var        0.264906
S.E. of regression          0.107428    Akaike info criterion    -1.389035
Sum squared resid           0.230816    Schwarz criterion        -1.008405
Log likelihood              27.44649    Hannan-Quinn criter.     -1.272673
Durbin-Watson stat          2.367083
==========================================================================

* p-value incompatible with t-Bounds distribution.


F-Bounds Test                       Null Hypothesis: No levels relationship
==========================================================================
Test Statistic               Value          Signif.         I(0)       I(1)
==========================================================================

F-statistic                6.710348           10%            2.37       3.2
k                              3               5%            2.79       3.67
                                             2.5%            3.15       4.08
                                               1%            3.65       4.66
==========================================================================
```

Botswana

```
ARDL Error Correction Regression
Dependent Variable: D(GOV)
Selected Model: ARDL(1, 1, 2, 3)
Case 2: Restricted Constant and No Trend
Date: 07/12/23   Time: 15:34
Sample: 1990 2021
Included observations: 29
============================================================================
                              ECM Regression
                 Case 2: Restricted Constant and No Trend
============================================================================
        Variable         Coefficient    Std. Error    t-Statistic    Prob.
============================================================================
        D(LGCF)            3.141220      1.529989      2.053100     0.0549
         D(EMP)            0.220095      0.127568      1.725319     0.1016
       D(EMP(-1))         -0.352404      0.151129     -2.331804     0.0315
       D(OUTPUT)           0.114455      0.316888      0.361186     0.7222
     D(OUTPUT(-1))         0.235382      0.339788      0.692732     0.4973
     D(OUTPUT(-2))        -0.573717      0.331495     -1.730697     0.1006
      CointEq(-1)*        -0.993755      0.152061     -6.535234     0.0000
============================================================================
R-squared                  0.764811    Mean dependent var        -0.030690
Adjusted R-squared         0.700668    S.D. dependent var         1.076824
S.E. of regression         0.589143    Akaike info criterion      1.986211
Sum squared resid          7.635981    Schwarz criterion          2.316248
Log likelihood            -21.80006    Hannan-Quinn criter.       2.089575
Durbin-Watson stat         1.837348
============================================================================
* p-value incompatible with t-Bounds distribution.


F-Bounds Test                         Null Hypothesis: No levels relationship
============================================================================
Test Statistic              Value          Signif.          I(0)        I(1)
============================================================================
F-statistic               6.988792           10%            2.37         3.2
k                            3                5%            2.79        3.67
                                            2.5%            3.15        4.08
                                              1%            3.65        4.66
============================================================================
```

Namibia

```
ARDL Error Correction Regression
Dependent Variable: D(OUTPUT)
Selected Model: ARDL(1, 0, 0, 0)
Case 2: Restricted Constant and No Trend
Date: 03/01/24   Time: 19:20
Sample: 1990 2021
Included observations: 31
=====================================================================
                          ECM Regression
             Case 2: Restricted Constant and No Trend
=====================================================================
       Variable          Coefficient    Std. Error   t-Statistic   Prob.
=====================================================================
     CointEq(-1)*         -0.615375     0.180044    -3.417912    0.0021
=====================================================================
R-squared                  0.280196   Mean dependent var       0.011019
Adjusted R-squared         0.280196   S.D. dependent var       1.129406
S.E. of regression         0.958202   Akaike info criterion    2.784211
Sum squared resid          27.54455   Schwarz criterion        2.830468
Log likelihood            -42.15527   Hannan-Quinn criter.     2.799290
Durbin-Watson stat         1.904216
=====================================================================
* p-value incompatible with t-Bounds distribution.


F-Bounds Test                        Null Hypothesis: No levels relationship
=====================================================================
Test Statistic              Value          Signif.        I(0)       I(1)
=====================================================================
F-statistic               2.024901          10%          2.37        3.2
k                             3              5%          2.79       3.67
                                           2.5%          3.15       4.08
                                             1%          3.65       4.66
=====================================================================
```

Appendix E: ARDL long run results.

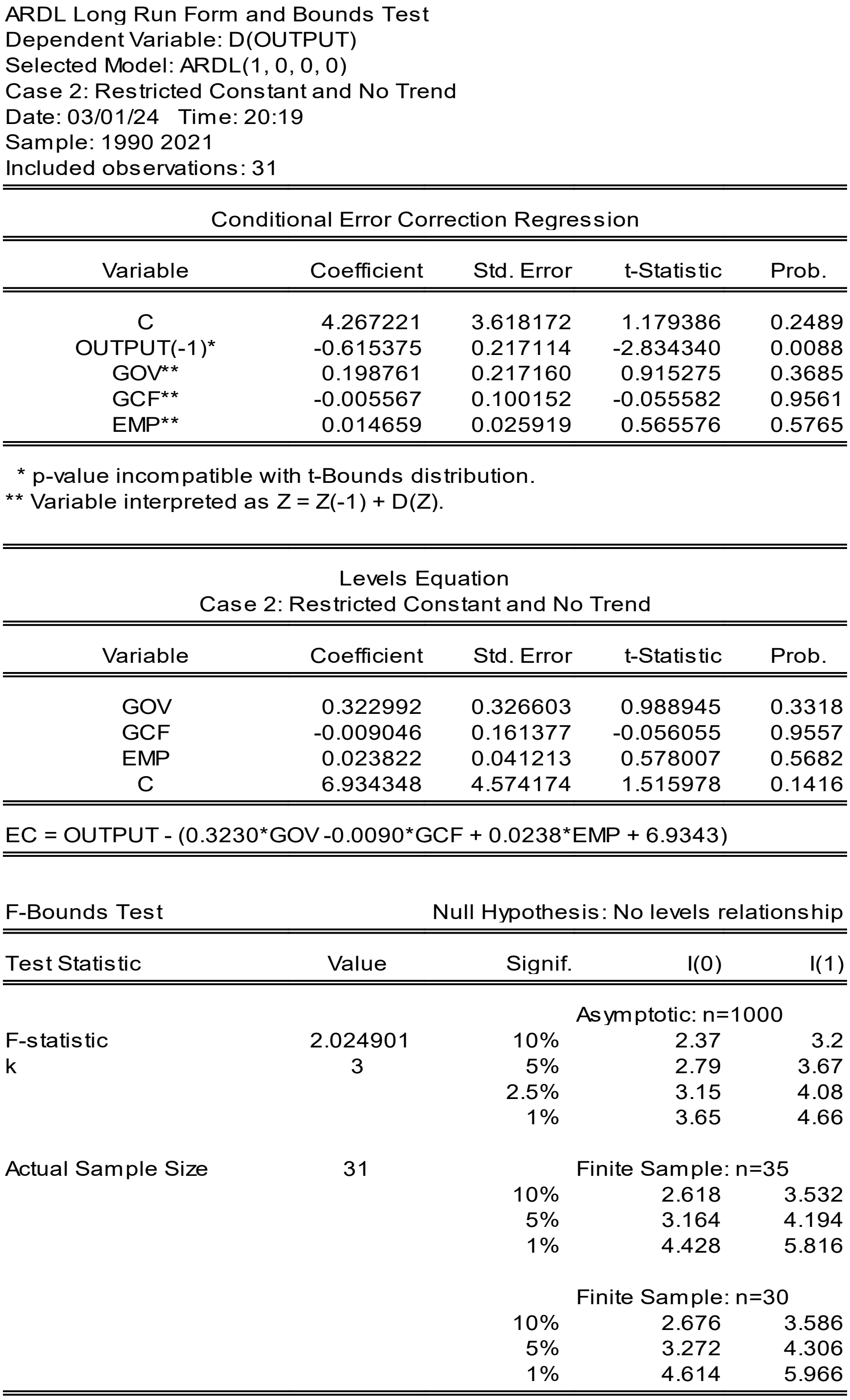
South Africa

```
ARDL Long Run Form and Bounds Test
Dependent Variable: D(AGRICULTURAL_OUTPUT__GDP)
Selected Model: ARDL(3, 3, 3, 3)
Case 2: Restricted Constant and No Trend
Date: 06/27/23   Time: 18:25
Sample: 1990 2021
Included observations: 29
========================================================================
              Conditional Error Correction Regression
========================================================================
        Variable         Coefficient   Std. Error   t-Statistic   Prob.
========================================================================
           C              -0.638215    0.442101     -1.443593    0.1725
  AGRICULTURAL  OUT...    -1.121571    0.198484     -5.650697    0.0001
  GOVERNMENT  EXPE...      0.356266    0.085498      4.166956    0.0011
 AGRICULTURAL_MACH...      8.41E-05     2.20E-05     3.819300    0.0021
 EMPLOYMENT_IN_AGR...      0.287677    0.054791      5.250464    0.0002
 D(AGRICULTURAL_OU...      0.757289    0.157456      4.809535    0.0003
 D(AGRICULTURAL_OU...      0.279437    0.139997      1.996017    0.0673
 D(GOVERNMENT_EXP...       0.155312    0.057545      2.698989    0.0182
 D(GOVERNMENT_EXP...      -0.020107    0.084684     -0.237433    0.8160
 D(GOVERNMENT  EXP...     -0.255957    0.067805     -3.774900    0.0023
 D(AGRICULTURAL  MA...     6.49E-05     2.46E-05     2.632955    0.0207
 D(AGRICULTURAL  MA...    -9.57E-05     2.35E-05    -4.074136    0.0013
 D(AGRICULTURAL  MA...    -2.67E-05     2.38E-05    -1.122009    0.2822
 D(EMPLOYMENT  IN  A...    0.092146    0.122954      0.749430    0.4669
 D(EMPLOYMENT  IN  A...   -0.213708    0.113094     -1.889652    0.0813
 D(EMPLOYMENT  IN  A...   -0.139161    0.112887     -1.232737    0.2395
========================================================================
  * p-value incompatible with t-Bounds distribution.

========================================================================
                          Levels Equation
              Case 2: Restricted Constant and No Trend
========================================================================
        Variable         Coefficient   Std. Error   t-Statistic   Prob.
========================================================================
  GOVERNMENT  EXPE...      0.317649    0.076061      4.176249    0.0011
 AGRICULTURAL  MACH...     7.50E-05     1.87E-05     4.019980    0.0015
 EMPLOYMENT  IN  AGR...    0.256494    0.027071      9.474999    0.0000
           C              -0.569036    0.414147     -1.373995    0.1927
========================================================================
EC = AGRICULTURAL  OUTPUT    GDP - (0.3176*GOVERNMENT  EXPENDIT
      URE  IN  AGRICULTURE + 0.0001*AGRICULTURAL  MACHINARY   TRA
      CTORS + 0.2565*EMPLOYMENT_IN_AGRICULTURE____EMPLOYMENT -
      0.5690)
========================================================================

F-Bounds Test                          Null Hypothesis: No levels relationship
========================================================================
Test Statistic              Value        Signif.        I(0)        I(1)
========================================================================
                                              Asymptotic: n=1000
F-statistic               7.795082        10%          2.37         3.2
k                             3            5%          2.79        3.67
                                         2.5%          3.15        4.08
                                           1%          3.65        4.66

Actual Sample Size           29               Finite Sample: n=35
                                          10%         2.618       3.532
                                           5%         3.164       4.194
                                           1%         4.428       5.816

                                              Finite Sample: n=30
                                          10%         2.676       3.586
                                           5%         3.272       4.306
                                           1%         4.614       5.966
========================================================================
```

Botswana

```
ARDL Long Run Form and Bounds Test
Dependent Variable: D(GOV)
Selected Model: ARDL(1, 1, 2, 3)
Case 2: Restricted Constant and No Trend
Date: 07/12/23   Time: 15:32
Sample: 1990 2021
Included observations: 29
=========================================================================
                 Conditional Error Correction Regression
=========================================================================
        Variable          Coefficient    Std. Error    t-Statistic    Prob.
=========================================================================
            C              23.43724      7.048299      3.325233      0.0038
         GOV(-1)*         -0.993755      0.194447     -5.110669      0.0001
         LGCF(-1)         -3.913702      1.198812     -3.264652      0.0043
          EMP(-1)         -0.229288      0.109749     -2.089210      0.0512
        OUTPUT(-1)        -0.206406      0.361518     -0.570943      0.5751
         D(LGCF)           3.141220      1.950942      1.610104      0.1248
          D(EMP)           0.220095      0.157458      1.397806      0.1792
        D(EMP(-1))        -0.352404      0.199464     -1.766752      0.0942
        D(OUTPUT)          0.114455      0.419112      0.273090      0.7879
      D(OUTPUT(-1))        0.235382      0.498758      0.471936      0.6426
      D(OUTPUT(-2))       -0.573717      0.447037     -1.283375      0.2156
=========================================================================
  * p-value incompatible with t-Bounds distribution.

=========================================================================
                            Levels Equation
               Case 2: Restricted Constant and No Trend
=========================================================================
        Variable          Coefficient    Std. Error    t-Statistic    Prob.
=========================================================================
          LGCF            -3.938296      1.227839     -3.207501      0.0049
           EMP            -0.230729      0.072077     -3.201132      0.0050
         OUTPUT           -0.207703      0.308392     -0.673505      0.5092
            C              23.58451      6.019781      3.917836      0.0010
=========================================================================
EC = GOV - (-3.9383*LGCF -0.2307*EMP -0.2077*OUTPUT + 23.5845)
=========================================================================

F-Bounds Test                          Null Hypothesis: No levels relationship
=========================================================================
Test Statistic              Value          Signif.          I(0)        I(1)
=========================================================================
                                                  Asymptotic: n=1000
F-statistic                6.988792          10%            2.37         3.2
k                             3               5%            2.79        3.67
                                            2.5%            3.15        4.08
                                              1%            3.65        4.66

Actual Sample Size           29                   Finite Sample: n=35
                                             10%           2.618       3.532
                                              5%           3.164       4.194
                                              1%           4.428       5.816

                                                  Finite Sample: n=30
                                             10%           2.676       3.586
                                              5%           3.272       4.306
                                              1%           4.614       5.966
=========================================================================
```

Namibia



```
ARDL Long Run Form and Bounds Test
Dependent Variable: D(OUTPUT)
Selected Model: ARDL(1, 0, 0, 0)
Case 2: Restricted Constant and No Trend
Date: 03/01/24   Time: 20:19
Sample: 1990 2021
Included observations: 31
==========================================================================
                Conditional Error Correction Regression
==========================================================================
        Variable          Coefficient    Std. Error    t-Statistic    Prob.
==========================================================================
           C               4.267221      3.618172      1.179386     0.2489
      OUTPUT(-1)*         -0.615375      0.217114     -2.834340     0.0088
         GOV**             0.198761      0.217160      0.915275     0.3685
         GCF**            -0.005567      0.100152     -0.055582     0.9561
         EMP**             0.014659      0.025919      0.565576     0.5765
==========================================================================
  * p-value incompatible with t-Bounds distribution.
** Variable interpreted as Z = Z(-1) + D(Z).

==========================================================================
                          Levels Equation
                Case 2: Restricted Constant and No Trend
==========================================================================
        Variable          Coefficient    Std. Error    t-Statistic    Prob.
==========================================================================
          GOV              0.322992      0.326603      0.988945     0.3318
          GCF             -0.009046      0.161377     -0.056055     0.9557
          EMP              0.023822      0.041213      0.578007     0.5682
           C               6.934348      4.574174      1.515978     0.1416
==========================================================================
EC = OUTPUT - (0.3230*GOV -0.0090*GCF + 0.0238*EMP + 6.9343)
==========================================================================

F-Bounds Test                       Null Hypothesis: No levels relationship
==========================================================================
Test Statistic              Value         Signif.          I(0)        I(1)
==========================================================================
                                                   Asymptotic: n=1000
F-statistic               2.024901          10%            2.37         3.2
k                             3              5%            2.79        3.67
                                           2.5%            3.15        4.08
                                             1%            3.65        4.66

Actual Sample Size           31                    Finite Sample: n=35
                                            10%           2.618       3.532
                                             5%           3.164       4.194
                                             1%           4.428       5.816

                                                   Finite Sample: n=30
                                            10%           2.676       3.586
                                             5%           3.272       4.306
                                             1%           4.614       5.966
==========================================================================
```

Appendix F: Granger Causality Test

South Africa

Pairwise Granger Causality Tests
Date: 03/01/24   Time: 21:58
Sample: 1990 2021
Lags: 2

Null Hypothesis:	Obs	F-Statistic	Prob.
GOV does not Granger Cause OUTPUT	30	3.69361	0.0393
OUTPUT does not Granger Cause GOV		3.43190	0.0482
LGCF does not Granger Cause OUTPUT	30	2.40446	0.1109
OUTPUT does not Granger Cause LGCF		4.53107	0.0209
EMP does not Granger Cause OUTPUT	30	7.51993	0.0028
OUTPUT does not Granger Cause EMP		1.52178	0.2379
LGCF does not Granger Cause GOV	30	4.36482	0.0237
GOV does not Granger Cause LGCF		0.37420	0.6916
EMP does not Granger Cause GOV	30	1.04589	0.3663
GOV does not Granger Cause EMP		1.22109	0.3119
EMP does not Granger Cause LGCF	30	3.38459	0.0500
LGCF does not Granger Cause EMP		0.15770	0.8550

Botswana

```
Pairwise Granger Causality Tests
Date: 07/13/23   Time: 18:57
Sample: 1990 2021
Lags: 2
=====================================================================
 Null Hypothesis:                          Obs   F-Statistic    Prob.
=====================================================================
 LGCF does not Granger Cause OUTPUT         30     0.58356     0.5653
 OUTPUT does not Granger Cause LGCF                1.85562     0.1773
=====================================================================
 GOV does not Granger Cause OUTPUT          30     1.73442     0.1971
 OUTPUT does not Granger Cause GOV                 1.51184     0.2400
=====================================================================
 EMP does not Granger Cause OUTPUT          30     0.16659     0.8475
 OUTPUT does not Granger Cause EMP                 1.77607     0.1900
=====================================================================
 GOV does not Granger Cause LGCF            30     0.52573     0.5975
 LGCF does not Granger Cause GOV                   2.37273     0.1139
=====================================================================
 EMP does not Granger Cause LGCF            30     0.81476     0.4542
 LGCF does not Granger Cause EMP                   0.31373     0.7336
=====================================================================
 EMP does not Granger Cause GOV             30     4.18705     0.0270
 GOV does not Granger Cause EMP                    0.48562     0.6210
=====================================================================
```

Namibia

```
Pairwise Granger Causality Tests
Date: 03/01/24   Time: 21:51
Sample: 1990 2021
Lags: 2
=====================================================================
 Null Hypothesis:                          Obs   F-Statistic    Prob.
=====================================================================
 GOV does not Granger Cause OUTPUT          30     2.05789     0.1488
 OUTPUT does not Granger Cause GOV                 2.25496     0.1258
=====================================================================
 GCF does not Granger Cause OUTPUT          30     0.34367     0.7125
 OUTPUT does not Granger Cause GCF                 4.55422     0.0206
=====================================================================
 EMP does not Granger Cause OUTPUT          30     0.02555     0.9748
 OUTPUT does not Granger Cause EMP                 0.29474     0.7473
=====================================================================
 GCF does not Granger Cause GOV             30     0.24730     0.7828
 GOV does not Granger Cause GCF                    4.54189     0.0208
=====================================================================
 EMP does not Granger Cause GOV             30     3.23709     0.0562
 GOV does not Granger Cause EMP                    1.76942     0.1911
=====================================================================
 EMP does not Granger Cause GCF             30     0.25755     0.7750
 GCF does not Granger Cause EMP                    0.05734     0.9444
=====================================================================
```

Appendix G: Ramsey Reset Test

South Africa

```
Ramsey RESET Test
Equation: UNTITLED
Omitted Variables: Squares of fitted values
Specification: OUTPUT OUTPUT(-1) OUTPUT(-2) OUTPUT(-3) OUTPUT(
      -4) GOV GOV(-1) LGFC LGFC(-1) LGFC(-2) LGFC(-3) EMP EMP(-1)
      EMP(-2) EMP(-3) C
==========================================================================

                           Value         df       Probability
t-statistic              1.413425        12         0.1829
F-statistic              1.997770     (1, 12)       0.1829
Likelihood ratio         4.311759         1         0.0378
==========================================================================

F-test summary:
                          Sum of Sq.      df      Mean Squares
Test SSR                 0.037432         1        0.037432
Restricted SSR           0.262272        13        0.020175
Unrestricted SSR         0.224840        12        0.018737
==========================================================================

LR test summary:
                           Value
Restricted LogL          25.65780
Unrestricted LogL        27.81368
==========================================================================


Unrestricted Test Equation:
Dependent Variable: OUTPUT
Method: Least Squares
Date: 03/02/24   Time: 12:42
Sample: 1994 2021
Included observations: 28
==========================================================================
        Variable          Coefficient    Std. Error    t-Statistic     Prob.
==========================================================================

       OUTPUT(-1)          -0.389400     0.542210     -0.718172      0.4864
       OUTPUT(-2)          -0.011902     0.192053     -0.061973      0.9516
       OUTPUT(-3)           0.059069     0.249333      0.236907      0.8167
       OUTPUT(-4)           0.329420     0.409864      0.803731      0.4372
          GOV              -1.067393     1.274884     -0.837247      0.4188
         GOV(-1)           -0.398416     0.388813     -1.024699      0.3257
          LGFC             -3.271218     3.832865     -0.853465      0.4101
        LGFC(-1)            0.345893     0.843338      0.410148      0.6889
        LGFC(-2)            0.876960     1.341731      0.653603      0.5257
        LGFC(-3)           -2.350613     3.055517     -0.769301      0.4566
          EMP              -0.457482     0.527638     -0.867038      0.4029
         EMP(-1)           -0.282790     0.377466     -0.749181      0.4682
         EMP(-2)            0.301474     0.388463      0.776068      0.4527
         EMP(-3)           -0.208300     0.303661     -0.685962      0.5058
           C               23.41092     26.18198       0.894161      0.3888
       FITTED^2             0.491746     0.347911      1.413425      0.1829
==========================================================================

R-squared                   0.962873    Mean dependent var       2.539073
Adjusted R-squared          0.916465    S.D. dependent var       0.473599
S.E. of regression          0.136882    Akaike info criterion   -0.843834
Sum squared resid           0.224840    Schwarz criterion       -0.082575
Log likelihood              27.81368    Hannan-Quinn criter.    -0.611110
F-statistic                 20.74773    Durbin-Watson stat       2.012676
Prob(F-statistic)           0.000003
==========================================================================
```

Botswana

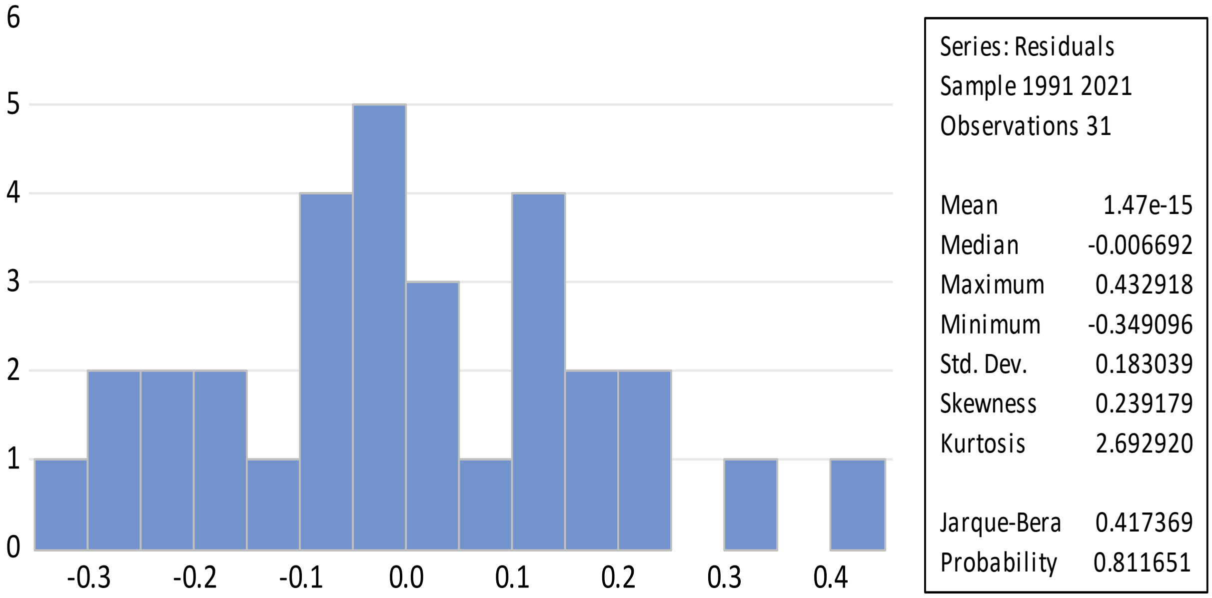
```
Ramsey RESET Test
Equation: UNTITLED
Omitted Variables: Squares of fitted values
Specification: GOV GOV(-1) LGCF LGCF(-1) EMP EMP(-1) EMP(-2)
      OUTPUT OUTPUT(-1) OUTPUT(-2) OUTPUT(-3) C
==========================================================================

                         Value          df        Probability
t-statistic             0.290774        17          0.7747
F-statistic             0.084549      (1, 17)       0.7747
Likelihood ratio        0.143874        1           0.7045
==========================================================================

F-test summary:
                        Sum of Sq.      df       Mean Squares
Test SSR                0.037790        1          0.037790
Restricted SSR          7.635981        18         0.424221
Unrestricted SSR        7.598191        17         0.446952
==========================================================================

LR test summary:
                         Value
Restricted LogL         -21.80006
Unrestricted LogL       -21.72813
==========================================================================


Unrestricted Test Equation:
Dependent Variable: GOV
Method: Least Squares
Date: 07/12/23   Time: 15:38
Sample: 1993 2021
Included observations: 29
Huber-White-Hinkley (HC1) heteroskedasticity consistent standard errors
      and covariance
==========================================================================
       Variable          Coefficient    Std. Error    t-Statistic    Prob.
==========================================================================

       GOV(-1)           -0.001093      0.178724      -0.006118     0.9952
        LGCF              1.290001      5.825045       0.221458     0.8274
       LGCF(-1)          -2.968832      12.19962      -0.243354     0.8106
         EMP              0.091492      0.391953       0.233426     0.8182
       EMP(-1)           -0.324854      1.343720      -0.241757     0.8119
       EMP(-2)            0.133165      0.625533       0.212883     0.8339
       OUTPUT             0.055625      0.578525       0.096149     0.9245
      OUTPUT(-1)         -0.082162      0.513732      -0.159931     0.8748
      OUTPUT(-2)         -0.334312      1.401564      -0.238528     0.8143
      OUTPUT(-3)          0.231464      1.029923       0.224739     0.8249
          C               11.29961      35.03561       0.322518     0.7510
       FITTED^2           0.072463      0.201666       0.359319     0.7238
==========================================================================

R-squared                 0.691793    Mean dependent var        4.144138
Adjusted R-squared        0.492365    S.D. dependent var        0.938329
S.E. of regression        0.668545    Akaike info criterion     2.326078
Sum squared resid         7.598191    Schwarz criterion         2.891855
Log likelihood           -21.72813    Hannan-Quinn criter.      2.503272
F-statistic               3.468889    Durbin-Watson stat        1.852252
Prob(F-statistic)         0.010696    Wald F-statistic          9.649105
Prob(Wald F-statistic)    0.000027
==========================================================================
```

Namibia

```
Ramsey RESET Test
Equation: UNTITLED
Omitted Variables: Squares of fitted values
Specification: OUTPUT GOV GCF EMP  C
==========================================================================

                            Value          df        Probability
t-statistic               0.305305         27          0.7625
F-statistic               0.093211      (1, 27)        0.7625
Likelihood ratio          0.110282          1          0.7398
==========================================================================

F-test summary:
                          Sum of Sq.       df      Mean Squares
Test SSR                  0.106301          1        0.106301
Restricted SSR            30.89794         28        1.103498
Unrestricted SSR          30.79164         27        1.140431
==========================================================================

LR test summary:
                            Value
Restricted LogL           -44.84529
Unrestricted LogL         -44.79015
==========================================================================


Unrestricted Test Equation:
Dependent Variable: OUTPUT
Method: Least Squares
Date: 03/01/24   Time: 22:21
Sample: 1990 2021
Included observations: 32
==========================================================================
        Variable          Coefficient    Std. Error    t-Statistic    Prob.
==========================================================================

          GOV              1.720908      4.532173      0.379709      0.7071
          GCF             -0.426235      1.125090     -0.378845      0.7078
          EMP              0.130222      0.342922      0.379743      0.7071
           C               26.52839      58.66227      0.452222      0.6547
        FITTED^2          -0.238688      0.781801     -0.305305      0.7625
==========================================================================

R-squared                 0.208789    Mean dependent var         8.659532
Adjusted R-squared        0.091573    S.D. dependent var         1.120442
S.E. of regression        1.067910    Akaike info criterion      3.111884
Sum squared resid         30.79164    Schwarz criterion          3.340905
Log likelihood           -44.79015    Hannan-Quinn criter.       3.187798
F-statistic               1.781231    Durbin-Watson stat         1.321879
Prob(F-statistic)         0.161754
==========================================================================
```

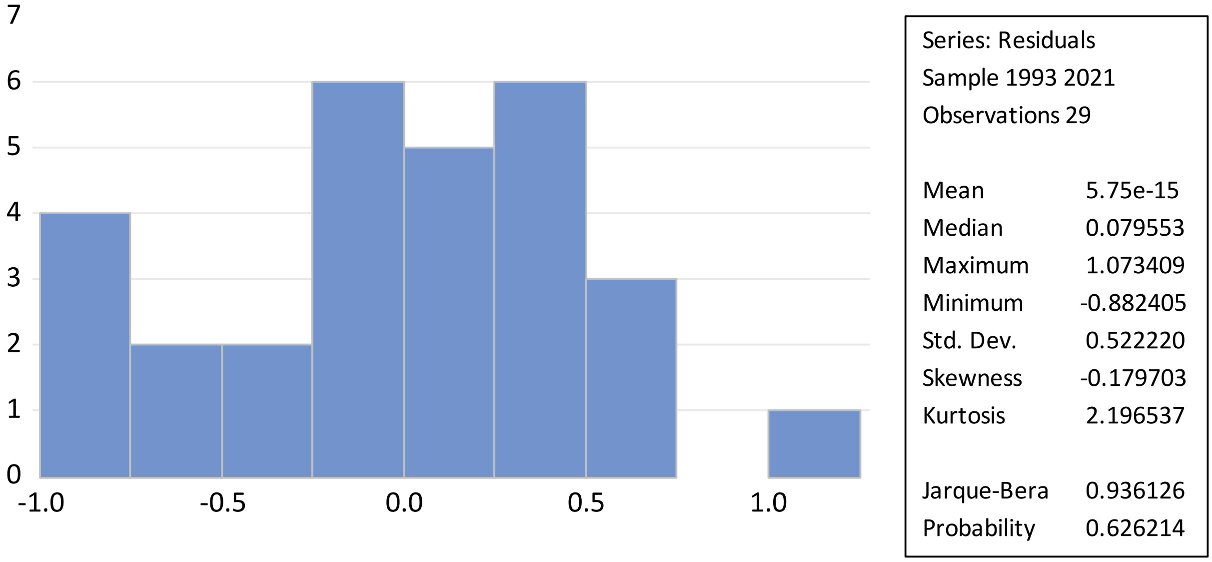
Appendix H: Diagnostics Tests, Histogram

South Africa



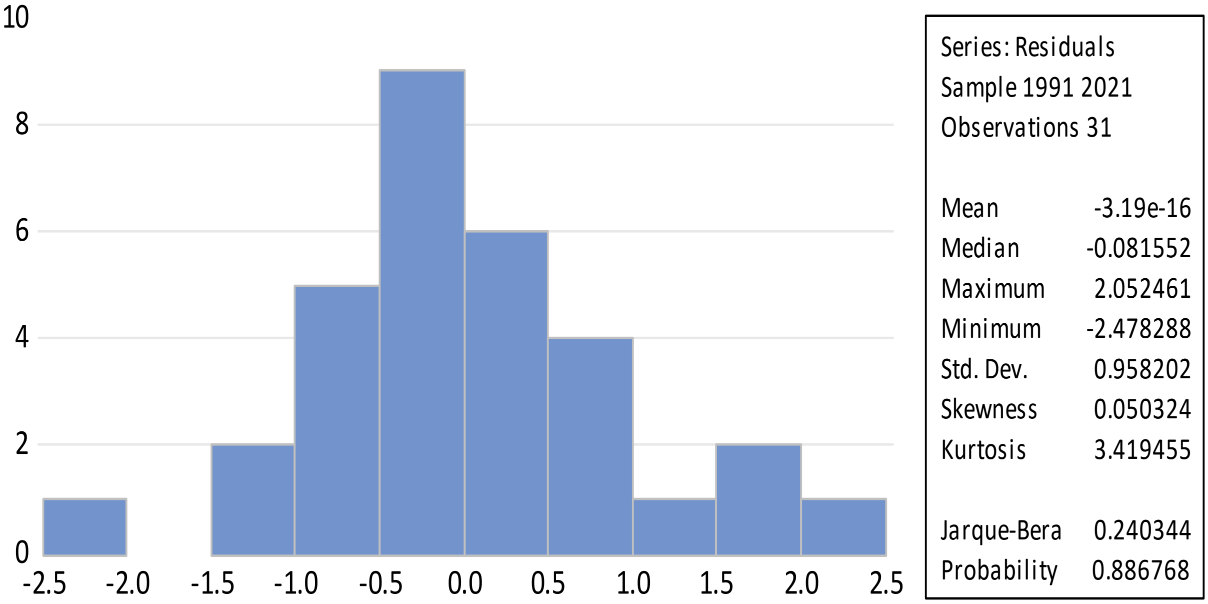
```
Series: Residuals
Sample 1991 2021
Observations 31

Mean          1.47e-15
Median       -0.006692
Maximum       0.432918
Minimum      -0.349096
Std. Dev.     0.183039
Skewness      0.239179
Kurtosis      2.692920

Jarque-Bera   0.417369
Probability   0.811651
```

Botswana



```
Series: Residuals
Sample 1993 2021
Observations 29

Mean          5.75e-15
Median        0.079553
Maximum       1.073409
Minimum      -0.882405
Std. Dev.     0.522220
Skewness     -0.179703
Kurtosis      2.196537

Jarque-Bera   0.936126
Probability   0.626214
```

Namibia



Appendix I: Diagnostics Test, Breusch-Godfrey LM test

South Africa

```
Breusch-Godfrey Serial Correlation LM Test:
Null hypothesis: No serial correlation at up to 2 lags
=====================================================================
F-statistic              0.835356    Prob. F(2,23)              0.4465
Obs*R-squared            2.099333    Prob. Chi-Square(2)        0.3501
=====================================================================

Test Equation:
Dependent Variable: RESID
Method: ARDL
Date: 03/02/24   Time: 12:58
Sample: 1991 2021
Included observations: 31
Presample missing value lagged residuals set to zero.
=====================================================================
        Variable         Coefficient    Std. Error    t-Statistic    Prob.
=====================================================================

      OUTPUT(-1)          -0.002310      0.287595     -0.008031     0.9937
          GOV              0.045041      0.101472      0.443875     0.6613
        GOV(-1)           -0.019026      0.096050     -0.198086     0.8447
          LGFC            -0.034463      0.407236     -0.084626     0.9333
          EMP             -0.004737      0.075571     -0.062680     0.9506
           C               0.125256      1.896807      0.066035     0.9479
       RESID(-1)           0.089236      0.337867      0.264115     0.7940
       RESID(-2)          -0.300878      0.268010     -1.122641     0.2732
=====================================================================
R-squared                0.067720    Mean dependent var        1.47E-15
Adjusted R-squared      -0.216017    S.D. dependent var        0.183039
S.E. of regression       0.201843    Akaike info criterion    -0.145016
Sum squared resid        0.937035    Schwarz criterion         0.225045
Log likelihood           10.24774    Hannan-Quinn criter.     -0.024385
F-statistic              0.238673    Durbin-Watson stat        1.895781
Prob(F-statistic)        0.970919
=====================================================================
```

Botswana

```
Breusch-Godfrey Serial Correlation LM Test:
Null hypothesis: No serial correlation at up to 2 lags
==========================================================================
F-statistic             0.497000    Prob. F(2,16)                  0.6174
Obs*R-squared           1.696244    Prob. Chi-Square(2)            0.4282
==========================================================================


Test Equation:
Dependent Variable: RESID
Method: ARDL
Date: 07/12/23   Time: 15:42
Sample: 1993 2021
Included observations: 29
Presample missing value lagged residuals set to zero.
==========================================================================
        Variable          Coefficient    Std. Error    t-Statistic    Prob.
==========================================================================

         GOV(-1)           -0.156564      0.317995     -0.492346     0.6292
          LGCF              0.004657      2.008038      0.002319     0.9982
        LGCF(-1)           -0.541675      2.597004     -0.208577     0.8374
           EMP             -0.054570      0.173291     -0.314905     0.7569
         EMP(-1)            0.093374      0.291558      0.320258     0.7529
         EMP(-2)           -0.097053      0.236792     -0.409866     0.6873
         OUTPUT             0.039338      0.441574      0.089086     0.9301
       OUTPUT(-1)          -0.157173      0.484499     -0.324404     0.7498
       OUTPUT(-2)           0.107148      0.467646      0.229121     0.8217
       OUTPUT(-3)          -0.111480      0.507535     -0.219649     0.8289
            C               4.135738      10.08473      0.410099     0.6872
        RESID(-1)           0.275396      0.451198      0.610367     0.5502
        RESID(-2)          -0.260610      0.285363     -0.913259     0.3747
==========================================================================
R-squared               0.058491    Mean dependent var           5.75E-15
Adjusted R-squared     -0.647640    S.D. dependent var           0.522220
S.E. of regression      0.670324    Akaike info criterion        2.339733
Sum squared resid       7.189343    Schwarz criterion            2.952659
Log likelihood         -20.92613    Hannan-Quinn criter.         2.531693
F-statistic             0.082833    Durbin-Watson stat           1.920429
Prob(F-statistic)       0.999952
==========================================================================
```

Namibia

```
Breusch-Godfrey Serial Correlation LM Test:
Null hypothesis: No serial correlation at up to 2 lags
=====================================================================

F-statistic              0.998555   Prob. F(2,24)               0.3832
Obs*R-squared            2.381434   Prob. Chi-Square(2)         0.3040
=====================================================================


Test Equation:
Dependent Variable: RESID
Method: ARDL
Date: 03/02/24   Time: 11:32
Sample: 1991 2021
Included observations: 31
Presample missing value lagged residuals set to zero.
=====================================================================
       Variable          Coefficient   Std. Error   t-Statistic   Prob.
=====================================================================

      OUTPUT(-1)           0.776197     0.845921     0.917576    0.3680
          GOV             -0.060749     0.254367    -0.238825    0.8133
          GCF              0.029286     0.123840     0.236485    0.8151
          EMP             -0.022024     0.034303    -0.642047    0.5269
           C              -6.567039     8.396905    -0.782079    0.4418
       RESID(-1)          -0.752424     0.816568    -0.921447    0.3660
       RESID(-2)          -0.512918     0.366802    -1.398350    0.1748
=====================================================================

R-squared                0.076820   Mean dependent var       -3.19E-16
Adjusted R-squared      -0.153974   S.D. dependent var        0.958202
S.E. of regression       1.029332   Akaike info criterion     3.091376
Sum squared resid        25.42857   Schwarz criterion         3.415180
Log likelihood          -40.91633   Hannan-Quinn criter.      3.196928
F-statistic              0.332852   Durbin-Watson stat        1.929260
Prob(F-statistic)        0.912859
=====================================================================
```

Appendix J: Diagnostic Test, ARCH Test

South Africa

```
Heteroskedasticity Test: ARCH
==========================================================================
F-statistic              0.080857   Prob. F(1,28)                  0.7782
Obs*R-squared            0.086383   Prob. Chi-Square(1)            0.7688
==========================================================================

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 03/02/24   Time: 13:06
Sample (adjusted): 1992 2021
Included observations: 30 after adjustments
Huber-White-Hinkley (HC1) heteroskedasticity consistent standard errors
    and covariance
==========================================================================
        Variable          Coefficient    Std. Error    t-Statistic    Prob.
==========================================================================
           C                 0.025977      0.007241       3.587427   0.0013
      RESID^2(-1)            0.039827      0.124513       0.319862   0.7514
==========================================================================
R-squared                0.002879   Mean dependent var           0.027256
Adjusted R-squared      -0.032732   S.D. dependent var           0.032348
S.E. of regression       0.032873   Akaike info criterion       -3.928007
Sum squared resid        0.030257   Schwarz criterion           -3.834593
Log likelihood           60.92010   Hannan-Quinn criter.        -3.898123
F-statistic              0.080857   Durbin-Watson stat           1.696346
Prob(F-statistic)        0.778231
==========================================================================
```

Botswana

```
Heteroskedasticity Test: ARCH
==========================================================================
F-statistic             0.727497    Prob. F(1,27)                   0.4012
Obs*R-squared           0.760885    Prob. Chi-Square(1)             0.3831
==========================================================================

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 03/02/24   Time: 12:36
Sample (adjusted): 1993 2021
Included observations: 29 after adjustments
==========================================================================
        Variable         Coefficient    Std. Error    t-Statistic   Prob.
==========================================================================
            C             0.072585      0.032131      2.258997     0.0322
       RESID^2(-1)        0.159683      0.187215      0.852935     0.4012
==========================================================================
R-squared               0.026237    Mean dependent var            0.087918
Adjusted R-squared     -0.009828    S.D. dependent var            0.142716
S.E. of regression      0.143415    Akaike info criterion        -0.979672
Sum squared resid       0.555335    Schwarz criterion            -0.885376
Log likelihood          16.20524    Hannan-Quinn criter.         -0.950140
F-statistic             0.727497    Durbin-Watson stat            1.933623
Prob(F-statistic)       0.401199
==========================================================================
```

Namibia

```
Heteroskedasticity Test: ARCH
=====================================================================
F-statistic            0.077763    Prob. F(1,28)                0.7824
Obs*R-squared          0.083087    Prob. Chi-Square(1)          0.7732
=====================================================================

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 03/02/24   Time: 11:45
Sample (adjusted): 1992 2021
Included observations: 30 after adjustments
=====================================================================
      Variable          Coefficient    Std. Error   t-Statistic   Prob.
=====================================================================
          C              0.934387      0.313620     2.979356     0.0059
     RESID^2(-1)        -0.052627      0.188720    -0.278861     0.7824
=====================================================================
R-squared              0.002770    Mean dependent var        0.887674
Adjusted R-squared    -0.032846    S.D. dependent var        1.428934
S.E. of regression     1.452212    Akaike info criterion     3.648393
Sum squared resid      59.04972    Schwarz criterion         3.741806
Log likelihood        -52.72589    Hannan-Quinn criter.      3.678277
F-statistic            0.077763    Durbin-Watson stat        1.520539
Prob(F-statistic)      0.782401
=====================================================================
```